

**CODE CASES**

**2019**

ASME Boiler and  
Pressure Vessel Code  
An International Code

**Boilers and  
Pressure Vessels**

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AN INTERNATIONAL CODE

# 2019 ASME Boiler & Pressure Vessel Code

2019 Edition

July 1, 2019

## CODE CASES

## Boilers and Pressure Vessels

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The American Society of  
Mechanical Engineers

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## LIST OF SECTIONS

### SECTIONS

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  - Part C — Specifications for Welding Rods, Electrodes, and Filler Metals
  - Part D — Properties (Customary)
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- III Rules for Construction of Nuclear Facility Components
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## INTERPRETATIONS

Interpretations are issued in real time in ASME's Interpretations Database at <http://go.asme.org/Interpretations>. Historical BPVC interpretations may also be found in the Database.

## CODE CASES

The Boiler and Pressure Vessel Code committees meet regularly to consider proposed additions and revisions to the Code and to formulate Cases to clarify the intent of existing requirements or provide, when the need is urgent, rules for materials or constructions not covered by existing Code rules. Those Cases that have been adopted will appear in the appropriate 2019 Code Cases book: "Boilers and Pressure Vessels" or "Nuclear Components." Each Code Cases book is updated with seven Supplements. Supplements will be sent or made available automatically to the purchasers of the Code Cases books up to the publication of the 2021 Code. Code Case users can check the current status of any Code Case at <http://go.asme.org/BPVCCDatabase>. Code Case users can also view an index of the complete list of Boiler and Pressure Vessel Code Cases and Nuclear Code Cases at <http://go.asme.org/BPVCC>.

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## SUMMARY OF CHANGES

The 2019 Edition of the Code Cases includes Code Case actions published through Supplement 7 to the 2017 Edition.

Changes given below are identified on the pages by a margin note, **(19)**, placed next to the affected area. Errata, if any, are identified by a margin note, **(E)**, placed next to the affected area.

The Record Numbers listed below are explained in more detail in “List of Changes in Record Number Order” following this Summary of Changes.

<i>Page</i>	<i>Location</i>	<i>Change (Record Number)</i>
iv	List of Sections	Updated
xi	Notes to Numeric Index	Revised
xiii	Numeric Index	Updated
xvii	Subject Index	Updated
xxvii	Index of Material Specifications Referred to in Cases	Updated
1 (1750-28)	1750-28	Revised (15-2588)
1 (1855-2)	1855-2	Revised (18-429)
1 (2130-4)	2130-4	Annulled (10-865)
1 (2151-3)	2151-3	Revised (18-1067)
1 (2235-14)	2235-14	Revised (18-1248)
1 (2309)	2309	Annulled (17-2107)
1 (2468-2)	2468-2	Revised (18-1068)
1 (2473-2)	2473-2	Revised (17-3037)
1 (2476)	2476	Annulled (17-2108)
1 (2496-4)	2496-4	Revised (18-1069)
1 (2594-2)	2594-2	Revised (18-1070)
1 (2602-1)	2602-1	Annulled (17-2112)
1 (2638)	2638	Annulled (17-2109)
1 (2671-2)	2671-2	Revised (17-3042)
1 (2674-1)	2674-1	Revised (18-1071)
1 (2681-1)	2681-1	Revised (18-1072)
1 (2702-5)	2702-5	Revised (17-834)
1 (2711-1)	2711-1	Revised (18-1073)
1 (2727-1)	2727-1	Revised (18-1074)
1 (2728-1)	2728-1	Revised (18-1075)
1 (2737-2)	2737-2	Revised (18-1076)
1 (2740-1)	2740-1	Revised (18-1077)

<i>Page</i>	<i>Location</i>	<i>Change (Record Number)</i>
1 (2748-2)	2748-2	Revised (18-1078)
1 (2749-2)	2749-2	Revised (18-1079)
1 (2777-1)	2777-1	Revised (17-1739)
1 (2781-1)	2781-1	Revised (17-2273)
1 (2807-1)	2807-1	Revised (18-490)
1 (2815-1)	2815-1	Revised (18-1081)
1 (2818)	2818	Annulled (17-2110)
1 (2831-1)	2831-1	Revised (18-1082)
1 (2840-1)	2840-1	Revised (18-1083)
1 (2842-1)	2842-1	Revised (18-1103)
1 (2890-1)	2890-1	Revised (17-2547)
1 (2897-1)	2897-1	Revised (18-1205)
1 (2924)	2924	Added (18-987)
1 (2933)	2933	Added (17-2787)
1 (2934)	2934	Added (17-2786)
1 (2935)	2935	Added (18-962)
1 (2936)	2936	Added (18-1144)
1 (2937)	2937	Added (18-632)
1 (2938)	2938	Added (17-3371)
1 (2939)	2939	Added (17-2883)
1 (2940)	2940	Added (18-1959)
1 (2941)	2941	Added (17-1778)
1 (2942)	2942	Added (17-1481)
1 (2943)	2943	Added (18-1536)
1 (2944)	2944	Added (18-220)
1 (2945)	2945	Added (18-795)
1 (2947)	2947	Added (18-2436)
1 (2948)	2948	Added (18-2228)

**NOTE:** Cases 1518-5 (17-982), 2564-5 (10-322), and 2567(15-1182) have been incorporated into their respective Sections of the 2019 Edition and will be annulled six months after publication.

## LIST OF CHANGES IN RECORD NUMBER ORDER

Record Number	Change
10-322	Incorporated Case 2564-5 into Section VIII, Division 3, and will annul Case 2564-5 six months after publication of the 2019 edition.
10-865	Annulled Case 2130.
15-1182	Incorporated Case 2567 into Section VIII, Division 3 and will annul Case 2567 six months after publication of the 2019 edition.
15-2588	Revised Case 1750-27, Table 1, for ASTM B365 and B708, changed "R04200, R04210, R04251, and R04261" to "R05200, R05400, R05255, and R05252." In Table 1, removed Note (2) from in the Maximum Pressure Design Basis column for ASTM B365 and B708 and replaced with "no limit;" for ASTM A576, deleted "max" from "20°F to 650°F" in the Permissible Design Temperature column.
17-834	Revised Case 2702 to add ASTM B637, change solution annealing time, apply new welding WPS and WPQ, exempt PWHT to join non-load bearing fins and re-write paragraph on marking and the MDR.
17-982	Incorporated Case 1518-5 into UW-50 and will annul Case 1518-5 six months after publication of the 2019 edition.
17-1481	Added Case 2942 to add a new design configuration (thin tube wall and/or limited weld access) tube-to-tubesheet welds code case.
17-1739	Revised Case 2777 to include Section VIII, Division 1 and Section VIII, Division 2 for applicability. Added (a)(10) to address the joint efficiency factor.
17-1778	Added Case 2941 to permit waiving the repetition of mechanical testing of parts formed from normalized plate material and renormalized after forming, when the holding time at normalizing temperature of the test specimen is less than "80% of time at temperature" of the two normalizing cycles.
17-2107	Annulled Case 2309 on alternative rules for ultrasonic examination of cladding and base metal clad interfaces.
17-2108	Annulled Case 2476 on radiography using phosphor imaging plate.
17-2109	Annulled Case 2638 on alternative piping calibration blocks.
17-2110	Annulled Case 2818 on acoustic pulse reflectometry (APR) examination method that may be used for examination of heat exchanger tubing and other tubing and piping.
17-2112	Annulled Case 2602-1 on dry film storage of digital radiographic images.
17-2273	Revised Case 2781 by adding SI equation to Table 2 to accurately measure elongation at all thicknesses.
17-2547	Revised Case 2890 to reflect the correct metric equation to measure elongation in Table 2, added new specifications to Table 3 and added a sentence in para. (i) that allows qualifications under an earlier edition do not need to be requalified with new Code Case edition to show weldability does not change.
17-2786	Added Case 2934 for use of alloy SUS444TP pipe in accordance with JIS G 3459:2016 in the construction of heating boilers.
17-2787	Added Case 2933 for use of alloy SUS444TB tube in accordance with JIS G 3463:2012 in the construction of heating boilers.
17-2883	Added Case 2939 for use of ASTM A372/A372M-16, Grade N, Classes 100 and 120 and Grade P, Classes 100 and 120.
17-3037	Revised Case 2473-1 to allow for use by Section I. This filler metal has not been assigned an F-No in in the 2017 Edition of Section IX.
17-3042	Revised Case 2671 by adding Section I to applicability.
17-3371	Added Case 2938 for hydrogen crack growth rate constants, $K_{IH}$ , and exemption to critical crack size determination per KD-1030(a) for SA-372 and SA-723 steels.
18-220	Added Case 2944 permitting pressure vessels being designed and constructed to the same design specifications to follow a single UDS, and their compliance to the UDS and code rules to be documented on a single MDR.

Record Number	Change
18-429	Revised Case 1855 by adding item (c) to require postweld heat treatment to the time and temperature requirements of Section VIII, Div. 1 unless the welds satisfy the exemptions for PWHT in Section I and Section VIII, Division 1. Revised Manufacturer's Data Report reference to Section VIII in (c)(3).
18-490	Revised Case 2807 to include provisions for relaxing post forming heat treatment requirements for thin walled tubing and pipe.
18-632	Added Case 2937 to allow additional method of proof testing (bursting test) for HLW water heaters and storage tanks made from stainless steels.
18-795	Added Case 2945 to address multiple process welding procedures.
18-962	Added Case 2935 on manual UT examination.
18-987	Added Case 2924 for heat-affected zone impact testing in weld procedure qualification.
18-1067	Revised Case 2151 to limit the application to Section VIII, Division 2, Class 2 only.
18-1068	Revised Case 2468-1 to limit the application to Section VIII, Division 2, Class 2 only.
18-1069	Revised Case 2496-3 to limit the application to Section VIII, Division 2, Class 2 only with regard to VIII Division 2.
18-1070	Revised Case 2594-1 to limit the application to Section VIII, Division 2, Class 2 only.
18-1071	Revised Case 2674 to limit the application to Section VIII, Division 2, Class 2 only.
18-1072	Revised Case 2681 to limit the application to Section VIII, Division 2, Class 2 only.
18-1073	Revised Case 2711 to limit the application to Section VIII, Division 2, Class 2 only.
18-1074	Revised Case 2727 to limit the application to Section VIII, Division 2, Class 2 only.
18-1075	Revised Case 2728 to limit the application to Section VIII, Division 2, Class 2 only.
18-1076	Revised Case 2737-1 to limit the application to Section VIII, Division 2, Class 2 only.
18-1077	Revised Case 2740 to limit the application to Section VIII, Division 2, Class 2 only.
18-1078	Revised Case 2748-1 to limit the application to Section VIII, Division 2, Class 2 only.
18-1079	Revised Case 2749-1 to limit the application to Section VIII, Division 2, Class 2 only.
18-1081	Revised Case 2815 to limit the application to Section VIII, Division 2, Class 2 only.
18-1082	Revised Case 2831 to limit the application to Section VIII, Division 2, Class 2 only with regard to VIII, Division 2.
18-1083	Revised Case 2840 to limit the application to Section VIII, Division 2, Class 2 only with regard to VIII, Division 2.
18-1103	Revised Case 2842 to limit the application to Section VIII, Division 2, Class 2 only with regard to VIII Division 2.
18-1144	Added Case 2936 to address boron modified ASTM A372/A372M-16, Grade J, Class 1102 material with the addition of 5 to 20 ppm boron.
18-1205	Revised Case 2897 to add Section I to applicability.
18-1248	Revised Case 2235-13 to remove Section XII applicability.
18-1536	Added Case 2943 that provides the allowable stress basis for Section VIII, Division 2, Class 1 vessels with design temperatures in the creep range.
18-1959	Added Case 2940 to address assignment of ISO material group 11.1 to Examination Groups 1b, 2b, or 3b.
18-2228	Added Case 2948 to allow immediate use of corresponding revisions in Section VIII, Divisions 1 and 2 that clarified intent of the code regarding removal of HAZ impact test specimen sets.
18-2436	Added Case 2947 to eliminate maximum depth of bevel on tubes attached by welding stipulated in HLW-413.

# CROSS-REFERENCING AND STYLISTIC CHANGES IN THE BOILER AND PRESSURE VESSEL CODE

There have been structural and stylistic changes to BPVC, starting with the 2011 Addenda, that should be noted to aid navigating the contents. The following is an overview of the changes:

## Subparagraph Breakdowns/Nested Lists Hierarchy

- First-level breakdowns are designated as (a), (b), (c), etc., as in the past.
- Second-level breakdowns are designated as (1), (2), (3), etc., as in the past.
- Third-level breakdowns are now designated as (-a), (-b), (-c), etc.
- Fourth-level breakdowns are now designated as (-1), (-2), (-3), etc.
- Fifth-level breakdowns are now designated as (+a), (+b), (+c), etc.
- Sixth-level breakdowns are now designated as (+1), (+2), etc.

## Footnotes

With the exception of those included in the front matter (roman-numbered pages), all footnotes are treated as endnotes. The endnotes are referenced in numeric order and appear at the end of each BPVC section/subsection.

## Submittal of Technical Inquiries to the Boiler and Pressure Vessel Standards Committees

*Submittal of Technical Inquiries to the Boiler and Pressure Vessel Standards Committees* has been moved to the front matter. This information now appears in all Boiler Code Sections (except for Code Case books).

## Cross-References

It is our intention to establish cross-reference link functionality in the current edition and moving forward. To facilitate this, cross-reference style has changed. Cross-references within a subsection or subarticle will not include the designator/identifier of that subsection/subarticle. Examples follow:

- *(Sub-)Paragraph Cross-References.* The cross-references to subparagraph breakdowns will follow the hierarchy of the designators under which the breakdown appears.
  - If subparagraph (-a) appears in X.1(c)(1) and is referenced in X.1(c)(1), it will be referenced as (-a).
  - If subparagraph (-a) appears in X.1(c)(1) but is referenced in X.1(c)(2), it will be referenced as (1)(-a).
  - If subparagraph (-a) appears in X.1(c)(1) but is referenced in X.1(e)(1), it will be referenced as (c)(1)(-a).
  - If subparagraph (-a) appears in X.1(c)(1) but is referenced in X.2(c)(2), it will be referenced as X.1(c)(1)(-a).
- *Equation Cross-References.* The cross-references to equations will follow the same logic. For example, if eq. (1) appears in X.1(a)(1) but is referenced in X.1(b), it will be referenced as eq. (a)(1)(1). If eq. (1) appears in X.1(a)(1) but is referenced in a different subsection/subarticle/paragraph, it will be referenced as eq. X.1(a)(1)(1).

## NOTES TO NUMERIC INDEX

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- All Code Cases remain available for use until annulled by the ASME Boiler and Pressure Vessel Standards Committees. Code Cases will be reviewed routinely for possible incorporation into the body of the ASME Boiler and Pressure Vessel Code.
- Supplement 7 is the last supplement published for the 2017 edition. Supplement 8 is incorporated into the 2019 edition.
- Cases may be used beginning with the date of approval shown on the Case.
- Annulled Cases will remain in the Numeric Index and Subject Index until the next Edition, at which time they will be deleted.
- Newly revised cases supersede previous versions. Previous code case number will be added in the "Annulled Date/Supersedes" column next to the newly revised code case.
- The digit following a Case Number is used to indicate the number of times a Case has been revised.
- The Cases are arranged in numerical order, and each page of a Case is identified at the top with the appropriate Case Number.

### *Legend of Abbreviations*

Supp. = Supplement

R = Reinstated

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		SA-516/SA-516M	2576, 2624
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*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 1325-18  
Nickel-Iron-Chromium Alloys 800 and 800H (UNS  
N08800 and N08810) and Nickel-Iron-Chromium-  
Molybdenum-Copper Low-Carbon Alloy (UNS N08028)  
Section I**

*Inquiry:* May Nickel-Iron-Chromium Alloys 800 and 800H (UNS N08800 and N08810) and nickel-iron-chromium-molybdenum-copper low-carbon alloy UNS N08028 conforming to the specifications listed in [Table 1](#) be used for water wetted service in Section I construction?

*Reply:* It is the opinion of the Committee that nickel-iron-chromium and nickel-iron-chromium-molybdenum-copper low-carbon alloy forms as shown in [Table 1](#) may be used for water wetted service in Section I construction provided the following requirements are met.

(a) The maximum allowable design stress shall not exceed that shown in Table 1B of Section II, Part D.

(b) Welded fabrication shall conform to the applicable requirements of Section I.

(1) The procedure and performance qualifications shall be conducted as prescribed in Section IX, except that the tensile strength of the reduced section specimen shall not be less than the minimum tensile strength of the materials specified in the Inquiry.

(2) Welding on N08800 and N08810 shall be done by any welding process or combination of processes capable of meeting the requirements. Welding on N08028 shall be by the gas tungsten arc process only.

(3) Welds that are exposed to corrosive action of the contents of the vessel should have a resistance to corrosion equal to that of the base metal. The use of filler metal that will deposit weld metal with practically the same composition as the material joined is recommended. When the manufacturer is of the opinion that a physically

better joint can be made by departure from these limits, filler metal of a different composition may be used provided the strength of the weld metal at the operating temperature is not appreciably less than that of the high-alloy material to be welded, and user is satisfied that its resistance to corrosion is satisfactory for the intended service.

(4) Where welding repair of a defect is required, it shall be followed by reexamination as required in PW-11. Where a defect is removed and welding repair is not necessary, care shall be taken to contour the surface so as to eliminate any sharp notches or corners. The contoured surface shall then be reinspected by the same means originally used for locating the defect to be sure it has been completely removed.

(5) When these materials are cold formed, the rules of Section I, para. PG-19 shall apply for alloys N08800 and N08810. Other than these requirements, any other heat treatment after forming or fabrication is neither required nor prohibited, but if heat treatment is applied to alloy N08028, it shall be performed at 1975°F–2085°F (1080°C–1140°C) followed by rapid cooling.

(c) This Case number shall be shown on the Data Report.

**CAUTION: Austenitic alloys are subject to stress corrosion cracking, intergranular attack, pitting and crevice corrosion when used in boiler applications in aqueous environments. Factors that affect the susceptibility of these materials are applied or residual stress, water chemistry and deposition of solids, and material condition. Susceptibility to attack is enhanced when the material is used in a sensitized condition, or with residual cold work. Concentration of corrosive agents (e.g. chlorides, caustic, or reduced sulfur species) can occur under deposits formed on the surface of these materials, and can result in severe underdeposit wastage or cracking. For successful operation in water environments, careful attention must be paid to continuous control of water chemistry.**

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Product Specifications**

<b>Form</b>	<b>Specification</b>
<b>UNS N08800 and N08810</b>	
Seamless condenser and heat exchanger tubes	SB-163
Rod and bars	SB-408
Seamless pipe and tube	SB-407
Plate, sheet, and strip	SB-409
Welded tubes	SB-515
<b>UNS N08028</b>	
Seamless tubes	SB-668
Plate, sheet, and strip	SB-709

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**Case 1518-5**  
**Weld Joint Examination for Pneumatically Tested**  
**Pressure Vessels**  
**Section VIII, Division 1**

*Inquiry:* Under what circumstances may the weld joint examination requirements of para. UW-50 of Section VIII, Division 1, be waived for welded pressure vessels that are pneumatically tested in accordance with para. UG-100?

*Reply:* It is the opinion of the Committee that the weld joint examination requirements of para. UW-50 may be waived provided all of the following requirements are met.

(a) The maximum allowable working pressure of the vessel is no greater than 500 psig.

(b) The governing thickness for UCS materials shall be as defined in UCS-66(a).

(c) For UCS materials, the maximum governing thickness for Fig. UCS-66 Curve A materials is no greater than  $\frac{1}{2}$  in. and for Curves B, C, or D materials is no greater than 1 in.

(d) For UHA material, Austenitic Chromium nickel stainless steels 304, 304L, 316, 316L, 321, and 347, the governing thickness is no greater than  $\frac{3}{4}$  in.

(e) For UNF material, Aluminum or Aluminum Alloy 3000 Series, 5000 Series and 6061-T6, the governing thickness is no greater than 1 in.

(f) All other requirements of the Code shall apply.

(g) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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(19)

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**Case 1750-28**  
**Materials for Bodies, Bonnets, Yokes, Housings, and**  
**Holders of Pressure Relief Devices**  
**Section I; Section VIII, Division 1; Section X; Section XII**

*Inquiry:* Under what conditions and limitations may the following materials be utilized in the construction of the bodies, bonnets, and yokes of pressure relief valves, housings for breaking or buckling pin devices, and holders for rupture disks covered by the provisions of Section I; Section VIII, Division 1; Section X; and Section XII?

SA-351 Grade CK3MCuN  
 SA-352 Grade LCC  
 SA-675 Grades 50, 55, 60, 65, and 70  
 SA-995 Grade CD4MCuN  
 ASTM A108 Grades 1016, 1018, 1020, 1117, 1118, 1137, 1141, 1215, and 12L14  
 ASTM A126  
 ASTM A314 Type 303  
 ASTM A494/A494M Grades CY-40, CZ-100, and M35-1  
 ASTM A576 Grades 1040, 1042, 1045, and 1117  
 ASTM A582 Types 303 and 416  
 ASTM A744 Grade CK3MCuN  
 ASTM B16  
 ASTM B21 Alloys 464, 482, and 485  
 ASTM B85 Alloy SC84B  
 ASTM B176 Alloy C85800  
 ASTM B211 Alloy 2024 Temper T351<sup>1</sup>  
 ASTM B283 Alloys C377, C464, and C485  
 ASTM B365 Alloys R05200, R05400, R05255, and R05252  
 ASTM B371 Alloy C69700  
 ASTM B392 Alloys R04200, R04210, R04251, and R04261  
 ASTM B393 Alloys R04200, R04210, R04251, and R04261  
 ASTM B453 Alloy C34500  
 ASTM B584 Alloys C87400 and C84400  
 ASTM B708 Alloys R05200, R05400, R05255, and R05252  
 EN 1982 number CC499K, material conditions GC, GS, and GZ

EN 12164 number CW614N material conditions R400, R380, and R360

EN 12164 number CW617N, material conditions R360 and R430

EN 12165:1998 number CW617N material condition H080

*Reply:* It is the opinion of the Committee that the materials described in the Inquiry may be used in the construction of the bodies, bonnets, and yokes of pressure relief valves, housings for breaking or buckling pin devices, and holders for rupture disks, covered by the provisions of Section I; Section VIII, Division 1; Section X; and Section XII, provided the following additional requirements and limitations are met:

(a) The pressure, temperature, and size limitations of Table 1 shall apply.

(b) These materials shall not be welded, except as otherwise permitted by this Code Case.

(c) A representative finished model of each product size and design having a bonnet, body, or yoke of pressure relief valves, housings for breaking or buckling pin devices, and holders for rupture disks constructed of ASTM B16; ASTM B21 Alloys 464, 482, and 485; ASTM B176 Alloy C85800; ASTM B283 Alloys C377, C464, and C485; ASTM B371 Alloy C69700; ASTM B453 Alloy C34500; EN 1982 number CC499K material conditions GC, GS, and GZ; EN 12164 number CW614N material conditions R400, R380, and R360; EN 12164 number CW617N material conditions R360 and R430; EN 12165:1998 number CW617N material condition H080; or ASTM B584 Alloy C84400 shall be tested to determine the presence of residual stresses that might result in failure of individual parts due to stress corrosion cracking. Tests shall be conducted in accordance with ASTM B154 or ASTM B858.

(d) Material conforming to ASTM B16, ASTM B371 Alloy C69700, and ASTM B453 Alloy C34500 shall be tested to determine the presence of residual stresses that might result in failure of individual parts due to stress corrosion cracking. Tests shall be conducted in accordance with ASTM B154 or ASTM B858. The test frequency shall be as specified in SB-249.

<sup>1</sup> Temper designation T351 designates rolled or cold finished rod or bar that has been solution heat treated, then given a minimum permanent set by stretching of 1% and maximum of 3%.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

(e) Material conforming to ASTM B16 and ASTM B21 Alloys 464, 482, and 485 shall be used only in the soft and half-hard tempers.

(f) Material conforming to ASTM B584 Alloy C84400 or A108 Grades 1117, 1118, 1137, 1141, 1215, and 12L14 shall be limited in bodies, bonnets, and yokes of pressure relief valves, housings for breaking or buckling pin devices, and holders for rupture disks to use in zones subject only to secondary pressure.<sup>2</sup>

(g) Material conforming to ASTM A126 shall not be used for pressure relief valves, breaking or buckling pin devices, or rupture disks installed on vessels in lethal or flammable service.

(h) Material conforming to ASTM B85 Alloy SC84B shall be used only in air service.

(i) Material conforming to ASTM B211 Alloy 2024 Temper T351<sup>1</sup> shall not be used in Section I service.

(j) Material conforming to ASTM A108 Grades 1016, 1018, 1020, and 12L14 shall meet the fine grain limitations of ASTM A29. Each heat/lot of material shall be mechanically tested and the results reported per Supplementary Requirement S6 of ASTM A108. The results shall be reported to the purchaser (i.e., the pressure relief device manufacturer) in accordance with para. 10 of ASTM A108.

(k) Material conforming to SA-351 Grade CK3MCuN, SA-352 Grade LCC (SA-995 Grade CD4MCuN), and A744 Grade CK3MCuN may be repair welded in accordance with SA-351, SA-352, SA-995, A351, and A744 respectively.

(l) Material conforming to ASTM A494/A494M Grades CY-40, CZ-100, and M35-1, Class 1 may be repair welded in accordance with ASTM A494/A494M using welding procedures and welders qualified under Section IX.

(m) To prevent rotation after final setting, the adjustment screw may be tack welded to a valve body constructed of ASTM A576 Grade 1117 material, provided the weld is located in the secondary pressure zone of the valve body and is limited to the last thread of engagement of the threaded interface between the adjustment screw and the valve body.

(n) Material conforming to EN 1982 number CC499K shall have the GC, GS, or GZ material condition denoting casting process. Inspection lot sampling for analysis and mechanical testing is mandatory. Certification is mandatory.

(o) Material conforming to EN 12164 number CW614N shall have the R400, R380, or R360 material condition denoting mandatory tensile property requirements. Inspection lot sampling for analysis and mechanical testing is mandatory. Certification is mandatory.

(p) Material conforming to EN 12164 number CW617N shall have the R360 or R430 material condition denoting mandatory tensile property requirements. Inspection lot sampling for analysis and mechanical testing is mandatory. Certification is mandatory.

(q) Material conforming to EN 12165: 1998 number CW617N shall have the H080 material condition denoting mandatory hardness requirements. Inspection lot sampling for analysis and mechanical testing is mandatory. Certification is mandatory.

(r) The minimum 0.2% proof strength value of materials EN 12164 numbers CW614N and CW617N, condition R360 shall be 150 MPa.

(s) See Section II, Part B, Nonmandatory Appendix A for ordering information to obtain an English language copy of EN 1982, EN 12164, and EN 12165: 1998, and their references.

(t) Material conforming to SA-675 Grades 50, 55, 60, 65, and 70

(1) may be used without conforming to the requirements of Supplementary Requirement S7.1 for non-welded applications

(2) shall be supplied in one of the following requirements unless governed by UG-20(f)

(-a) if purchased to a coarse austenitic grain structure, a Charpy impact test shall be performed at -20°F and meet the requirements of Figure UG-84.1

(-b) if purchased to a fine austenitic grain structure, the material shall be normalized.

(u) All other restrictions and limitations placed on the use of these types of materials in Section I; Section VIII, Division 1; Section X; or Section XII shall be complied with.

<sup>2</sup> Secondary pressure is that existing in the body or outlet of the device during operation of the device.

**Table 1  
Limitations**

Material	Limitations		
	Maximum Pressure Design Basis	Permissible Design Temperature	Maximum Size
ASTM B371: Alloy C69700	No limit	406°F max.	Not over NPS 3
ASTM B584: Alloys C87400 and C84400:	No limit	406°F max.	Not over NPS 3
ASTM B16	No limit	406°F max.	Not over NPS 3
ASTM B21: Alloys 464, 482, and 485	No limit	406°F max.	Not over NPS 3
ASTM B176: Alloy C85800	No limit	406°F max.	Not over NPS 3
ASTM B211: Alloy 2024 Temper T351	No limit	406°F max.	Not over NPS 3
ASTM B283: Alloys C377, C464, and C485	No limit	406°F max.	Not over NPS 3
ASTM B453: Alloy C34500	No limit	406°F max.	Not over NPS 3
ASTM B85: Alloy SC84B	300 psi	150°F max.	No limit
ASTM A126	250 psi	-20°F to 450°F	No limit
ASTM A108: Grades 1117, 1118, 1137, 1141, and 1215	[Note (1)] and [Note (2)]	-20°F to 500°F	Not over NPS 2
ASTM A314: Type 303	[Note (3)]	-20°F to 500°F	Not over NPS 2
ASTM A576: Grade 1117	[Note (1)] and [Note (2)]	-20°F to 500°F	Not over NPS 2
ASTM A 582: Types 303 and 416	No limit	-20°F to 500°F	Not over NPS 2
ASTM A108: Grades 1016, 1018, and 1020	[Note (1)]	-20°F to 400°F	Not over NPS 2
ASTM A108: Grade 12L14	[Note (1)]	-20°F to 250°F	Not over NPS 2
ASTM B393: Alloys R04200, R04210, R04251, and R04261	[Note (2)]	400°F max.	No limit
ASTM B392: Alloys R04200, R04210, R04251, and R04261	[Note (2)]	400°F max.	No limit
ASTM B365: Alloys R05200, R05252, R05255, and R05400	No limit	400°F max.	No limit
ASTM B708: Alloys R05200, R05252, R05255, and R05400	No limit	400°F max.	No limit
SA-351: Grade CK3MCuN	[Note (4)]	700°F max.	No limit
SA-352: Grade LCC	[Note (4)]	-55°F to 650°F	No limit
SA-675: Grades 50, 55, 60, 65, and 70	No limit	-20°F to 500°F	Not over NPS 2
SA-995: Grade CD4MCuN	[Note (4)]	500°F max.	No limit
ASTM A494/A494M:			
Grade CZ-100	[Note (5)]	750°F max.	No limit
Grade CY-40	[Note (6)]	900°F max.	No limit
Grade M35-1	[Note (7)]	900°F max.	No limit
ASTM A576: Grades 1040, 1042, and 1045	[Note (1)]	-20°F to 650°F	No limit
ASTM A744 Grade CK3MCuN	[Note (8)]	700°F max.	No limit
EN 1982 number CC499K: material conditions GC, GS, and GZ	No limit	406°F max.	Not over NPS 3
EN 12164: number CW614N material conditions R400, R380, and R360	No limit	406°F max.	Not over NPS 3
EN 12164: number CW617N, material conditions R360 and R430	No limit	406°F max.	Not over NPS 3
EN 12165:1998 number CW617N material condition H080	No limit	406°F max.	Not over NPS 3

## NOTES:

- (1) ASME B16.5 — Class 600 Material Group 1.1 Ratings.
- (2) Use of grades to which Bi, Se, or Te have been added is prohibited.
- (3) ASME B16.5 — Class 600 Material Group 2.1 Ratings.
- (4) ASME Section II, Part D, Tables 1A and 1B allowable stresses.
- (5) ASME B16.5 — Class 600 Material Group 3.2 Ratings.
- (6) ASME B16.5 — Class 600 Material Group 3.4 Ratings.
- (7) ASME B16.5 — Class 2500 Material Group 3.4 Ratings.
- (8) ASME Section II, Part D, Table 1A (Ref. SA-351, Grade CK3MCuN allowable stresses).

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**Case 1827-3**  
**Nickel-Chromium-Iron (Alloy N06600) for**  
**Water-Wetted Service**  
**Section I**

*Inquiry:* May nickel-chromium-iron (Alloy UNS N06600) seamless condenser and heat exchanger tubes, seamless pipe and tubes, plate, sheet and strip, rod and bar, conforming to the Specifications SB-163, SB-166, SB-167, and SB-168, be used for water-wetted service in Section I construction?

*Reply:* It is the opinion of the Committee that nickel-chromium-iron (Alloy UNS N06600) conforming to the Specifications SB-163, SB-166, SB-167, and SB-168 may be used for water-wetted service in Code construction under Section I provided:

(a) They meet the chemical analysis and the minimum tensile requirements of the ASME specifications for the respective forms.

(b) The maximum allowable stress values for the material shall be those given in Table 1B of Section II, Part D.

(c) Welded fabrication shall conform to the applicable requirements of Section I.

(1) The procedure and performance qualifications shall be conducted as prescribed in Section IX.

(2) Welding shall be done by any welding process or combination of processes capable of meeting the requirements.

(3) The use of filler metal that will deposit weld metal with nominally matching composition as the material joined is recommended. When the Manufacturer is of

the opinion that a physically better joint can be made by departure from these limits, filler metal of a different composition may be used provided the strength of the weld metal at the operating temperature is not appreciably less than that of the high alloy material to be welded, and the user is satisfied that its resistance to corrosion is satisfactory for the intended service.

(4) Where welding repair of a defect is required, this shall be followed by reexamination as required in PW-11. Where a defect is removed and welding repair is not necessary, care shall be taken to contour the surface so as to eliminate any sharp notches or corners. The contoured surface shall then be reinspected by the same means originally used for locating the defect to be sure it has been completely removed.

(d) Heat treatment after forming or fabrication is neither required nor prohibited.

(e) This Case number will be shown on the Data Report.

**CAUTION: Austenitic alloys are subject to stress corrosion cracking, intergranular attack, pitting, and crevice corrosion when used in boiler applications in aqueous environments. Factors that affect the susceptibility of these materials are applied or residual stress, water chemistry and deposition of solids, and material condition. Susceptibility to attack is enhanced when the material is used in a sensitized condition, or with residual cold work. Concentration of corrosive agents (e.g., chlorides, caustic, or reduced sulfur species) can occur under deposits formed on the surface of these materials, and can result in severe underdeposit wastage or cracking. For successful operation in water environments, careful attention must be paid to continuous control of water chemistry.**

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: August 4, 2004

*Code Cases will remain available for use until annulled by the applicable Standards Committee.***Case 1849-1**  
**Gray Cast Iron Castings**  
**Section I**

*Inquiry:* May gray iron castings conforming to SA-278 Grades 20, 25, 30, and 35 be used in construction of economizer tubing under Section I rules?

*Reply:* It is the opinion of the Committee that gray iron castings conforming to SA-278 Grades 20, 25, 30, and 35 as shown in [Table 1](#) may be used for construction of economizer tubing under Section I rules under the following conditions, provided all other requirements of Section I are satisfied.

*(a) Service Restrictions*

(1) Cast iron economizer tubing shall not be used where subject to direct radiation from the furnace.

(2) The design pressure for the economizer tubing shall not exceed 250 psi (1700 kPa) at temperatures not greater than 450°F (232°C).

(3) Cast iron flanges and flanged fittings conforming to ANSI B 16.1-75, Cast Iron Pipe Flanges and Flanged Fittings, Class 125 and 250, may be used for pressures not exceeding the American National Standard ratings for temperatures not exceeding 450°F (232°C).

(4) Material shall be tested in accordance with the requirements of Section II.

(5) All castings shall be finished free from surface defects, porosity, blow holes, and warping.

(6) Mating surfaces shall be machined.

(7) All internal pressure surfaces shall be circular in form.

(8) When no rules are given and it is impractical to calculate the strength of the economizer tubing with a reasonable degree of accuracy, the design pressure shall be determined in accordance with A-22 of Section I. A factor of 10 instead of 6.67 shall be used in the formula A-22.6.3.2.2. Where previous tests were conducted by the manufacturer in the presence of the authorized inspector, he may produce certified documentation of such tests.

(9) Economizers constructed of cast iron tubing shall be hydrostatically tested by the method described in PG-99 except that the test pressure shall be two times the maximum allowable working pressure.

(10) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values for**  
**SA-278 Cast Iron**

Spec No.	Class	Tensile Strength, min., ksi (MPa)	Allowable Stress ksi (MPa) for Metal Temp. Not Exceeding
			450°F (232°C)
SA-278	20	20.0 (140)	2.0 (13.8)
SA-278	25	25.0 (170)	2.5 (17.2)
SA-278	30	30.0 (205)	3.0 (20.7)
SA-278	35	35.0 (240)	3.5 (24.1)

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Approval Date: December 18, 2018

(19)

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**Case 1855-2**  
**Section VIII, Division 1, Unfired Steam Boiler in Section I System**  
**Section I**

*Inquiry:* Code rules permit unfired steam boilers as defined in the Preamble of Section I to be constructed under the provisions of Section I or Section VIII, Division 1. If it is desired to construct an unfired steam boiler under the provisions of Section VIII, Division 1, under what conditions may it be installed in a Section I system?

*Reply:* It is the opinion of the Committee that an unfired steam boiler constructed in accordance with the rules of Section VIII, Division 1 [see UW-2(c)], may be installed in a Section I system when the requirements of PG-58, PG-59, PG-60, PG-61, and PG-67 through PG-73 of Section I, applicable to piping and protective devices, are satisfied by an appropriate Section I certificate holder, and when the following additional requirements are satisfied.

(a) When any steam drum is not an integral part of the unfired boiler it shall be constructed in accordance with Section VIII, Division 1, including UW-2(c) or in accordance with Section I.

(b) *Materials*

(1) For those vessels or chambers constructed to Section VIII, Division 1 rules, the materials shall be limited to those permitted by Section VIII, Division 1;<sup>1</sup>

(2) For those portions constructed to Section I rules, the materials shall be limited to those permitted by Section I.

(c) Welds in unfired steam boilers shall be postweld heat treated to the minimum holding time and temperature requirements of Section VIII, Division 1 unless the welds satisfy the exemptions in both Section I and Section VIII, Division 1.

(d) *Stamping and Data Reports*

(1) Those vessels or chambers constructed to Section VIII, Division 1 rules shall be stamped with the ASME Code "U" Symbol and additional marking required by UG-116, and be documented with the ASME U-1 or U-1A Data Report. A nameplate per UG-119 shall be furnished and shall be marked "Case\_\_\_."

(2) All portions constructed to the rules of Section I shall be stamped with the applicable Section I Symbol and be documented with the applicable Section I data report forms. This Case number shall be shown on the Section I master stamping.

(3) This Case number shall be shown on the Section VIII Manufacturer's Data Report for the unfired steam boiler and the Section I Master Data Report.

<sup>1</sup> Except that any nonintegral steam drum, in water or steam service, shall be constructed of materials permitted by Section I, PG-9.1.

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Approval Date: April 26, 2013

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 1876-5**  
**Design of Safety Valve Connections**  
**Section I**

*Inquiry:* For Section I construction, what design criteria may be used for boiler proper safety valve inlet connections?

*Reply:* It is the opinion of the Committee that, for Section I construction, the following design criteria may be used for safety valve inlet connections to the boiler proper:

(a) For the condition with the safety valve closed, the wall thickness of the connection shall be no less than required by the rules of PG-27 for the internal pressure using the maximum allowable stress from Table 1A of Section II, Part D.

(b) For the condition of safety valve operation (blowing steam), the combined pressure stress and bending stress from internal pressure plus valve reaction forces may exceed the allowable stresses in Table 1A of Section II, Part D, but shall not exceed the values shown in Tables 1 and 1M.

(c) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Combined Stress in Safety Valve Inlet Connection When Valve Is Blowing**

Temperature, °F	Carbon Steel, ksi [Note (1)] and [Note (2)]	1 <sup>1</sup> / <sub>4</sub> Cr- <sup>1</sup> / <sub>2</sub> Mo-Si, ksi [Note (3)]	2 <sup>1</sup> / <sub>4</sub> Cr-1Mo, ksi [Note (4)]	9Cr-1Mo-V, ksi [Note (5)]
-20 to 400	27.0	23.6	24.2	49.2
500	25.5	23.2	24.2	49.2
600	23.3	22.5	24.2	49.1
650	22.8	21.9	24.2	48.6
700	22.7	21.1	24.2	47.9
750	22.0	20.5	24.2	46.8
800	17.5	20.2	24.0	45.4
850	12.7	19.5	23.6	40.7
900	...	19.0	23.1	34.8
950	...	18.4	19.0	29.3
1000	...	17.8	14.3	24.3
1050	...	12.4	12.3	19.8
1100	...	...	9.1	15.8
1150	...	...	...	12.3
1175	...	...	...	10.7
1200	...	...	...	9.2

GENERAL NOTES:

- (a) The stress values in this table may be interpolated to determine values for intermediate temperatures.
- (b) The stress values in this table do not exceed either 90% of the yield strength at temperature or 67% of the average stress to produce rupture in 1000 hr.

NOTES:

- (1) Upon prolonged exposure to temperatures above about 800°F, the carbide phase of carbon steel may be converted to graphite.
- (2) Material shall conform to one of the following Specifications and Grades:

Specification No.	Grade or Class
SA-105	...
SA-106	B, C
SA-181	60, 70
SA-210	C, A1
SA-216	WCA, WCB, WCC
SA-266	1, 2, 3, 4

- (3) Material shall conform to one of the following Specifications and Grades:

SA-182	F11, Class 2
SA-213	T11
SA-217	WC6
SA-335	P11

- (4) Material shall conform to one of the following Specifications and Grades:

SA-182	F22, Class 3
SA-213	T22
SA-217	WC9
SA-335	P22
SA-336	F22, F22A

- (5) Material shall conform to one of the following Specifications and Grades:

SA-182	F91
SA-213	T91
SA-335	P91
SA-336	F91

**Table 1M**  
**Maximum Allowable Combined Stress in Safety Valve Inlet Connection When Valve Is Blowing**

Temperature, °C	Carbon Steel, MPa [Note (1)] and [Note (2)]	1 <sup>1</sup> / <sub>4</sub> Cr- <sup>1</sup> / <sub>2</sub> Mo-Si, MPa [Note (3)]	2 <sup>1</sup> / <sub>4</sub> Cr- 1Mo, MPa [Note (4)]	9Cr-1Mo-V, MPa [Note (5)]
-30 to 204	186	163	167	339
250	178	161	167	339
300	164	157	167	339
325	159	154	167	338
350	157	150	167	334
375	156	145	167	329
400	151	141	167	322
425	123	139	166	313
450	92.7	135	163	288
454	87.6	...	...	281
475	...	132	161	250
500	...	128	141	215
525	...	124	113	183
550	...	106	91.3	154
566	...	85.5	...	137
575	...	...	78.7	127
593	...	...	62.7	109
600	...	...	...	103
625	...	...	...	81.4
649	...	...	...	63.3

## GENERAL NOTES:

- (a) The stress values in this table may be interpolated to determine values for intermediate temperatures.  
 (b) The stress values in this table do not exceed either 90% of the yield strength at temperature or 67% of the average stress to produce rupture in 1000 hr.

## NOTES:

- (1) Upon prolonged exposure to temperatures above about 425°C, the carbide phase of carbon steel may be converted to graphite.  
 (2) Material shall conform to one of the following Specifications and Grades:

Specification No.	Grade or Class
SA-105	...
SA-106	B, C
SA-181	60, 70
SA-210	C, A1
SA-216	WCA, WCB, WCC
SA-266	1, 2, 3, 4

- (3) Material shall conform to one of the following Specifications and Grades:

SA-182	F11, Class 2
SA-213	T11
SA-217	WC6
SA-335	P11

- (4) Material shall conform to one of the following Specifications and Grades:

SA-182	F22, Class 3
SA-213	T22
SA-217	WC9
SA-335	P22
SA-336	F22, F22A

- (5) Material shall conform to one of the following Specifications and Grades:

SA-182	F91
SA-213	T91
SA-335	P91
SA-336	F91

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**Case 1924-2**  
**Nickel-Molybdenum-Chromium Alloy (UNS N10276)**  
**Section I**

*Inquiry:* May nickel-molybdenum-chromium alloy (UNS N10276) fittings, rod, plate, sheet and strip, welded pipe, seamless pipe and tube, and welded tube conforming to SB-366, SB-574, SB-575, SB-619, SB-622, and SB-626 be used for water-wetted service Section I construction?

*Reply:* It is the opinion of the Committee that nickel-molybdenum-chromium alloy (UNS N10276) may be used for water-wetted service in Section I construction, provided the following additional requirements are met:

(a) The maximum allowable stress values for the material shall be those listed in Section II, Part D, Table 1B for SB-366, SB-574, SB-575, SB-619, SB-622, and SB-626.

(b) Welded fabrication shall conform to the applicable requirements of Section I.

(1) Welding procedure and performance qualifications shall be conducted in accordance with Section IX.

(2) Welding shall be done by any welding process capable of meeting the requirements.

(3) Welding electrodes and filler metal shall conform to the requirements of PW-5.4.

(4) Where welding repair of a defect is required, it shall be followed by reexamination as required in PW-11. Where a defect is removed and welding repair is not necessary, care shall be taken to contour the surface so as to eliminate any sharp notches or corners. The contoured surface shall then be reinspected by the same means originally used for locating the defect to be sure it has been completely removed.

(c) Heat treatment after forming or fabrication is neither required nor prohibited.

(d) This Case number shall be identified in the Data Report.

**CAUTION: Austenitic alloys are subject to stress corrosion cracking, intergranular attack, pitting, and crevice corrosion when used in boiler applications in aqueous environment. Factors that affect the susceptibility of these materials are applied or residual stress, water chemistry and deposition of solids, and material condition. Susceptibility to attack is enhanced when the material is used in a sensitized condition, or with residual cold work. Concentration of corrosive agents (e.g., chlorides, caustic, or reduced sulfur species) can occur under deposits formed on the surface of these materials, and can result in severe underdeposit wastage or cracking. For successful operation in water environment, careful attention must be paid to continuous control of water chemistry.**

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: August 4, 2006

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**Case 1932-5**  
**SA-736/SA-736M Plates and ASTM A859/A859M-95**  
**Forgings**  
**Section VIII, Division 1; Section VIII, Division 2; Section VIII, Division 3**

*Inquiry:* Under what conditions may low-carbon, age-hardening nickel-copper-chromium-molybdenum-columbium alloy steel plates and forgings conforming to SA-736/SA-736M, Grade A, and ASTM specification A859/A859M-95, be used in welded construction under the rules of Section VIII, Divisions 1, 2, and 3?

*Reply:* It is the opinion of the Committee that the materials described in the Inquiry may be used under the rules of Section VIII, Divisions 1, 2, and 3, subject to the following additional requirements:

(a) The following allowable stress values, the allowable stress intensity values, and yield strength values shall apply:

(1) *Division 1.* The maximum allowable stress values shall be those shown in Table 1.

(2) *Division 2.* The design stress intensity values,  $S_m$ , shall be those shown in Table 2. The yield strength values,  $S_y$ , for Division 2 shall be those shown in Table 3.

(3) *Division 3.* The yield strength values,  $S_y$ , for Division 3 shall be those shown in Table 3 of this Code Case.

(b) For external pressure design, the following requirements shall apply:

(1) *Divisions 1 and 2.* Use Fig. CS-2 of Section II, Part D.

(2) *Division 3.* Use KD-222 of Section VIII, Division 3.

(c) Separate welding procedure and performance qualifications shall be conducted for these materials in accordance with Section IX.

(d) *Preheat.* Preheat is not required when the base metal temperature is 50°F or warmer, for nominal thicknesses up to 1½ in. inclusive. A preheat of 200°F is required for nominal thicknesses greater than 1½ in.

(e) *Postweld Heat Treatment.* Postweld heat treatment is prohibited.

(f) *Impact Test Requirement.* The following requirements shall apply:

(1) *Divisions 1 and 2.* For material with thicknesses greater than 1½ in. up to and including 4 in., the lateral expansion at the lowest permissible temperature (MDMT) specified shall be 25 mils. minimum.

(2) *Division 3.* Transverse Charpy V-notch impact test specimens shall be used for Division 3 construction. The test specimens, the testing requirements, and the energy values shall meet the requirements of Article KM-2 in Part KM.

(g) The following requirements shall apply:

(1) *Division 1 Construction:* Part UCS.

(2) *Division 2 Construction:* Article M-2.

(3) *Division 3 Construction:* KM-101, Articles KM-2 and KE-2.

(h) For Division 3 construction, the materials certification shall be in accordance with KM-101 of Section VIII, Division 3.

(i) This Case number shall be shown on the Manufacturer's Data Report Form.

**Table 1**  
**Maximum Allowable Stress Values,**  
**Division 1, ksi**

Specification, Grade, Class Thickness	For Metal Temperatures Not Exceeding 650°F [Note (1)]
<b>A736, Grade A</b>	
<b>Class 1</b>	
$t \leq \frac{3}{4}$ in.	25.7
<b>Class 2</b>	
$t \leq 2$ in.	20.6
2 in. < $t \leq 4$ in.	18.6
<b>Class 3</b>	
$t \leq 2$ in.	24.3
2 in. < $t \leq 4$ in.	21.4
<b>A859</b>	
<b>Class 1</b>	
$t \leq 4$ in.	18.6
<b>Class 2</b>	
$t \leq 4$ in.	21.4

NOTE:

(1) The revised criterion of 3.5 on tensile strength was used in establishing these values.

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**Table 2**  
**Design Stress Intensity Values,  $S_m$ , Division 2, ksi**

Specification, Grade, Class Thickness	For Metal Temperatures Not Exceeding 650°F
<b>A736, Grade A</b>	
<b>Class 1</b>	
$t \leq \frac{3}{4}$ in.	30.0
<b>Class 2</b>	
$t \leq 2$ in.	24.0
2 in. < $t \leq 4$ in.	21.7
<b>Class 3</b>	
$t \leq 2$ in.	28.3
2 in. < $t \leq 4$ in.	25.0
<b>A859</b>	
<b>Class 1</b>	
$t \leq 4$ in.	21.7
<b>Class 2</b>	
$t \leq 4$ in.	25.0

**Table 3**  
**Values of Yield Strength,  $S_y$**

Specification, Grade, Class Thickness, in.	Yield Strength, ksi, for Metal Temperature Not Exceeding, °F						
	100	200	300	400	500	600	650
<b>A736, Grade A</b>							
<b>Class 1</b>							
$t \leq 0.75$	80.0	75.3	72.6	69.4	67.6	65.5	64.2
<b>Class 2</b>							
$t \leq 1.00$	65.0	61.1	58.6	56.8	54.9	53.2	52.1
$1 < t \leq 2$	60.0	56.5	54.1	52.4	50.7	49.1	48.1
$2 < t \leq 4$	55.0	51.8	49.6	48.1	46.5	45.0	44.1
<b>Class 3</b>							
$t \leq 2$	75.0	70.6	67.6	65.6	63.4	61.4	60.2
$2 < t \leq 4$	65.0	61.1	58.6	56.8	54.9	53.2	52.1
<b>A859</b>							
<b>Class 1</b>							
$t \leq 4$ in.	55.0	51.8	49.6	48.1	46.5	45.0	44.1
<b>Class 2</b>							
$t \leq 4$ in.	65.0	61.1	58.6	56.8	54.9	53.2	52.1

Approval Date: May 25, 1983

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 1934**  
**Alternative Rules for Heat Treatment of Boiler External Piping**  
**Section I**

*Inquiry:* May a Certificate Holder who assembles boiler external piping (PG-58.3) apply Section I preheat and PWHT requirements to boiler external piping in lieu of ANSI/ASME B31.1 requirements?

*Reply:* It is the opinion of the Committee that any holder of the ASME "S," "A," or "PP" symbol stamp and Certificate of Authorization may apply the preheat and PWHT requirements of Section I to boiler external piping in lieu of the corresponding requirements of B31.1.

This Case number shall be identified in the Manufacturer's Data Report Form.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: September 23, 2007

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 1935-4**  
**Nickel-Chromium-Molybdenum-Columbium Alloy (UNS N06625)**  
**Section I**

*Inquiry:* May solution annealed (Grade 2) nickel-chromium-molybdenum-columbium alloy (UNS N06625) conforming to the specifications listed in Table 1 be used for Section I welded construction in water wetted service?

*Reply:* It is the opinion of the Committee that solution annealed (Grade 2) nickel-chromium-molybdenum-columbium alloy (UNS N06625) as described in the Inquiry may be used<sup>1</sup> in Section I construction in water wetted service, provided the following additional requirements are met.

(a) The maximum allowable stress values shall be those listed in Section II, Part D, Table 1B. The maximum metal temperature shall not exceed 1000°F (538°C).

(b) Welded fabrication shall conform to the applicable requirements of Section I.

(1) The procedure and performance qualifications shall be conducted as prescribed in Section IX. The material is P-No. 43.

(2) Welding shall be done by any welding process or combination of processes capable of meeting the requirements.

(c) This Case number shall be identified in the Manufacturer's Data Report.

**CAUTION: Austenitic alloys are subject to stress corrosion cracking, intergranular attack, pitting, and crevice corrosion when used in boiler applications in aqueous environments. Factors that affect the susceptibility of these materials are applied or residual stress, water chemistry and deposition of solids, and material condition. Susceptibility to attack is enhanced when the material is used in a sensitized condition, or with residual cold work. Concentration of corrosive agents (e.g., chlorides, caustic, or reduced sulfur species) can occur under deposits formed on the surface of these materials, and can result in severe underdeposit wastage or cracking. For successful operation in water environments, careful attention must be paid to continuous control of water chemistry.**

<sup>1</sup> Alloy N06625 is subject to severe loss of impact strength at room temperature after exposure in the range of 1000°F to 1100°F (540°C to 595°C).

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Material Specifications**

Plate, sheet, and strip	SB-443
Seamless pipe and tube	SB-444
Rod and bar	SB-446

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Approval Date: February 20, 2002

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 1936-3**  
**Nickel-Iron-Chromium-Molybdenum-Copper Alloy**  
**(UNS N08825) for Water Wetted Service**  
**Section I**

*Inquiry:* May nickel-iron-chromium-molybdenum-copper alloy (UNS N08825) conforming to ASME specifications SB-423, SB-424, SB-425, and SB-704 be used for water wetted service in Section I construction?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used for water wetted service in Section I construction at a design temperature of 1000°F or less, provided the following additional requirements are met:

(a) The maximum allowable stress values for welded construction shall be those listed in Section II, Part D, Table 1B for SB-423, SB-424, and SB-425.

(b) For SB-704, the maximum allowable stresses shall be those given in Section II, Part D, Table 1B for Section VIII-1 use. Or, provided the following additional requirements are met, the stress values given in Section II, Part D, Table 1B for SB-423 may be used:

(1) The tubing shall be used for boiler, waterwall, superheater, and economizer tubes that are enclosed within the setting.

(2) The maximum outside diameter shall be  $3\frac{1}{2}$  in.

(3) The weld seam of each tube shall be subjected to an angle beam ultrasonic inspection per SB-751.

(4) A complete volumetric inspection of the entire length of each tube shall be performed in accordance with SB-751.

(5) Material test reports shall be supplied.

(c) Welded fabrication shall conform to the applicable requirements of Section I.

(1) The procedure and performance qualifications shall be conducted as prescribed in Section IX.

(2) Welding shall be done by any welding process or combination of processes capable of meeting the requirements.

(d) For external pressure design (see Section II, Part D), use Fig. NFN-7 up to and including 700°F. For temperatures above 700°F use Fig. NFN-8.

(e) This Case number shall be identified in the Manufacturer's Data Report.

**CAUTION: Austenitic alloys are subject to stress corrosion cracking, intergranular attack, pitting, and crevice corrosion when used in boiler applications in aqueous environments. Factors that affect the susceptibility of these materials are applied or residual stress, water chemistry and deposition of solids, and material condition. Susceptibility to attack is enhanced when the material is used in a sensitized condition, or with residual cold work. Concentration of corrosive agents (e.g., chlorides, caustic, or reduced sulfur species) can occur under deposits formed on the surface of these materials and can result in severe underdeposit wastage or cracking. For successful operation in water environments, careful attention must be paid to continuous control of water chemistry.**

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: February 20, 2004

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 1949-4**  
**Forgings of Nickel-Iron-Chromium Alloys N08800 and N08810**  
**Section I**

*Inquiry:* May forgings of nickel-iron-chromium alloys N08800 and N08810 that conform to SB-564 be used for water wetted service in Code construction under Section I?

*Reply:* It is the opinion of the Committee that nickel-iron-chromium alloys N08800 and N08810 as described in the Inquiry may be used in Section I construction, provided the following additional requirements are met.

(a) The maximum allowable stress values shall be those listed in Table 1B of Section II, Part D.

(b) Welded fabrication shall conform to the applicable requirements of Section I.

(1) The procedure and performance qualification shall be conducted as prescribed in Section IX.

(2) Welding shall be done by any welding process or combination of processes capable of meeting the requirements.

(c) This Case number shall be shown on the Data Report.

**CAUTION:** Austenitic alloys are subject to stress corrosion cracking, intergranular attack, pitting, and crevice corrosion when used in boiler applications in aqueous environments. Factors that affect the susceptibility of these materials are applied or residual stress, water chemistry and deposition of solids, and material condition. Susceptibility to attack is enhanced when the material is used in a sensitized condition, or with residual cold work. Concentration of corrosive agents (e.g., chlorides, caustic, or reduced sulfur species) can occur under deposits formed on the surface of these materials, and can result in severe underdeposit wastage or cracking. For successful operation in water environments, careful attention must be paid to continuous control of water chemistry.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: December 2, 1990

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 1968-1**  
**Use of Acoustic Emission Examination in Lieu of**  
**Radiography**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions and limitations may an acoustic emission (AE) examination conducted during the hydrostatic test be used in lieu of radiography (RT), when radiography in accordance with UW-51 is required by UW-11 of Section VIII, Division 1, for the circumferential closure weld in pressure vessels?

*Reply:* It is the opinion of the Committee that the circumferential closure weld in pressure vessels may be examined using the acoustic emission (AE) method in lieu of radiography (RT) provided that all of the following requirements are met.

(a) The materials of construction shall be P-No. 1 Group 1 or Group 2 and the weld thickness shall not exceed 2½ in.

(b) The vessel shall not exceed 2 ft inside diameter, 2 ft inside length, or 7 ft<sup>3</sup> capacity.

(c) The acoustic emission examination shall be performed in accordance with a written procedure that is certified by the manufacturer to be in accordance with Section V, Article 12, Acoustic Emission Examination of Metallic Vessels During Pressure Testing. The written procedure shall be demonstrated to the satisfaction of the Inspector.

(d) The manufacturer shall certify that personnel performing and evaluating AE examinations have been qualified and certified in accordance with their employer's written practice. SNT-TC-1A-1984 shall be used as a guideline for employers to establish a written practice for qualifying and certifying personnel. The qualification records of certified personnel shall be maintained by their employer.

(e) The AE examination shall be conducted throughout the hydrostatic test that is required by UG-99. Two pressurization cycles from atmospheric pressure to the test pressure required by UG-99 shall be used.

(f) Evaluation and acceptance criteria shall be as follows.

(1) During the first pressurization cycle, any rapid increase in AE events or any rapid increase in AE count rate shall require a pressure hold. If either of these conditions continues during the pressure hold, the pressure shall be immediately reduced to atmospheric pressure and the cause determined.

(2) During the second pressurization cycle, the requirements of (1) above shall apply and, in addition, the following AE indications shall be unacceptable:

(-a) any AE event during any pressure hold;

(-b) any single AE event that produces more than 500 counts, or that produces a signal attribute equivalent to 500 counts;

(-c) six or more AE events detected by any single sensor;

(-d) three or more AE events from any circular area whose diameter is equal to the weld thickness or 1 in., whichever is greater;

(-e) two or more AE events from any circular area (having a diameter equal to the weld thickness or 1 in., whichever is greater) that emitted multiple AE events during the first pressurization.

(g) Welds that produce questionable acoustic emission response signals (i.e., AE signals that cannot be interpreted by the AE examiner) shall be evaluated by radiography in accordance with UW-51. If the construction of the pressure vessel does not permit interpretable radiographs to be taken, ultrasonic examination may be substituted for radiography in accordance with UW-11(a)(7). Final acceptance (or rejection) of such welds shall be based on the radiographic or ultrasonic results, as applicable.

(h) The AE sensors shall be positioned so that the entire pressure vessel is monitored by the AE system and all AE response signals shall be recorded and used in the evaluation. The same AE acceptance standards shall be applied to the rest of the vessel that are applied to the circumferential closure weld.

(i) The AE test results and records shall be retained in accordance with the Section VIII requirements for radiographic film.

(j) This Case number shall be shown on the Data Report Form.

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Approval Date: October 26, 2016

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 1993-7**  
**Precipitation-Hardening Nickel Alloy (UNS N07718)**  
**Used as Bolting Material**  
**Section I**

*Inquiry:* May precipitation-hardened nickel alloy rod, bar, forgings, and forging stock (UNS N07718) conforming to SB-637 be used as a bolting material for Section I construction?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used as a bolting material in Section I construction at a design temperature of 1,150°F (621°C) or less, provided the following additional requirements are met.

(a) The maximum allowable stress values shall be those listed in [Table 1](#) and [Table 1M](#).

(b) Except for nonstructural tack welds used as a locking device, no welding is permitted.

(c) This Case number shall be shown on the Manufacturer's Data Report.

**CAUTION: Austenitic alloys are subject to stress corrosion cracking, intergranular attack, pitting, and crevice corrosion when used in boiler applications in aqueous environments. Factors that affect the susceptibility of these materials are applied or residual stress, water chemistry and deposition of solids, and material condition. Susceptibility to attack is enhanced when the material is used in the sensitized condition, or with residual cold work. Concentration of corrosive agents (e.g., chlorides, caustic or reduced sulfur species) can occur under deposits formed on the surface of these materials, and can result in severe underdeposit wastage or cracking. For successful operation in water environments, careful attention must be paid to continuous control of water chemistry.**

For Metal Temperature Not Exceeding, °F	Allowable Stress Values, Max., ksi
100	37.0
200	37.0
300	37.0
400	37.0
500	37.0
600	37.0
700	37.0
750	37.0
800	37.0
850	37.0
900	37.0
950	37.0
1,000	37.0
1,050	37.0
1,100	37.0
1,150	37.0

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**Table 1M**  
**Maximum Allowable Stresses, MPa**

For Metal Temperature Not Exceeding, °C	Allowable Stress Values, Max., MPa
45	255
65	255
100	255
125	255
150	255
175	255
200	255
225	255
250	255
275	255
300	255
325	255
350	255
375	255
400	255
425	255
450	255
475	255
500	255
525	255
550	255
575	255
600	255
625 [Note (1)]	255

NOTE:

(1) The value provided at 625°C is for interpolation use only. The maximum use temperature is 621°C.

Approval Date: August 12, 1996

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2016-1**  
**Alternative Requirements for Seal Welding of Threaded Connections, UF-32(b)**  
**Section VIII, Division 1**

*Inquiry:* For Section VIII, Division 1 construction, what alternative requirements may be used to qualify welding procedure and welder performance for seal welding of threaded connections in seamless forged pressure vessels of SA-372 Grades A, B, C, D, E, F, G, H, and J material in lieu of making a groove weld specimen as required for seal welding in Section VIII, Division 1, para. UF-32(a) for material with a permitted carbon content of 0.35% or less and in Section VIII, Division 1, para. UF-32(b) for material with a permitted carbon content exceeding 0.35%?

*Reply:* It is the opinion of the Committee that for Section VIII, Division 1 construction, the following requirements may be used to qualify welding procedure and welder performance for seal welding of threaded connections in seamless forged pressure vessels of SA-372 Grades A, B, C, D, E, F, G, H, and J material in lieu of making a groove weld specimen as required for seal welding in Section VIII, Division 1, para. UF-32(a) for material with a permitted carbon content of 0.35% or less and in Section VIII, Division 1, para. UF-32(b) for material with a permitted carbon content exceeding 0.35%.

(a) The suitability of the welding procedure, including electrode, and the welder performance shall be established by making a seal weld in the welding position to be used for the actual work and in a full-size prototype of the vessel neck, including at least some portion of the integrally forged head, conforming to the requirements of Section VIII, Division 1, para. UF-43 and the same geometry, thickness, vessel material type, threaded-plug material type, and heat treatment as that for the production vessel it represents. Separate welding procedure qualifications and performance qualifications shall be conducted for each grade.

(b) The seal weld in the prototype at the threaded connection of the neck and plug shall be cross-sectioned to provide four macro-test specimens taken 90 deg. apart.

(c) One face of each cross section shall be smoothed and etched with a suitable etchant (see Section VIII, Division 1, para. QW-470) to give a clear definition of the weld metal and heat affected zone. Visual examination of the cross sections of the weld metal and heat affected zone shall show complete fusion and freedom from cracks.

(d) All production welding shall be done in accordance with the procedure qualification of (a) above, including the preheat and the electrode of the same classification as that specified in the procedure, and with welders qualified using that procedure

(e) This Case number shall be shown on the Manufacturer's Data Report.

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Approval Date: February 7, 2000

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2038-5**  
**25Cr-22Ni-2Mo-N, UNS S31050, Austenitic Stainless Steel Forgings**  
**Section VIII, Division 1; Section VIII, Division 2**

*Inquiry:* May solution-annealed austenitic stainless steel, 25Cr-22Ni-2Mo-N, UNS S31050 forgings meeting the chemical and mechanical property requirements given in [Table 1](#) and [Table 2](#), and otherwise conforming to the requirements of Specification SA-182, as applicable, be used in welded construction under the rules of Section VIII, Divisions 1 and 2?

*Reply:* It is the opinion of the Committee that the material listed in the Inquiry may be used in welded construction under the rules of Section VIII, Divisions 1 and 2, provided the following additional requirements are met.

(a) The forgings shall be solution annealed at a minimum temperature of 1925°F and liquid quenched to a temperature below 500°F.

(b) The rules for austenitic stainless steels in Section VIII, Divisions 1 and 2, as applicable, shall apply.

(c) The maximum allowable design stress values for Division 1 shall be those listed in [Table 3](#). The maximum design stress intensity values, and yield strength values, for Division 2 shall be those listed in [Table 4](#).

(d) For external pressure design, use Fig. HA-2 of Section II, Part D for both Divisions 1 and 2.

(e) This material is classified as P-No. 8 Group 2.

(f) This Case number shall be referenced in the documentation of the material and recorded on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Chemical Requirements (Heat Analysis)**

Element	Weight, %
Carbon, max.	0.025
Manganese, max.	2.00
Phosphorus, max.	0.020
Sulfur, max.	0.015
Silicon, max.	0.4
Nickel	20.5–23.5
Chromium	24.0–26.0
Molybdenum	1.6–2.6
Nitrogen	0.09–0.15

**Table 2**  
**Mechanical Property Requirements**

Property	ksi
Tensile strength, min.	78
Yield strength, 0.2% offset, min.	37
Elongation in 2 in., min., %	25

**Table 3**  
**Maximum Allowable Stress Values, Division 1**

For Metal Temperature	
Not Exceeding, °F	Allowable Stress Values, ksi [Note (1)]
100	22.3
200	21.0, 22.0 [Note (2)]
300	19.1, 20.8 [Note (2)]
400	17.8, 20.0 [Note (2)]
500	16.8, 19.5 [Note (2)]
600	15.9, 19.0 [Note (2)]

## NOTES:

- (1) See Note G5 of Table 1A in Section-II, Part D.  
 (2) The revised criterion of 3.5 on tensile strength was used in establishing these values.

**Table 4**  
**Design Stress Intensity and Yield Strength Values, Division 2**

For Metal Temperature Not Exceeding, °F	Design Stress	
	Intensity Values, $S_m$ , ksi Forgings	Yield Strength Values, $S_y$ , ksi
100	24.7	37.0
200	24.7	31.5
300	24.3	28.6
400	23.4	26.7
500	22.7	25.2
600	21.5	23.9

Approval Date: May 4, 1999

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2055-2**  
**Pneumatic Testing of Pressure Vessels, UG-20**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions may pressure vessels, fabricated under the provisions of Section VIII, Division 1, be tested pneumatically in lieu of the hydrostatic test set forth in UG-20(f)(2)?

*Reply:* It is the opinion of the Committee that pneumatic test provisions of UG-100 and the requirements of UG-20(f) may be used provided the following additional requirements are met:

(a) The test pressure is at least 1.3 MAWP but shall not exceed 1.3 times the basis for calculated test pressure defined in Appendix 3-2;

(b) The MAWP is no greater than 500 psi;

(c) The following thickness limitations shall apply:

(1) For butt joints, the nominal thickness at the thickest welded joint shall not exceed  $\frac{1}{2}$  in.

(2) For corner or lap welded joints, the thinner of the two parts joined shall not exceed  $\frac{1}{2}$  in.

(d) This Case number shall be shown on the Manufacturer's Data Report.

**CAUTION: The vessel(s) should be tested in such a manner as to ensure personnel safety from a release of the total energy of the vessel(s).**

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: October 2, 2008

*Code Cases will remain available for use until annulled by the applicable Standards Committee.***Case 2063-6  
Ni-22Cr-14W-2Mo-La Alloy (UNS N06230)  
Section I**

*Inquiry:* May solution-annealed alloy UNS N06230 wrought plate, sheet, strip, bar, welded pipe and tube, wrought fittings, seamless pipe and tube, and forgings conforming to the specifications listed in Table 1 be used in water service in welded construction under Section I?

*Reply:* It is the opinion of the Committee that solution-annealed alloy UNS N06230 wrought plate, sheet, strip, rod, welded pipe and tube, wrought fittings, seamless pipe and tube, and forgings as described in the Inquiry may be used in water wetted service in welded construction complying with the rules of Section I provided the following additional requirements are met:

(a) The maximum allowable stress values for the material shall be those given in Tables 2 and 2M. For welded pipe, tube, and fitting products, a joint efficiency factor of 0.85 shall be used.

(b) Welded fabrication shall conform to the applicable requirements of Section I. When welding is performed with filler metal of the same nominal composition as the base metal, only GMAW or GTAW processes are allowed.

(c) Welding procedure and performance qualifications shall be conducted in accordance with Section IX.

(d) Heat treatment after forming or welding is neither required nor prohibited. When heat treatment is applied, the temperature, time, and method of heat treatment shall be covered by agreement between the user and manufacturer.

(e) For Section I, which requires a temperature-dependent parameter,  $y$  [see PG-27.4, Note (6)], the  $y$  values shall be 0.4.

(f) This Case number shall be referenced in the documentation of the material and recorded on the Manufacturer's Data Report.

**CAUTION: Austenitic alloys are subject to stress corrosion cracking, intergranular attack, pitting, and crevice corrosion when used in boiler applications in aqueous environments. Factors that affect the susceptibility of these materials are applied or residual stress, water chemistry and deposition of solids, and material condition. Susceptibility to attack is enhanced when the material is used in a sensitized condition or with residual coldwork. Concentration of corrosive agents (e.g. chlorides, caustic, or reduced sulfur species) can occur under deposits formed on the surface of these materials and can result in severe underdeposit wastage or cracking. For successful operation in water environments, careful attention must be paid to continuous control of water chemistry.**

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**Table 1  
 Product Specifications**

Bar	SB-572
Forgings	SB-564
Plate, sheet, and strip	SB-435
Seamless pipe and tube	SB-622
Welded pipe	SB-619
Welded tube	SB-626
Wrought fittings	SB-366

**Table 2  
 Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F		
Exceeding, °F	Maximum Allowable Stress, ksi [Note (1)]	
-20 to 100	30.0	30.0
200	28.2	30.0 [Note (2)]
300	26.4	30.0 [Note (2)]
400	24.7	30.0 [Note (2)]
500	23.1	30.0 [Note (2)]
600	22.0	29.4 [Note (2)]
650	21.5	29.1 [Note (2)]
700	21.2	28.7 [Note (2)]
750	21.0	28.4 [Note (2)]
800	20.9	28.2 [Note (2)]
850	20.9	28.2 [Note (2)]
900	20.9	28.2 [Note (2)]
950	20.9	28.2 [Note (2)]
1000	20.9	28.2 [Note (2)]

NOTES:

- (1) These values are based on the use of a tensile strength criterion of 3.5.
- (2) Due to the relatively low yield strength of these materials, these higher stress values were established at temperatures where the short time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed  $66\frac{2}{3}\%$  but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.

**Table 2M  
 Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C		
Exceeding, °C	Maximum Allowable Stress, MPa [Note (1)]	
-30 to 40	207	207
65	201	207 [Note (2)]
100	193	207 [Note (2)]
125	187	207 [Note (2)]
150	182	207 [Note (2)]
175	176	207 [Note (2)]
200	171	207 [Note (2)]
225	166	207 [Note (2)]
250	161	207 [Note (2)]
275	157	206 [Note (2)]
300	154	204 [Note (2)]
325	150	202 [Note (2)]
350	148	200 [Note (2)]
375	146	198 [Note (2)]
400	145	196 [Note (2)]
425	144	194 [Note (2)]
450	144	194 [Note (2)]
475	144	194 [Note (2)]
500	144	194 [Note (2)]
525	144	194 [Note (2)]
550	144 [Note (3)]	194 [Note (2)], [Note (3)]

NOTES:

- (1) These values are based on the use of a tensile strength criterion of 3.5.
- (2) Due to the relatively low yield strength of these materials, these higher stress values were established at temperatures where the short time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed  $66\frac{2}{3}\%$  but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.
- (3) The maximum use temperature is 538°C; the value listed as 550°C is provided for interpolation purposes only.

**Approval Date: October 29, 1999**

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2073-1**  
**SA-487 Grade CA6NM Class A**  
**Section I**

*Inquiry:* May high alloy ferrous steel castings conforming to SA-487 Grade CA6NM Class A be used in welded construction under Section I?

*Reply:* It is the opinion of the Committee that castings described in the Inquiry may be used in welded construction complying with the rules of Section I, provided the following additional requirements are met:

(a) The maximum allowable stress values shall be as shown in [Table 1](#). A casting quality factor in accordance with PG-25 shall be applied to these allowable stresses except as otherwise proved in PG-42.

(b) Welded fabrication shall conform to the applicable requirements in Section I.

(1) The welding procedure and performance qualifications shall be conducted as prescribed in Section IX for P-No. 6 Group 4 material.

(2) The postweld heat treatment of welds shall be in accordance with PW-39 and [Table 2](#) of this Code Case.

(c) This Case number shall be shown on the Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values**

For Temperature Not Exceeding, °F	Maximum Allowable Stress, ksi [Note (1)]
-20 to 100	31.4
200	31.4
300	30.8
400	30.0
500	29.4
600	28.8
650	28.5
700	28.0

NOTE:

(1) The allowable stress values are based on the revised criterion of tensile strength at temperature divided by 3.5, where applicable.

**Table 2**  
**Mandatory Requirements For Postweld Heat Treatment of Pressure Parts and Attachments**

Material	Holding Temperature Range, °F	Minimum Holding Time at Temperature for Weld Thickness (Nominal)			
		$\frac{1}{2}$ or less	Over $\frac{1}{2}$ in. to 2 in.	Over 2 in. to 5 in.	Over 5 in.
P-No.6	1050-1150	30 min.	1 hr./in.	1 hr./in.	5 hrs. plus 15 min. for each additional inch over 5 in.

Approval Date: June 19, 1990

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2093**  
**A439 Type D-2 Austenitic Ductile Iron**  
**Section VIII, Division 1**

*Inquiry:* May Type D-2 austenitic ductile iron castings conforming to ASTM A439-83 be used in Section VIII, Division 1 construction?

*Reply:* It is the opinion of the Committee that Type D-2 austenitic ductile iron castings conforming to ASTM A439-83 may be used in Section VIII, Division 1 construction provided the following additional requirements are met.

(a) The rules in Section VIII, Division 1, that apply are those in Part UCI, except for UCI-5.

(b) The maximum allowable stress value in tension shall be 5.4 ksi; maximum metal temperature shall not exceed 450°F. (This value is less than  $\frac{1}{10}$  of the room temperature specified minimum tensile strength.)

(c) This Case number shall be included in the Manufacturer's Data Report.

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Approval Date: October 29, 1999

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2120-1**  
**Nickel-Iron-Chromium-Molybdenum-Copper Low Carbon Alloy (UNS N08926) for Code Construction Section VIII, Division 1**

*Inquiry:* May austenitic nickel-base alloy (UNS N08926) sheet, strip, plate, bar, fittings, welded pipe and tube, and seamless pipe and tube that meet the chemical composition and mechanical property requirements in [Table 1](#) and [2](#), and otherwise conforming to the requirements of SB-625, SB-649, SB-462, SB-366, SB-673, SB-674, and SB-677, respectively, be used in Section VIII, Division 1, welded construction?

*Reply:* It is the opinion of the Committee that Ni-Fe-Cr-Mo-Cu low carbon alloy (UNS N08926) plate, sheet, strip, plate, bar, fittings, welded pipe and tube, and seamless pipe and tube as described in the Inquiry may be used in Section VIII, Division 1 construction provided the following additional requirements are met.

(a) The maximum allowable stress values for the material shall be those given in [Table 3](#). For welded pipe, welded tubing, and welded fittings, the stress values shall be multiplied by a factor of 0.85.

(b) For pipe and tube sizes larger than those listed in ASTM B677 seamless pipe and ASTM B673 welded pipe, the dimensional requirements of ASTM B464 shall be used. The maximum nominal pipe size and wall thickness are 30 and 0.5 in., respectively.

(c) The material shall be considered as P-No. 45.

(d) Heat treatment during or after fabrication is neither required nor prohibited. All other requirements in Part UNF for nickel-base alloys shall be required.

(e) For external pressure design, Fig. NFN-9 of Section II, Part D shall be used.

(f) This Case number shall be shown on the documentation and marking of the material and recorded in the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1  
Chemical Composition**

Element	Composition, %
Carbon, max.	0.020
Manganese, max.	2.00
Phosphorus, max.	0.03
Sulfur, max.	0.01
Silicon, max.	0.5
Nickel	24.00-26.00
Chromium	19.00-21.00
Molybdenum	6.0-7.0
Copper	0.5-1.5
Nitrogen	0.15-0.25
Iron	Balance

**Table 2  
Mechanical Property Requirements (All Product Forms)**

Tensile strength, min., ksi	94.0
Yield strength, min., ksi	43.0
Elongation in 2 in., or 4D min., %	35

**Table 3  
Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F		Stress Values, ksi [Note (1)]
100		26.9
200		24.1, 26.9 [Note (2)]
300		21.5, 26.2 [Note (2)]
400		19.7, 24.8 [Note (2)]
500		18.7, 23.7 [Note (2)]
600		18.0, 22.8 [Note (2)]
650		17.7, 22.4 [Note (2)]
700		17.5, 22.0 [Note (2)]
750		17.4, 21.6 [Note (2)]

NOTES:

- (1) The revised criterion of 3.5 on tensile strength was used in establishing these values.
- (2) Due to the relatively low yield strength of these materials, these higher stress values were established at temperatures where the short time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed  $\frac{2}{3}$ , but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.

Approval Date: September 18, 2006

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2127-3**  
**Type 304LN (Alloy UNS S30453) Austenitic Stainless Steel**  
**Section VIII, Division 1**

*Inquiry:* May solution annealed Type 304LN (Alloy UNS S30453) plate, sheet, strip, bar, forgings, fittings, seamless and welded tubing, and pipe conforming to SA-182, SA-240, SA-213, SA-312, SA-376, and SA-479, and SA-965 be used in welded and unwelded construction under Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that solution annealed Type 304LN (Alloy UNS S30453) plate, sheet, strip, bar, forgings, fittings, seamless and welded tubing, and pipe as described in the Inquiry may be used in Section VIII, Division 1 construction provided.

(a) The material meets the chemical analysis and minimum tensile requirements detailed in the Inquiry and specifications.

(b) The Maximum Design Temperature does not exceed 100°F.

(c) The requirements, limitations and maximum allowable design stress values [limited in accordance with (b)] given in Part UHA and Table 1A of Section II, Part D, applicable to solution annealed Type 304 (Alloy UNS S30400) are used for this material.

(d) The provisions of UW-2(b)(1) permitting Type No. 2 joints for Category A welds in Type 304 material are also applicable to this material.

(e) The testing requirements of UHA-51(b)(5)(-d) shall be applicable to all welding processes used for this material.

(f) For external pressure use Fig. HA-1 of Section II, Part D.

(g) When the material's chemical analysis requirements of Table 1 are met, the exemption from base material impact testing in UHA-51 will be applicable at minimum design metal temperatures of -452°F and warmer.

(h) The exemption from Vessel (Production) Test Plates of UHA-51 may be considered to be applicable to Type 304LN material at minimum design metal temperatures of -452°F and warmer where all of the following conditions are satisfied:

(1) The chemistry requirements of Table 1 are met.

(2) The deposited filler material meets the requirements of Table 2.

(3) The welding processes used are limited to Gas Tungsten Arc (GTAW) and Plasma Arc (PAW).

(4) Each lot of filler metal shall be subject to delta ferrite determination by the method provided in SFA-5.9. In order to be acceptable, the delta ferrite calculated in conjunction with Figure 1 shall be not less than FN 2 nor greater than FN 7; and

(5) The following requirements are applied in lieu of those of UG-84(h). The fracture toughness of the welds and heat affected zone of the procedure qualification test plates shall be determined by testing in accordance with ASTM E1820 and shall demonstrate at -452°F an equivalent fracture toughness  $K_{c}(J)$  of at least  $120\text{ksi} \cdot \sqrt{\text{in.}}$  determined from the test data using the expression  $K_{c}(J) = (E/J_c)^{1/2}$ . The specimens shall meet the orientation and location requirements of UG-84(g)(1) and UG-84(g)(2). Welding procedures for use only with base material less than 0.099 in. thickness are exempt from these fracture toughness testing requirements.

(i) This Case number shall be referenced in the documentation and marking of the material and recorded on the Manufacturer's Data Report.

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**Table 1**  
**Chemical Requirements of Base Metal Heat Analysis**

Element	Weight, %
Carbon, max.	0.030
Manganese	[Note (1)]
Phosphorus, max.	0.025
Sulfur, max.	0.015
Silicon	[Note (1)]
Nickel	[Note (1)]
Chromium	[Note (1)]
Nitrogen	0.13–0.16
Other Elements	[Note (1)]

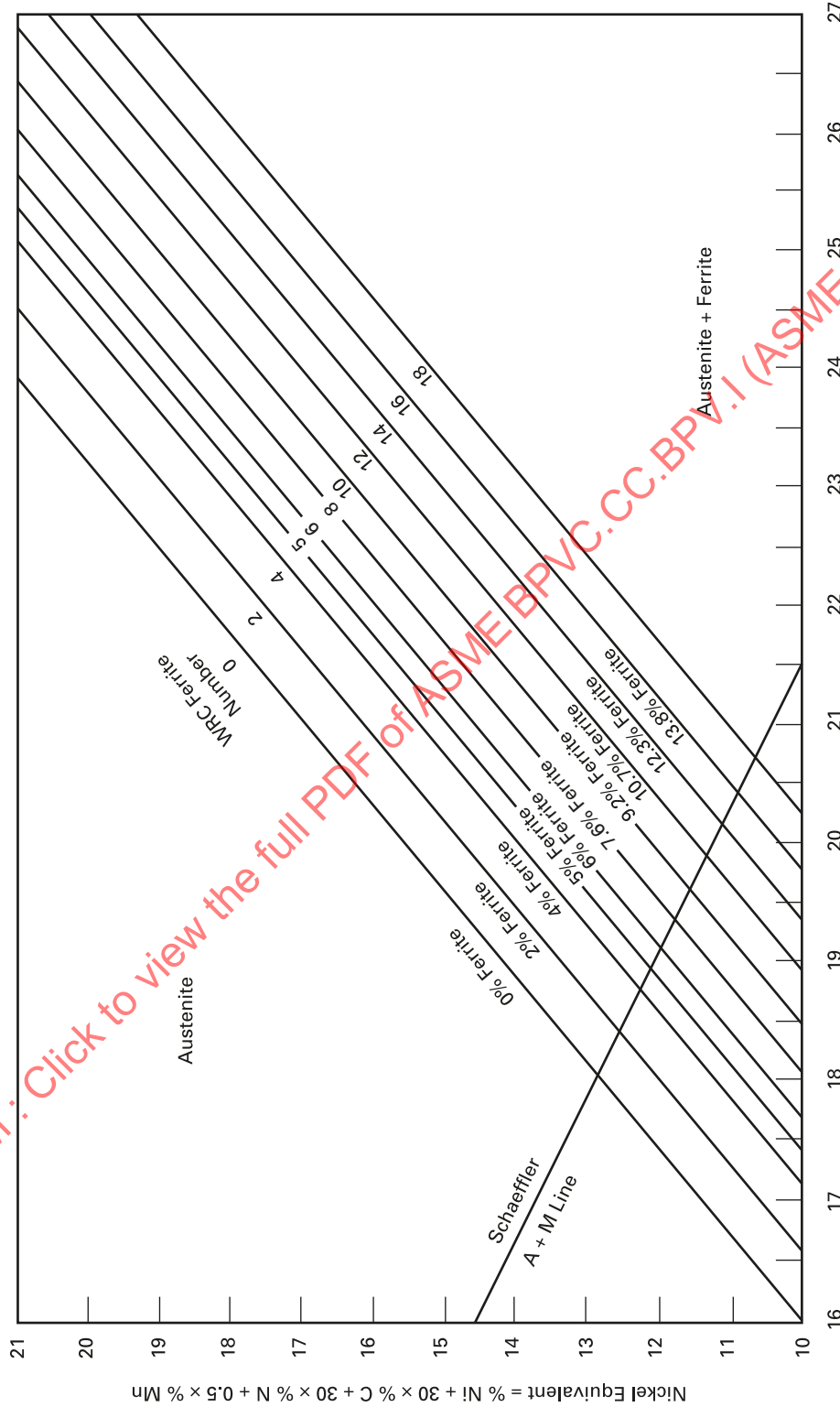
## NOTE:

(1) Chemical requirements are the same as listed in the applicable material form specifications.

**Table 2**  
**Chemical Requirements of Filler Metal Deposit Analysis**

Element	Weight, %
Carbon, max.	0.03
Manganese	1.00–2.5
Phosphorus, max.	0.03
Sulfur, max.	0.02
Silicon	0.30–0.50
Chromium	18.00–19.00
Nickel	12.00–14.00
Molybdenum	2.0–2.5
Nitrogen	0.035–0.060
Copper, max.	0.5

**Figure 1**  
**Delta Ferrite Content**



Chromium Equivalent =  $\% Cr + \% Mo + 1.5 \times \% Si + 0.5 \times \% Cb$

GENERAL NOTE: The actual nitrogen content is preferred. If this is not available, the following applicable nitrogen value shall be used:  
 (1) GMAW welds: 0.08% (except self-shielding flux cored electrode GMAW welds: 0.12%).  
 (2) welds of other process: 0.06%

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**Case 2130-4**  
**ASTM A841/A841M-98<sup>e</sup> Plate**  
**Section VIII, Division 1; Section VIII, Division 2;**  
**Section VIII, Division 3**

**ANNULLED**

Annulment Date: December 17, 2018

Reason: No longer needed.

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Approval Date: August 1, 2018

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2142-6**  
**F-Number Grouping for Ni-Cr-Fe Filler Metals**  
**Section I; Section VIII, Division 1; Section VIII, Division 2;**  
**Section VIII, Division 3; Section IX**

*Inquiry:* What alternate rules may be applied to grouping UNS N06052, UNS N06054, UNS N06055, and UNS N06056 Ni-Cr-Fe welding filler metals meeting the chemical requirements of [Table 1](#) but otherwise conforming to AWS 5.14 to reduce the number of welding procedure and performance qualifications?

*Reply:* It is the opinion of the Committee that UNS N06052, UNS N06054, UNS N06055, and UNS N06056 Ni-Cr-Fe welding filler metals meeting the chemical requirements of [Table 1](#) but otherwise conforming to AWS A5.14 may be considered as F-No. 43 for both procedure and performance qualification purposes. Further, these materials shall be identified as UNS N06052, UNS N06054, UNS N06055, and UNS N06056 in the Welding Procedure Specification, Procedure Qualification Record, and Performance Qualification Records.

This Case number shall be shown on the Manufacturer's Data Report.

**Table 1**  
**Chemical Requirements**

Element	52 Composition, UNS	52M Composition, UNS	52MSS Composition,	52i Composition, UNS
	N06052, %	N06054, %	UNS N06055, %	N06056, %
Carbon	0.04	0.04	0.03	0.055
Manganese	1.00	1.00	1.00	2.5-4.0
Phosphorus	0.02	0.02	0.02	0.02
Sulfur	0.015	0.015	0.015	0.015
Silicon	0.50	0.50	0.50	0.50
Chromium	28.0-31.5	28.0-31.5	28.5-31.0	26.0-28.0
Molybdenum	0.50	0.50	3.0-5.0	...
Nickel	Balance	Balance	52.0-62.0	Balance
Niobium (Columbium) plus Tantalum	0.10	0.5-1.0	2.1-4.0	2.0-2.8
Aluminum	1.10	1.10	0.50	0.60
Aluminum and Titanium	1.50	1.50	...	...
Copper	0.30	0.30	0.30	0.30
Iron	7.0-11.0	7.0-11.0	Balance	2.0-3.0
Titanium	1.0	1.0	0.50	0.40
Other elements	0.50	0.50	0.50	0.50

GENERAL NOTE: Maximum values unless range or minimum is indicated.

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Approval Date: April 1, 2014

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2143-2**

**F-Number Grouping for Ni-Cr-Fe, Classification UNS W86152 and UNS W86056 Welding Electrodes Section I; Section II, Part A; Section II, Part B; Section II, Part C; Section II, Part D; Section IV; Section VIII, Division 1; Section VIII, Division 2; Section VIII, Division 3; Section IX; Section X; Section XII; Section III, Division 1; Section XI, Division 1**

*Inquiry:* What alternate rules may be applied to grouping UNS W86152 and UNS W86056 Ni-Cr-Fe welding electrodes meeting the chemical and mechanical properties of [Tables 1](#) and [2](#) but otherwise conforming to AWS A5.11 to reduce the number of welding procedure and performance qualifications?

*Reply:* It is the opinion of the Committee that UNS W86152 and UNS W86056 Ni-Cr-Fe welding electrodes meeting the chemical and mechanical properties of [Tables 1](#) and [2](#) but otherwise conforming to AWS A5.11/A5.11M may be considered as F-No. 43 for both procedure and performance qualification purposes. Further, these materials shall be identified as UNS W86152 or UNS W86056, as appropriate, in the Welding Procedure Specification, Procedure Qualification Record, and Performance Qualification Records.

This Case number shall be shown on the Manufacturer's Data Report.

**Table 1  
Chemical Requirements**

Element	Composition, %	
	UNS W86152	UNS W86056
Carbon, max.	0.05	0.055
Manganese, max.	5.00	2.5-4.5
Phosphorus, max.	0.030	0.02
Sulfur, max.	0.015	0.015
Silicon, max.	0.75	0.50
Chromium	28.0-31.5	26.0-28.0
Molybdenum, max.	0.50	...
Nickel	Bal.	Bal.
Columbium	1.0-2.5	2.0-3.6
Aluminum, max.	0.50	0.60
Copper, max.	0.50	0.3
Iron	7.0-12.0	2.0-3.0
Titanium, max.	0.50	0.40
Other Elements, max.	0.50	0.50

**Table 2  
Mechanical Property Requirements (All  
Weld Metal Tension Test)**

Property	UNS W86152	UNS W86056
Tensile strength, min., ksi	80	90
Elongation in 2 in., min., %	30	30

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Approval Date: November 25, 1992

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2146**

**24Cr-17Ni-6Mn-4.5Mo-N, UNS S34565, Austenitic Stainless Steel Forgings, Bar, Fittings, Welded and Seamless Pipe and Tube, Plate, Sheet, and Strip Section VIII, Division 1**

*Inquiry:* May solution annealed austenitic stainless steel, 24Cr-17Ni-6Mn-4.5Mo-N, UNS S34565, forgings, bar, fittings, welded and seamless pipe and tube, plate, sheet and strip, meeting the chemical and mechanical property requirements given in [Tables 1](#) and [2](#), and otherwise conforming to the requirements of specifications of SA-182, SA-213, SA-240, SA-249, SA-312, SA-376, SA-403, SA-409, and SA-479, as applicable, be used in welded construction under the rules of Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that the material listed in the Inquiry may be used in welded construction under the rules of Section VIII, Division 1, provided the following additional requirements are met.

(a) The material shall be furnished in the solution annealed condition consisting of holding at a temperature in the range from 2050°F to 2140°F for a time ranging from 15–30 minutes, followed by water quenching, or rapid cooling by other means.

(b) The rules for austenitic stainless steels given in Part UHA shall apply.

(c) The maximum allowable design stress values shall be those listed in [Table 3](#).

(d) For external pressure design, use [Figure 1](#), the tabular values are listed in [Table 4](#).

(e) Separate welding procedure and performance qualifications shall be conducted for the material in accordance with Section IX.

(f) Postweld heat treatment after forming or fabrication is neither required nor prohibited, but when heat treatment is performed, it shall be as in (a) above.

(g) This Case number shall be referenced in the documentation of the material and recorded on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Chemical Requirements**

Element	Weight, %
Carbon, max.	0.03
Manganese	5.0-7.0
Phosphorus, max.	0.030
Sulfur, max.	0.010
Silicon, max.	1.0
Nickel	16.0-18.0
Chromium	23.0-25.0
Molybdenum	4.0-5.0
Nitrogen	0.4-0.6
Columbium, max.	0.1

**Table 2**  
**Mechanical Properties Requirements**

Yield strength, min., 0.2% offset, ksi	60
Tensile strength, min., ksi	115
Elongation in 2 in., min., %	35

**Table 3**  
**Maximum Allowable Stress Values, ksi**

For Metal Temperature Not Exceeding, °F	Forgings, Bar, Plate, Sheet, Strip, Seamless Pipe and Tube, Fittings	Welded Pipe and Tube, Welded Fittings [Note (1)]
100	28.8	24.5
200	28.4	24.1
300	26.9	22.9
400	25.9	22.0
500	25.3	21.5
600	25.0	21.3
650	24.8	21.1
700	24.6	20.9
750	24.3	20.7

NOTE:

(1) A quality factor of 0.85 has been applied in arriving at the allowable stress values for this material.

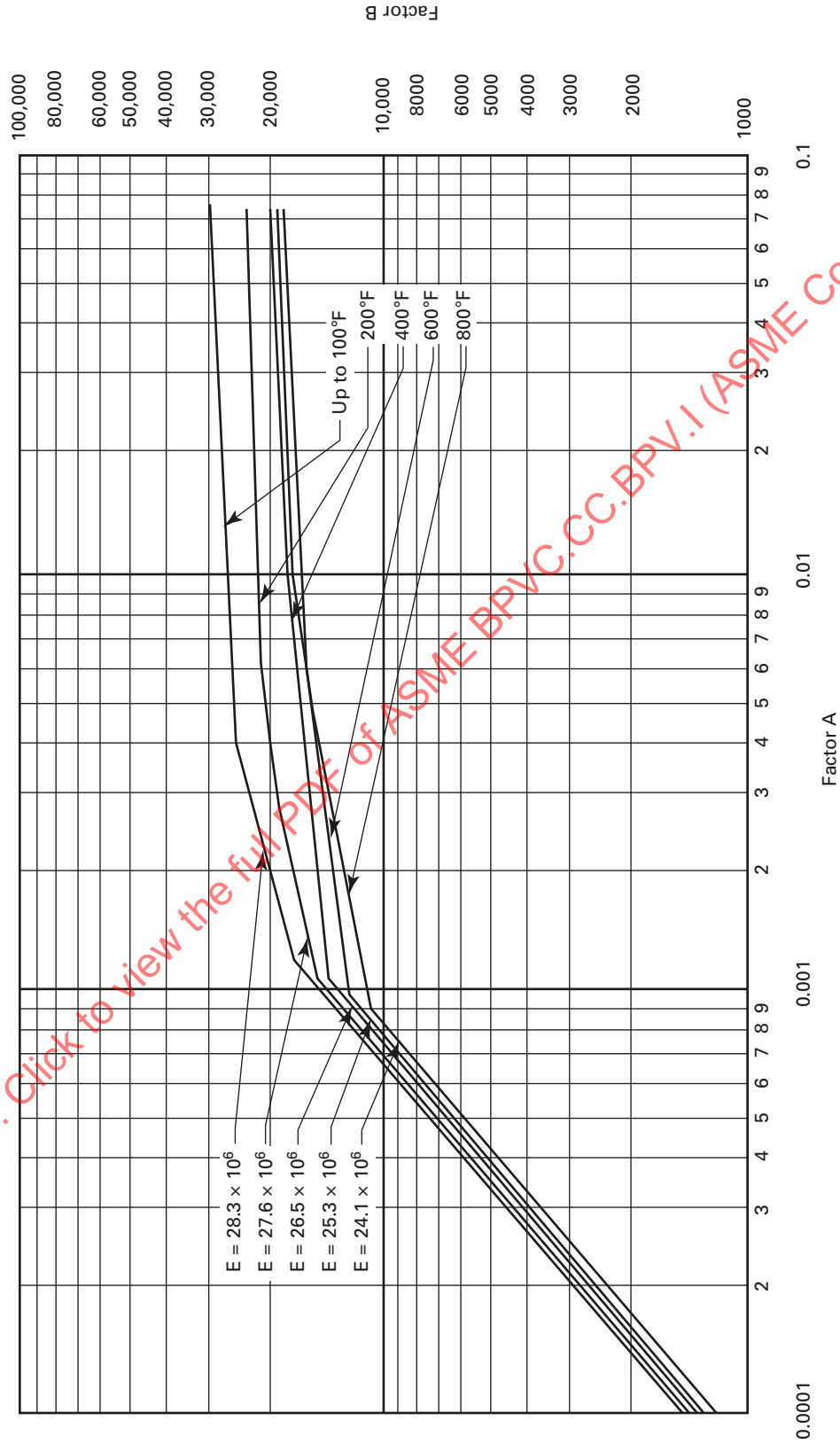
**Table 4**  
**Tabular Values for Figure 1**

Up to 100°F, $E = 28.3 \times 10^6$ psi		Temp. 200°F, $E = 27.6 \times 10^6$ psi		Temp. 400°F, $E = 26.5 \times 10^6$ psi		Temp. 600°F, $E = 25.3 \times 10^6$ psi		Temp. 800°F, $E = 24.1 \times 10^6$ psi	
A	B, psi	A	B, psi	A	B, psi	A	B, psi	A	B, psi
1.00 -04	1,416	1.00 -04	1,382	1.00 -04	1,327	1.00 -04	1,267	1.00 -04	1,207
1.25 -03	17,715	1.11 -03	15,324	1.08 -03	14,340	9.79 -04	12,400	8.84 -04	10,673
2.24 -03	21,848	2.76 -03	19,702	3.23 -03	16,464	3.77 -03	15,781	2.28 -03	13,728
4.01 -03	26,572	6.14 -03	21,891	6.78 -03	18,057	8.38 -03	17,885	5.90 -03	16,773
9.49 -03	28,344	1.64 -02	22,985	1.80 -02	19,651	2.41 -02	19,201	1.21 -03	17,789
4.29 -02	29,997	5.63 -02	23,697	7.47 -02	20,819	7.50 -02	20,163	2.19 -02	18,450
7.50 -02	31,107	5.72 -02	24,080	...	...	...	...	5.55 -02	19,314
...	...	7.50 -02	24,463	...	...	...	...	7.50 -02	19,713

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**Figure 1**  
**Chart for Determining Shell Thickness of Cylindrical and Spherical Vessels Under External Pressure When Constructed of Austenitic Stainless Steel UNS S34565**



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Approval Date: August 12, 1993

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**Case 2150**  
**Large-End Cone-to-Cylinder Junction for  $30 < \alpha \leq 60$**   
**Degrees**  
**Section VIII, Division 1**

*Inquiry:* Where radiography of a circumferential joint is not required, may a cone without a knuckle at the large end of the cone-to-cylinder junction having a half-apex angle  $\alpha$  greater than 30 deg be used in the construction of a vessel complying with the Section VIII, Division 1 rules without the special analysis specified in 1-5(g)?

*Reply:* It is the opinion of the Committee that when radiography of a circumferential joint is not required, a cone without a knuckle at the large end of a cone-to-cylinder junction having a half-apex angle  $\alpha$  greater than 30 deg may be used for Section VIII, Division 1 construction without the special analysis specified in 1-5(g), provided:

(a) Equations (1) and (2) and Figures 1 and 2 given below shall be used for calculating the localized stress at the discontinuity.

$$\sigma_{\theta} = \frac{PR}{t} \left( 1 - Y \sqrt{\frac{R}{t}} \right) \quad (1)$$

$$\sigma_x = \frac{PR}{t} \left( 0.5 + X \sqrt{\frac{R}{t}} \right) \quad (2)$$

where

$\sigma_{\theta}$  = membrane hoop stress plus average discontinuity hoop stress, psi

$\sigma_x$  = membrane longitudinal stress plus discontinuity longitudinal stress due to bending, psi  
 $X, Y$  = factors taken from Figure 1 or 2 (or tabular values taken from Table 1 or 2)

$P$  = internal pressure, psi

$R$  = inside radius of the cylinder at large end of cone, in.

$t$  = cylinder thickness, in.

(b) The half-apex angle  $\alpha$  is not greater than 60 deg.

(c) The axial forces come solely from internal pressure acting on the closed ends. When other loads (such as wind loads, dead loads, etc.) are involved, the design shall be in accordance with U-2(g).

(d)  $\sigma_{\theta}$  shall not be greater than  $1.5S$  and  $\sigma_x$  shall not be greater than  $3S$  where  $S$  is the maximum allowable stress value, in psi, obtained from the applicable table of stress values in Section II, Part D.

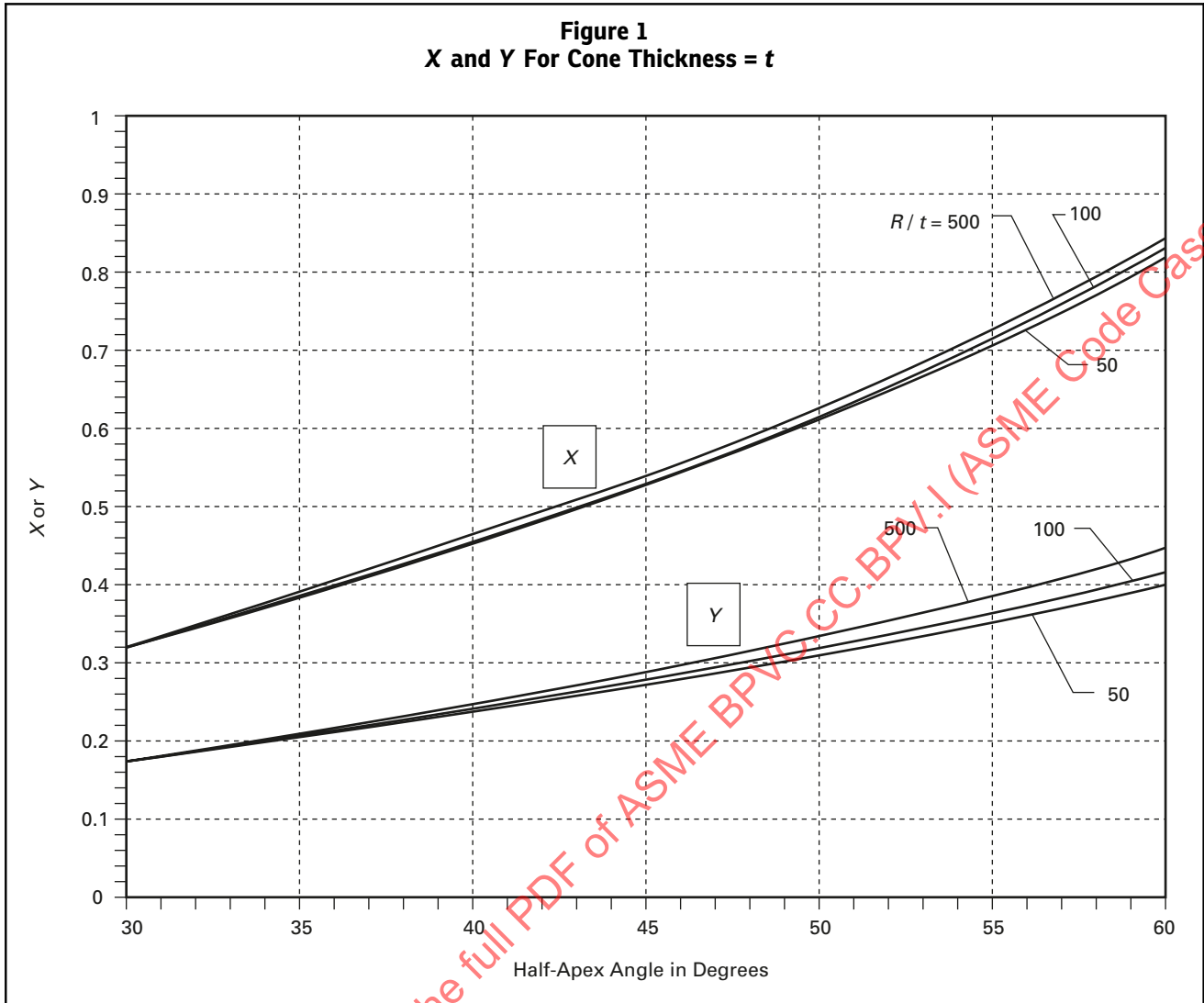
(e) After the required thickness for the shell has been determined by UG-27(c), and that for the cone by UG-32(g), the stress limits of (d) above must be checked with eqs. (a)(1) and (a)(2) using the calculated required thicknesses. If the limits of (d) are not met, the shell and cone thicknesses near the junction must be increased so that the limits of (d) are met. When additional thickness is required, the section of increased thickness shall extend a minimum distance from the junction as shown in Figure 3.

(f) The angle joint between the cone and cylinder shall be designed equivalent to a double butt-welded joint and there shall be no weak zones around the joint.

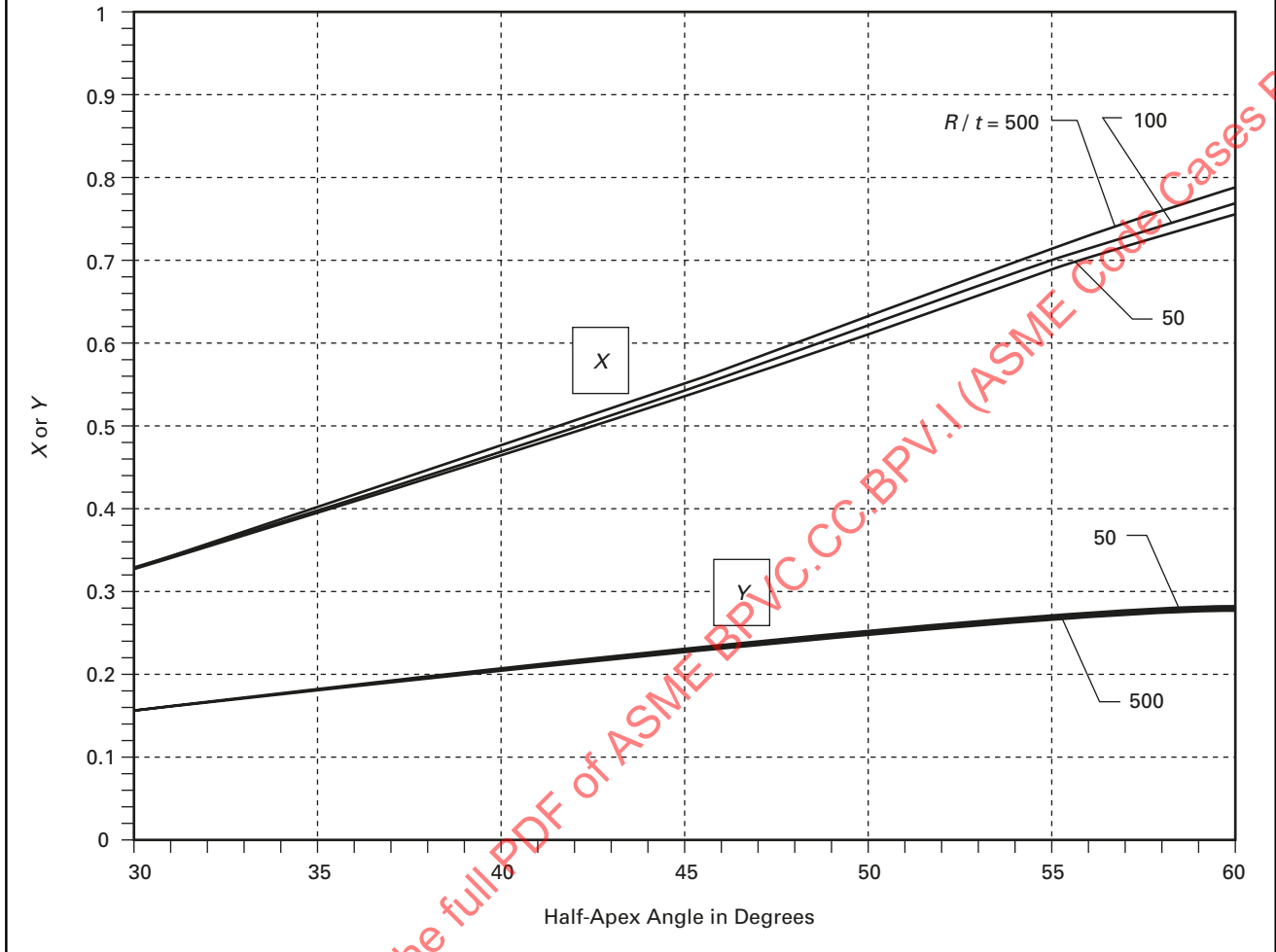
(g) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Figure 1**  
**X and Y For Cone Thickness = t**



**Figure 2**  
**X and Y For Cone Thickness =  $t/\cos \alpha$**



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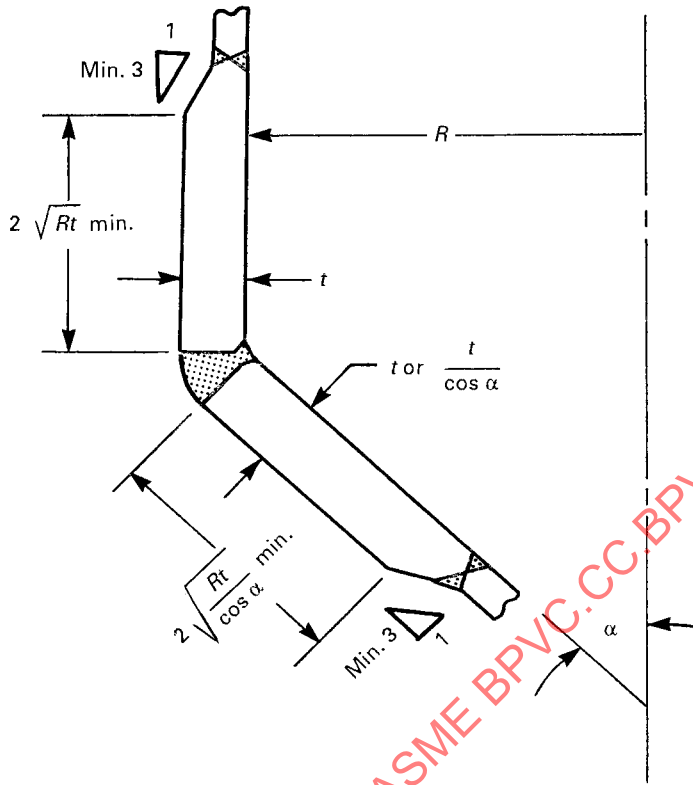
**Table 1**  
**Tabular Values for Figure 1**

Half-Apex Angle, deg	Y			X		
	R/t = 500	R/t = 100	R/t = 50	R/t = 500	R/t = 100	R/t = 50
30	0.1750	0.1721	0.1698	0.3239	0.3211	0.3182
31	0.1822	0.1788	0.1762	0.3378	0.3348	0.3317
32	0.1894	0.1854	0.1826	0.3517	0.3484	0.3451
33	0.1966	0.1921	0.1890	0.3655	0.3621	0.3586
34	0.2038	0.1987	0.1955	0.3794	0.3758	0.3720
35	0.2110	0.2054	0.2019	0.3933	0.3894	0.3855
36	0.2182	0.2121	0.2083	0.4072	0.4031	0.3990
37	0.2254	0.2187	0.2147	0.4211	0.4168	0.4124
38	0.2327	0.2254	0.2211	0.4349	0.4304	0.4259
39	0.2399	0.2320	0.2275	0.4488	0.4441	0.4393
40	0.2471	0.2387	0.2339	0.4627	0.4578	0.4528
41	0.2543	0.2454	0.2403	0.4766	0.4714	0.4663
42	0.2615	0.2520	0.2468	0.4905	0.4851	0.4797
43	0.2687	0.2587	0.2532	0.5043	0.4988	0.4932
44	0.2759	0.2653	0.2596	0.5182	0.5124	0.5066
45	0.2831	0.2720	0.2660	0.5321	0.5261	0.5201
46	0.2918	0.2799	0.2733	0.5493	0.5432	0.5369
47	0.3005	0.2878	0.2806	0.5665	0.5604	0.5537
48	0.3092	0.2958	0.2878	0.5836	0.5775	0.5704
49	0.3179	0.3037	0.2951	0.6008	0.5947	0.5872
50	0.3266	0.3116	0.3024	0.6180	0.6118	0.6040
51	0.3365	0.3204	0.3104	0.6379	0.6314	0.6232
52	0.3464	0.3291	0.3183	0.6577	0.6509	0.6423
53	0.3563	0.3379	0.3263	0.6776	0.6705	0.6615
54	0.3662	0.3466	0.3342	0.6974	0.6900	0.6806
55	0.3761	0.3554	0.3422	0.7173	0.7096	0.6998
56	0.3877	0.3654	0.3512	0.7411	0.7322	0.7217
57	0.3993	0.3754	0.3602	0.7649	0.7548	0.7436
58	0.4110	0.3854	0.3691	0.7887	0.7773	0.7654
59	0.4226	0.3954	0.3781	0.8125	0.7999	0.7873
60	0.4342	0.4054	0.3871	0.8363	0.8225	0.8092

**Table 2**  
**Tabular Values for Figure 2**

Half-Apex Angle, deg	Y			X		
	R/t = 500	R/t = 100	R/t = 50	R/t = 500	R/t = 100	R/t = 50
30	0.1601	0.1604	0.1613	0.3325	0.3297	0.3264
31	0.1646	0.1650	0.1660	0.3468	0.3437	0.3402
32	0.1691	0.1696	0.1708	0.3611	0.3578	0.3539
33	0.1735	0.1742	0.1755	0.3754	0.3718	0.3677
34	0.1780	0.1788	0.1802	0.3897	0.3858	0.3815
35	0.1825	0.1834	0.1849	0.4040	0.3998	0.3952
36	0.1870	0.1880	0.1897	0.4183	0.4139	0.4090
37	0.1915	0.1926	0.1944	0.4326	0.4279	0.4228
38	0.1959	0.1972	0.1991	0.4468	0.4419	0.4365
39	0.2004	0.2018	0.2038	0.4611	0.4559	0.4503
40	0.2049	0.2064	0.2086	0.4754	0.4700	0.4641
41	0.2094	0.2110	0.2133	0.4897	0.4840	0.4778
42	0.2139	0.2156	0.2180	0.5040	0.4980	0.4916
43	0.2183	0.2202	0.2227	0.5183	0.5120	0.5054
44	0.2228	0.2248	0.2275	0.5326	0.5261	0.5191
45	0.2273	0.2294	0.2322	0.5469	0.5401	0.5329
46	0.2309	0.2331	0.2359	0.5627	0.5555	0.5479
47	0.2345	0.2367	0.2397	0.5786	0.5709	0.5628
48	0.2382	0.2404	0.2434	0.5944	0.5864	0.5778
49	0.2418	0.2440	0.2472	0.6103	0.6018	0.5927
50	0.2454	0.2477	0.2509	0.6261	0.6172	0.6077
51	0.2484	0.2508	0.2540	0.6422	0.6325	0.6224
52	0.2515	0.2538	0.2572	0.6583	0.6479	0.6371
53	0.2545	0.2569	0.2603	0.6744	0.6632	0.6518
54	0.2576	0.2599	0.2635	0.6905	0.6786	0.6665
55	0.2606	0.2630	0.2666	0.7066	0.6939	0.6812
56	0.2628	0.2652	0.2688	0.7215	0.7078	0.6942
57	0.2649	0.2673	0.2710	0.7365	0.7217	0.7073
58	0.2671	0.2695	0.2733	0.7514	0.7356	0.7203
59	0.2692	0.2716	0.2755	0.7664	0.7495	0.7334
60	0.2714	0.2738	0.2777	0.7813	0.7634	0.7464

Figure 3



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Approval Date: September 30, 2018

(19)

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2151-3**  
**3 Chromium-1 Molybdenum- $\frac{1}{4}$  Vanadium-**  
**Columbium-Calcium Alloy Steel Plates and Forgings for**  
**Class 2**  
**Section VIII, Division 2**

*Inquiry:* Is it permissible in the construction of welded pressure vessels conforming to the requirements of Section VIII, Division 2 for Class 2, to use steel plates and forgings with chemical, tensile, and toughness requirements as described in applicable material specifications of Section II, Part A, tempered at minimum temperature of 1,250°F (675°C) after normalizing or quenching, but otherwise conforming to the requirements of one of the specifications listed in [Table 1](#)?

*Reply:* It is the opinion of the Committee that the materials specified in the Inquiry may be used in the construction of welded vessels under the rules of Section VIII, Division 2 for Class 2, provided the following additional requirements are met.

(a) The maximum design metal temperature shall not exceed 900°F (482°C).

(b) *Mechanical Properties*

(1) The maximum allowable stress values,  $S$ , for Division 2, for Class 2 shall be as listed in [Table 2](#) and [Table 2M](#).

(2) The physical properties in Section II, Part D shall apply.

(3) The stress-strain curve in Annex 3-D.3 of Section VIII, Division 2 for Class 2 shall apply.

(4) The design fatigue curve in Section VIII, Division 2, Annex 3-F shall apply. The interpolation using 552 MPa (80 ksi) curve, and 793 MPa to 892 MPa (115 ksi to 130 ksi) curve may be applicable.

(5) For external pressure applications, use Section II, Part D, Figure CS-3.

(c) The final postweld heat treatment shall be in accordance with the requirements of Division 2 for Class 2 for P-No. 5C Grade 1 material.

(d) The supplemental requirements for Cr-Mo steels in Section VIII, Division 2, 3.4, except 3.4.4.5 shall apply.

(e) Welding shall be limited to the submerged-arc (SAW), the shielded metal-arc (SMAW), and the gas tungsten-arc (GTAW) processes.

(f) All applicable requirements of Section II, Part D, Subpart 1, Table 5A, if appropriate, shall apply except as otherwise provided above.

(g) This Case number shall be referenced in the documentation of the material and recorded on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1  
Material Specifications**

Specification	Grade	Material
SA-182	F3Vcb	Forgings
SA-336	F3Vcb	Forgings
SA-508	3Vcb	Forgings
SA-541	3Vcb	Forgings
SA-542	Type E, Class 4a	Plates
SA-832	23V	Plates

**Table 2  
Maximum Stress Values, S, for Class 2**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Value, S, ksi
600	35.4
650	34.8
700	34.1
750	33.3
800	31.2
850	25.8
900	21.0

GENERAL NOTES:

- (a) Allowable stress for 800°F and above are values obtained from time-dependent properties.
- (b) The allowable stress values for temperatures of 800°F and above are the same values provided for 3Cr-1Mo-1/4V-Ti-B, which is similar to 3Cr-1Mo-1/4V-Cb-Ca, except that the creep strength of 3Cr-1Mo-1/4V-Cb-Ca alloy is slightly higher than that of 3Cr-1Mo-1/4V-Ti-B.

**Table 2M  
Maximum Stress Values, S, for Class 2**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Value, S, MPa
300	244
325	243
350	239
375	234
400	229
425	223
450	183
475	153
500 [Note (1)]	125

GENERAL NOTES:

- (a) Allowable stress for 450°C and above are values obtained from time-dependent properties.
- (b) The allowable stress values for temperatures of 425°C and above are the same values provided for 3Cr-1Mo-1/4V-Ti-B, which is similar to 3Cr-1Mo-1/4V-Cb-Ca, except that the creep strength of 3Cr-1Mo-1/4V-Cb-Ca alloy is slightly higher than that of 3Cr-1Mo-1/4V-Ti-B.

NOTE:

- (1) The value provided at 500°C is for interpolation only. See (a).

Approval Date: March 20, 2018

*Code Cases will remain available for use until annulled by the applicable Standards Committee.***Case 2155-2**  
**Use of Rod and Bar for Heads**  
**Section VIII, Division 1**

*Inquiry:* In lieu of the rules of UG-14, may rod and bar material be used for heads of pressure vessels constructed under Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that, in lieu of the rules of UG-14, rod and bar material may be used for heads of pressure vessels constructed under Section VIII, Division 1 provided the following additional requirements are met.

(a) The material shall conform to one of the specifications given in Section II and shall be limited to those permitted in the applicable part of Subsection C.

(b) Flat heads with welding hubs, and heads machined so that the axis of the finished head parallel to the axis of the vessel is parallel to the long axis of the rod or bar, shall:

(1) in addition to those required by the material specification, have at least two transverse tensile test specimens taken from each lot (as defined in the material specification) of rod or bar material and having the same diameter. The second specimen shall be oriented at

90 deg around the perimeter from the first specimen. The axis of the tensile specimen shall be located, as nearly as practicable, midway between the center thickness and the surface of the rod or bar. Both specimens shall meet the mechanical property requirements of the material specification and, for Table UCS-23 materials, the reduction of area shall be not less than 30%.

(2) be ultrasonically examined by the straight beam technique in accordance with SA-388. The examinations shall be performed along the perimeter of the head and also in the axial direction. The head shall be unacceptable if:

(-a) the examination results show one or more indications accompanied by loss of back reflection larger than 60% of the reference back reflection;

(-b) The examination results show indications larger than 40% of the reference back reflection when accompanied by a 40% loss of back reflection.

(3) before welding, have the cut surfaces of the head adjacent to the weld examined by magnetic particle or liquid penetrant methods in accordance with Mandatory Appendix 6 or 8, respectively, of Section VIII, Division 1.

(c) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: March 20, 2018

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2156-3**  
**Use of Rod and Bar for Hollow Cylindrical-Shaped Parts**  
**Section VIII, Division 1**

*Inquiry:* In lieu of the rules of UG-14, may rod and bar material be used for hollow cylindrical-shaped parts constructed under Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that, in lieu of the rules of UG-14, rod and bar material may be used for hollow cylindrical-shaped parts constructed under Section VIII, Division 1, provided the following additional requirements are met:

(a) The materials shall conform to one of the specifications given in Section II and shall be limited to those permitted in the applicable part of Subsection C.

(b) The longitudinal axis of the part shall be parallel to the longitudinal axis of the rod or bar.

(c) In addition to those required by the material specification, at least two transverse tensile test specimens shall be taken from each lot (as defined in the material specification) of rod or bar material and having the same diameter. The second specimen shall be taken at 90 deg

around the perimeter from the first specimen. The axis of the tensile specimen shall be located, as nearly as practicable, midway between the center thickness and the surface of the rod or bar. Both specimens shall meet the mechanical property requirements of the material specification and, for Table UCS-23 materials, the reduction of area shall be not less than 30%.

(d) Each rod or bar, before machining, shall be 100% ultrasonically examined perpendicular to the longitudinal axis by the straight beam technique in accordance with SA-388. The shell shall be unacceptable if:

(1) The examination results show one or more indications accompanied by loss of back reflection larger than 60% of the reference back reflection.

(2) The examination results show indications larger than 40% of the reference back reflection when accompanied by a 40% loss of back reflection.

(e) Before welding, the cut surfaces of the part adjacent to the weld shall be examined by magnetic particle or liquid penetrant methods in accordance with Mandatory Appendix 6 or 8, respectively, of Section VIII, Division 1.

(f) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: August 8, 1994

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2172**  
**Use of B43 Seamless Red Brass Pipe (UNS C23000) With**  
**Drawn General Purpose Temper (H58) for Threaded**  
**Piping for Construction of PMB and PEB Miniature**  
**Electric Boilers**  
**Section I**

*Inquiry:* May seamless red brass pipe (UNS C23000) manufactured to Specification B43 with drawn general purpose (H58) temper be used for threaded piping for Section I, PMB and PEB miniature electric boilers?

*Reply:* It is the opinion of the Committee that B43 seamless red brass pipe (UNS C23000) with drawn general purpose (H58) temper may be used for threaded piping for Section I, PMB and PEB miniature electric boilers provided the following additional requirements are met.

(a) The seamless red brass pipe meets all other requirements in Section II, Part B, Specification SB-43 except for temper.

(b) Stress values for design shall be those provided in Table 1B of Section II, Part D, SB-43, UNS C23000 for the annealed condition (O61).

(c) Operating temperatures do not exceed 406°F, as stipulated in para. PG-9.3.

(d) A warning label shall be provided stating that ammonia or ammonium compounds shall not be permitted to come into contact with the external or internal surface of the pipe. The label shall be attached to the boiler near the feed water inlet connections.

(e) This Case number shall be shown on the Manufacturer's Data Report.

**CAUTION: This material is sensitive to stress corrosion cracking in certain aqueous environments.**

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: June 28, 2012

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2179-8**  
**9Cr-2W, UNS K92460 Material**  
**Section I; Section VIII, Division 1**

*Inquiry:* May 9Cr-2W, UNS K92460 material conforming to one of the specifications listed in [Table 1](#) be used for Section I and Section VIII, Division 1 construction?

*Reply:* It is the opinion of the Committee that 9Cr-2W, UNS K92460 material conforming to one of the specifications listed in [Table 1](#) may be used for Section I and Section VIII, Division 1 construction, provided the following additional requirements are met:

(a) SA-369, FP92 material shall not exceed Brinell Hardness of 250 HBW/265 HV (25 HRC).

(b) The maximum allowable stress values, the tensile strength values, and the yield strength values for the material shall be those given in [Tables 2 and 2M](#), [3 and 3M](#), [4 and 4M](#), respectively. The maximum use temperature for the material shall be 1,200°F (649°C).

(c) For the purposes of procedure and performance qualifications, the material shall be considered P-No. 15E Group 1. The procedure and performance qualifications shall be conducted in accordance with Section IX. Postweld heat treatment for this material is mandatory, and the following rules shall apply:

(1) The time requirements shall be those given for P-No. 15E, Group 1 materials in [Tables PW-39 and UCS-56](#) for Sections I and VIII, Division 1, respectively.

(2) The PWHT temperature range shall be 1,350°F to 1,470°F (730°C to 800°C).

(d) For Section VIII, Division 1 applications, all requirements of Subsection C, Part UCS shall apply.

(e) Repair welding of base material shall be permitted as prescribed by the applicable material product specification or its general requirements specification. Repair welding of base material shall be performed using procedures and welders or welding operators that have been qualified in accordance with Section IX and with one of the following welding processes: SMAW, SAW, GTAW, and FCAW. The composition of the welding consumables shall be such that the lower critical transformation temperature of the consumables shall exceed the maximum postweld heat treatment temperature in para. (c)(2). If the lower critical transformation temperature is

calculated rather than measured, the formula used shall be reported. If requested, data supporting the validity of the formula shall be provided to the Manufacturer. All repair welds to base material shall be normalized and tempered according to the requirements of the applicable material product specification.

(f) Except as provided in (e), if during the manufacturing any portion of the component is heated to a temperature greater than 1,470°F (800°C), then the component must be re-austenitized and retempered in its entirety in accordance with the applicable material specification, or that portion of the component heated above 1,470°F (800°C), including the Heat-Affected Zone created by the local heating, must be replaced, or must be removed, re-austenitized, and retempered, and then replaced in the component.

(g) If the allowable stress values to be used are less than or equal to those provided in [Table 1A](#) of Section II, Part D for Grade 9 (SA-213 T9, SA-335 P9, or equivalent product specifications) at the design temperature, then the requirements of para. (e) may be waived, provided that the portion of the component heated to a temperature greater than 1,470°F (800°C) is reheat-treated within the temperature range 1,350°F to 1,425°F (730°C to 775°C). If this provision is exercised, it shall be noted on the Manufacturer's Data Report.

(h) Formed areas of vessel shell sections, heads, and other pressure boundary parts of this material shall be heat treated as follows:

(1) For Section I, forming strains shall be calculated using the equations of PG-19. For Section VIII, Division 1, forming strains (extreme fiber elongations) shall be calculated using the equations of UHA-44(a)(2). When the forming strains cannot be calculated as shown in PG-19 of Section I or UHA-44(a)(2) of Section VIII, Division 1, the Manufacturer shall have the responsibility to determine the maximum forming strain, except as limited by (2) and (3)(-a).

(2) *Hot-Forming.* For any hot-formed product form, the material shall be normalized and tempered in accordance with (3)(-d), regardless of the amount of strain. Hot-forming is defined as any forming that is performed at or above the temperature of 1,300°F (705°C) and produces permanent strain in the material.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

(3) *Cold-Forming.* Cold-forming is defined as any forming that is performed at a temperature below 1,300°F (705°C) and produces permanent strain in the material.

(-a) For cold-formed flares, swages, or upsets in tubing or pipe, the material shall be normalized and tempered in accordance with (-f) regardless of the amount of strain.

(-b) For design temperatures exceeding 1,000°F (540°C) but less than or equal to 1,115°F (600°C), and cold-forming strains greater than 25%, the material shall be normalized and tempered in accordance with (-f).

(-c) For design temperatures exceeding 1,115°F (600°C) and cold-forming strains greater than 20%, the material shall be normalized and tempered in accordance with (-f).

(-d) For design temperatures exceeding 1,000°F (540°C) but less than or equal to 1,115°F (600°C), and cold-forming strains greater than 5% but less than or equal to 25%, the material shall be heat treated in accordance with (-g), (-h), or (-i).

(-e) For design temperatures exceeding 1,115°F (600°C), and cold-forming strains greater than 5% but less than or equal to 20%, the material shall be heat treated in accordance with (-g) or (-i).

(-f) Normalization shall be performed in accordance with the requirements of the applicable material specification and shall not be performed locally. The material shall either be heat treated in its entirety, or the cold-strained area (including the transition to the undeformed portion) shall be cut away from the balance of the component and heat treated separately, or replaced.

(-g) Post cold-forming heat treatment shall be performed at 1,350°F to 1,425°F (730°C to 775°C) for 1 hr/in. (1 h/25 mm) or 30 min minimum. Alternatively, the material may be normalized and tempered in accordance with (-f).

(-h) For design temperatures less than or equal to 1,115°F (600°C) and cold-forming strains greater than 5% but less than or equal to 25%, if a portion of the component is heated above the post-forming heat treatment, then either the component shall be normalized and tempered according to (-f), or (g) shall apply.

(-i) If a longitudinal weld is made to a portion of the material that is cold-strained, that portion shall be normalized and tempered in accordance with (-f).

(i) This Case number shall be shown on the Manufacturer's Data Report and in the certification and marking of the material.

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**Table 1**  
**Material Specifications and Grades**

Flanges, fittings, valves, and parts	SA-182 F92
Forged and bored pipe	SA-369 FP92
Forgings	ASTM A336/A336M-10a F92
Plate	ASTM A1017/A1017M-11 Grade 92
Seamless pipe	SA-335 P92
Seamless tubes	SA-213 T92

**Table 2**  
**Maximum Allowable Stress Values**

For Metal Temperature	
Not Exceeding, °F	ksi
-20 to 100	25.7
200	25.7
300	25.3
400	24.5
500	23.8
600	23.2
650	22.8
700	22.4
750	21.9
800	21.4
850	20.8
900	20.1
950	19.2
1,000	18.3
1,050	15.7 [Note (1)]
1,100	12.0 [Note (1)]
1,150	8.6 [Note (1)]
1,200	5.6 [Note (1)]

NOTE:

(1) These stress values are obtained from time-dependent properties.

**Table 3**  
**Tensile Strength Values**

For Metal Temperature	
Not Exceeding, °F	ksi
-20 to 100	90.0
200	84.0
300	80.6
400	77.9
500	75.8
600	73.7
650	72.5
700	71.2
750	69.8
800	68.0
850	66.1
900	63.8
950	61.2
1,000	58.1
1,050	54.6
1,100	50.6
1,150	46.1
1,200	40.9

**Table 2M**  
**Maximum Allowable Stress Values**

For Metal Temperature	
Not Exceeding, °C	MPa
-30 to 40	177
85	177
100	177
125	177
150	174
200	169
250	165
300	161
325	159
350	156
375	154
400	151
425	148
450	144
475	140
500	135
525	129
550	123
575	99.5 [Note (1)]
600	77.0 [Note (1)]
625	56.5 [Note (1)]
650 [Note (2)]	38.3 [Note (1)]

NOTES:

(1) These stress values are obtained from time-dependent properties.

(2) The maximum use temperature is 649°C. The value at 650°C is provided for interpolation purposes only.

**Table 3M**  
**Tensile Strength Values**

For Metal Temperature	
Not Exceeding, °C	MPa
-30 to 40	621
85	621
100	621
125	621
150	610
200	592
250	577
300	563
325	556
350	547
375	539
400	528
425	517
450	504
475	489
500	472
525	452
550	429
575	404
600	376
625	344
650	309

**Table 4**  
**Yield Strength Values**

For Metal Temperature	
Not Exceeding, °F	ksi
-20 to 100	64.0
200	61.0
300	59.7
400	58.9
500	58.2
600	57.3
650	56.6
700	55.7
750	54.7
800	53.4
850	51.7
900	49.7
950	47.4
1,000	44.5
1,050	41.2
1,100	37.4
1,150	33.0
1,200	28.0

**Table 4M**  
**Yield Strength Values**

For Metal Temperature	
Not Exceeding, °C	MPa
-30 to 40	441
85	428
100	419
125	415
150	411
200	406
250	402
300	397
325	393
350	389
375	383
400	377
425	368
450	359
475	347
500	333
525	316
550	297
575	276
600	251
625	223
650	191

Approval Date: August 11, 2010

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2180-6**  
**Seamless 12Cr-2W Material**  
**Section I; Section VIII, Division 1**

*Inquiry:* May 12Cr-2W seamless tubes, pipes, plate, and forgings with the chemical analysis shown in Table 1, and minimum mechanical properties as shown in Table 2 that otherwise conform to the specifications listed in Table 3 be used for Sections I and VIII, Division 1 construction?

*Reply:* It is the opinion of the Committee that 12Cr-2W seamless tubes, pipes, plate, and forgings with the chemical analysis shown in Table 1, and minimum mechanical properties as shown in Table 2 that otherwise conform to the specifications listed in Table 3 be used for Sections I and VIII, Division 1 construction, provided the following requirements are met:

(a) The material shall be austenitized within the temperature range of 1900°F to 1975°F (1040°C to 1080°C), followed by air cooling or accelerated cooling, and tempered within the range of 1350°F to 1470°F (730°C to 800°C).

(b) The material shall not exceed a Brinell Hardness Number of 250 (Rockwell C 25).

(c) The maximum allowable stress values for the material shall be those given in Table 4.

(d) Separate weld procedure and performance qualifications conducted in accordance with Section IX shall be required for this material. Postweld heat treatment for this material is mandatory, and the following rules shall apply:

(1) The time requirements shall be those given for P-No. 15E, Group 1 materials in Tables PW-39 and UCS-56 for Sections I and VIII, Division 1, respectively.

(2) The PWHT temperature range shall be 1350°F to 1470°F (730°C to 800°C).

(e) For Section VIII, Division 1 applications, all requirements of Part UCS shall apply.

(f) Except as provided in (g) if during the manufacturing any portion of the component is heated to a temperature greater than 1470°F (800°C), then the component

must be re-austenitized and retempered in its entirety in accordance with (a) or that portion of the component heated above 1470°F (800°C), including the Heat-Affected Zone created by the local heating, must be replaced, or must be removed, re-austenitized, and retempered, and then replaced in the component.

(g) If the allowable stress values to be used are less than or equal to those provided in Table 1A of Section II, Part D for Grade 9 (SA-213 T9, SA-335 P9, or equivalent product specifications) at the design temperature, then the requirements of (e) may be waived provided that the portion of the component heated to a temperature greater than 1470°F (800°C) is reheat treated within the temperature range 1350°F to 1425°F (730°C to 775°C).

(h) This Case number shall be shown on the Manufacturer's Data Report.

(i) This Case number shall be shown in the material certification and marking of the material.

**Table 1**  
**Chemical Requirements**

Element	Composition Limits, %
Carbon	0.07-0.14
Manganese, max.	0.70
Phosphorus, max.	0.020
Sulfur, max.	0.010
Silicon, max.	0.50
Chromium	10.00-11.50
Molybdenum	0.25-0.60
Tungsten	1.50-2.50
Nickel, max.	0.50
Copper	0.30-1.70
Vanadium	0.15-0.30
Columbium	0.04-0.10
Nitrogen	0.040-0.100
Aluminum, max.	0.02
Boron, max.	0.005
Titanium, max.	0.01
Zirconium, max.	0.01

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**Table 2  
 Mechanical Property Requirements**

Tensile strength, min., ksi	90
Yield strength, min., ksi	58
Elongation in 2 in., min., % [Note (1)]	20

NOTE:

(1) For longitudinal strip tests, a deduction from the basic values of 1.00% for each  $\frac{1}{32}$  in. decrease in wall thickness below  $\frac{5}{16}$  in. shall be made. The following table gives the computed values.

Wall Thickness, in.	Elongation in 2 in., min., %
$\frac{5}{16}$ (0.312)	20.0
$\frac{9}{32}$ (0.281)	19.0
$\frac{1}{4}$ (0.250)	18.0
$\frac{7}{32}$ (0.219)	17.0
$\frac{3}{16}$ (0.188)	16.0
$\frac{5}{32}$ (0.156)	15.0
$\frac{1}{8}$ (0.125)	14.0
$\frac{3}{32}$ (0.094)	13.0
$\frac{1}{16}$ (0.062)	12.0
0.062 to 0.035, excl.	11.6
0.035 to 0.022, excl.	10.9
0.022 to 0.015, incl.	10.6

GENERAL NOTE: The above table gives the computed minimum elongation values for each  $\frac{1}{32}$  in. decrease in wall thickness. Where the wall thickness lies between two values shown above, the minimum elongation value shall be determined by the following equation:

$$E = 32t + 1.00$$

where

$E$  = elongation in 2 in., %  
 $t$  = actual thickness of specimen, in.

**Table 4  
 Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Max. Allowable Stress Values, ksi
-20 to 100	25.7
200	25.7
300	25.0
400	24.2
500	23.7
600	23.1
650	22.9
700	22.5
750	22.1
800	21.6
850	21.1
900	20.3
950	19.5
1,000	18.5
1,050	14.4
1,100	10.6
1,150	7.2
1,200	4.5

GENERAL NOTE: The allowable stress values are based on the revised criteria of tensile strength at temperature divided by 3.5, where applicable.

**Table 3  
 Specification**

Forgings	SA-182
Pipe	SA-335
Plate	SA-1017
Tube	SA-213

Approval Date: October 16, 2015

*Code Cases will remain available for use until annulled by the applicable Standards Committee.***Case 2192-9**  
**9Cr-1Mo-V Material, UNS J84090**  
**Section I**

*Inquiry:* May 9Cr-1Mo-V material, UNS J84090, with the chemical composition shown in [Table 1](#), the mechanical properties shown in [Table 2](#), and otherwise conforming to applicable requirements of Section II, Part A: SA-217/SA-217M, Grade C12A or SA-426/SA-426M, Grade CP91 be used for Section I construction?

*Reply:* It is the opinion of the Committee that 9Cr-1Mo-V material, UNS J84090, having the chemical requirements shown in [Table 1](#) and room temperature mechanical property requirements shown in [Table 2](#), may be used in Section I construction provided the following requirements are met:

(a) The material shall meet the chemical analysis and minimum tensile requirements described in the Inquiry, and shall otherwise meet the requirements of SA-217/SA-217M or SA-426/SA-426M, as applicable.

(b) The casting shall be inspected in accordance with the requirements of Supplementary Requirements S5 (Radiographic Inspection) or S7 (Ultrasonic Inspection), as described in ASTM A703. The choice of method shall be at the option of the material manufacturer unless otherwise stated in the purchase order.

(c) The material shall be austenitized within the temperature range of 1,900°F to 1,975°F (1 040°C to 1 080°C), followed by air or accelerated cooling<sup>1</sup> to a temperature of 200°F (95°C) or below, followed by tempering within the range of 1,350°F to 1,470°F (730°C to 800°C). However, if a major weld repair, as defined in SA-217/SA-217M, para. 9.4 is made to SA-217/SA-217M or SA-426/SA-426M castings after the austenitizing and tempering heat treatment, then a new austenitizing and tempering heat treatment in accordance with the requirements of this subparagraph shall be carried out.

(d) When heat treating single castings, compliance with the specified temperature range shall be verified by thermocouples placed directly on the casting. For castings that are heat treated in batches, compliance with the specified temperature range shall be verified by

thermocouples placed on selected castings in each heat treatment batch. The number and location of thermocouples to be placed on each casting, or on each heat treatment batch of castings, for verification of heat treatment shall be as agreed between the purchaser and the producer. A record of the final austenitizing and tempering heat treatment and any subsequent subcritical heat treatment, to include both the number and location of thermocouples applied to each casting, or to each heat treatment batch of castings, shall be prepared and made available to the purchaser. In addition, all heat treatment temperatures and cycle times for the final austenitizing and tempering heat treatment and any subsequent subcritical heat treatment shall be shown on the certification report.

(e) The hardness of the cast material after the final heat treatment shall be Brinell Hardness Number 185 – 248 HBW (Rockwell B90 – Rockwell C25).

(f) The maximum allowable stress values for the material shall be those given in [Table 3](#).

(g) Welding procedure and performance qualifications shall be conducted in accordance with Section IX. This material shall be considered P-No. 15E, Group 1.

(h) Weld repairs to castings or cast pipe shall be made with one of the following welding processes and consumables:

(1) SMAW, SFA-5.5/SFA-5.5M E90XX-B9

(2) SAW, SFA-5.23/SFA-5.23M EB9 + neutral flux

(3) GTAW, SFA-5.28/SFA-5.28M ER90S-B9

(4) FCAW, SFA-5.29/SFA-5.29M E91T1-B9

In addition, the Ni + Mn content of all welding consumables shall not exceed 1.0%.

(i) Weld repairs to castings or cast pipe as part of material manufacture shall be made with welding procedures and welders qualified in accordance with Section IX.

(j) All weld repairs shall be recorded with respect to their location on the casting. For all major weld repairs, as defined in SA-217/SA-217M, para. 9.4, the record shall include a description of the length, width, and depth of the repair. Supplementary Requirement S12 of ASTM A703 shall apply. For weld repairs performed as part of material manufacture, the documentation shall be included with

<sup>1</sup> To facilitate complete transformation to martensite after the austenitizing, cooling should be as uniform as possible.

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the Material Test Report. For weld repairs performed by the Manufacturer, documentation shall be included with the Manufacturer's Data Report.

(k) Except as provided in (l) if during the manufacturing any portion of the component is heated to a temperature greater than 1,470°F (800°C), then the component must be re-austenitized and retempered in its entirety in accordance with (c), or that portion of the component heated above 1,470°F (800°C), including the Heat-Affected Zone created by the local heating, must be replaced, or must be removed, re-austenitized, and retempered, and then replaced in the component.

(l) If the allowable stress values to be used are less than or equal to those provided in Table 1A of Section II, Part D for Grade 9 (SA-217/SA-217M, Grade C12; SA-426/SA-426M, Grade CP9; or equivalent product specifications) at the design temperature, then the requirements of (k) may be waived, provided the portion of the component heated to a temperature greater than 1,470°F (800°C) is reheat treated within the temperature range 1,350°F to 1,425°F (730°C to 775°C). Use of this waiver shall be recorded on the Manufacturer's Data Report.

(m) A manufacturer's test report meeting certification requirements of SA-703/SA-703M shall be provided.

(n) This Case number shall be shown in the material certification and marking of the material.

(o) This Case number shall be shown on the Manufacturer's Data Report.

**Table 1  
Chemical Requirements**

Element	Composition, %
Carbon	0.08-0.12
Manganese	0.30-0.60
Phosphorus, max.	0.020
Sulfur, max.	0.010
Silicon	0.20-0.50
Chromium	8.00-9.50
Molybdenum	0.85-1.05
Nickel, max.	0.40
Vanadium	0.18-0.25
Columbium	0.06-0.10
Nitrogen	0.03-0.07
Aluminum, max.	0.02
Titanium, max.	0.01
Zirconium, max.	0.01

**Table 2  
Mechanical Property Requirements (Room Temperature)**

Tensile strength, min., ksi (MPa)	85 (585)
Yield strength, min., ksi (MPa)	60 (415)
Elongation in 2 in. (50 mm), min., %	18

**Table 3  
Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Allowable Stress Values, Max., ksi [Note (1)]
-20 to 100	24.3
200	24.3
300	23.6
400	22.7
500	22.0
600	21.4
650	21.0
700	20.6
750	20.2
800	19.7
850	19.1
900	18.5
950	17.7
1,000	14.3
1,050	11.4
1,100	8.8
1,150	6.5
1,200	4.2

NOTE:

(1) The allowable stress values are based on the revised criterion of tensile strength at temperature divided by 3.5, where applicable.

Approval Date: February 7, 2000

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2195-1**  
**24.5Cr-22Ni-7.5Mo-3Mn-N Austenitic Stainless Steel**  
**(UNS S32654)**  
**Section VIII, Division 1**

*Inquiry:* May solution annealed alloy UNS S32654 wrought sheet, strip, plate, seamless and welded pipe, forgings, fittings, and welded tubing, with chemical composition conforming to [Table 1](#), room temperature mechanical properties conforming to [Table 2](#) and otherwise conforming to the specifications SA-240, SA-312, SA-182, SA-403, and SA-249 respectively, be used in welded construction under the rules of Section VIII, Division 1?

*Reply:* It is the opinion of the committee that solution annealed alloy UNS S32654 as described in the inquiry, may be used in welded construction under the rules of Section VIII, Division 1, provided the following additional requirements are met.

(a) The rules of Section VIII, Division 1, Subsection C that shall apply are given in part UHA for austenitic stainless steels.

(b) The maximum allowable stress values for the material shall be those given in [Table 3](#). For welded pipe and tube products, a joint efficiency factor of 0.85 shall be used for circumferential stress design.

(c) Separate welding procedure qualifications and performance qualifications, conducted in accordance with Section IX, shall be required for this material.

(d) For external pressure design, use Fig. HA-2 of Section II, Part D to a maximum temperature of 800°F.

(e) The minimum solution annealing temperature shall be 2100°F, to be followed by quenching in water or rapidly cooled by other means.

(f) Post-weld heat treatment after forming or fabrication is neither required nor prohibited, but when heat treatment is performed, it shall be as noted in (e).

(g) ENiCrMo-3 and ERNiCrMo-3 or similar corrosion resistant weld filler metals may be used to weld UNS S32654 materials.

(h) This Case number shall be shown on the documentation and marking of the material and on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Chemical Requirements**

Element	Composition, %
Carbon, max.	0.020
Manganese	2.00–4.00
Phosphorous, max.	0.030
Sulfur, max.	0.005
Silicon, max.	0.50
Chromium	24.00–25.00
Nickel	21.00–23.00
Molybdenum	7.00–8.00
Copper	0.30–0.60
Nitrogen	0.45–0.55
Iron	Balance

**Table 2**  
**Mechanical Test Requirements (Room Temperature)**

Tensile strength, ksi	109
Yield strength, 0.2% offset, ksi	62
Elongation in 2 in., min., %	35.0

**Table 3**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Allowable Stress Values, Max., ksi [Note (1)]
75/100	31.1
200	31.1
300	30.3
400	28.5
500	27.3
600	26.6
650	26.4
700	26.3
750	26.1
800	25.9

## NOTE:

(1) The revised criterion of 3.5 on tensile strength was used in establishing these values.

Approval Date: June 26, 2018

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2196-4**  
**Austenitic Stainless Steel Seamless Tubes and Pipe,**  
**Seamless Wrought Fittings, Plate, and Sheet, 18Cr-11Ni-**  
**Cb-N, UNS S34751, 347LN**  
**Section VIII, Division 1**

*Inquiry:* May solution annealed stainless steel seamless tubes and pipe, seamless wrought fittings, plate, and sheet, UNS S34751, 347LN, with the seamless tubes and pipe meeting the requirements of SA-213 TP347LN and SA-312 TP347LN, respectively; and the seamless wrought fittings, plate, and sheet, with chemical compositions conforming to [Table 1](#), mechanical properties conforming to [Table 2](#), and otherwise conforming to the applicable requirements of SA-182, SA-240, and SA-403 be used in welded construction under the rules of Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that solution-annealed austenitic stainless steel seamless tubes and pipe, seamless wrought fittings, plate, and sheet, UNS S34751, 347LN, as described in the Inquiry, may be used in welded construction under the rules of Section VIII, Division 1, provided that the following additional requirements are met:

(a) The seamless tubes and pipe shall meet the requirements of SA-213 TP347LN and SA-312 TP347LN, respectively.

(b) The seamless wrought fittings, plate, and sheet shall meet the chemical analysis of [Table 1](#) and the minimum tensile requirements of [Table 2](#), and shall otherwise meet the requirements of SA-182, SA-240, and SA-403, as applicable, except as shown in paras. (d) and (e).

(c) The rules of Section VIII, Division 1, Subsection C, Part UHA for austenitic stainless steels shall be met. The post-fabrication heat treatment rules of UHA-44 that apply to Grade 347, UNS S34700 shall apply to this material.

(d) The seamless wrought fittings, plate, and sheet material shall be solution annealed at a minimum temperature of 1,900°F (1,040°C).

(e) The hardness of the plate material shall not exceed 201 HBW (92 HRB).

(f) The yield strength and tensile strength values are shown in [Tables 3](#) and [3M](#).

(g) The maximum allowable stress values for the material shall be as given in [Tables 4](#) and [4M](#). The maximum design temperature is 1,250°F (677°C).

(h) For external pressure design, Fig. HA-2 in Section II, Part D shall be used.

(i) The physical property values (modulus of elasticity, coefficients of linear thermal expansion, thermal conductivity and diffusivity, and density) shall be those shown for 18Cr-10Ni-Cb and High Alloy Steels (300 series) material in Section II, Part D, Subpart 2.

(j) The material shall be considered as P-No. 8, Group 1.

(k) This Case number shall be included in the documentation and marking of the seamless wrought fitting, plate, and sheet material and in the Manufacturer's Data Report.

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**Table 1  
Chemical Requirements**

Element	Composition, %
Carbon	0.005–0.020
Manganese, max.	2.00
Phosphorus, max.	0.045
Sulfur, max.	0.030
Silicon, max.	1.00
Nickel	9.0–13.0
Chromium	17.0–20.0
Columbium	0.20–0.50 [Note (1)]
Nitrogen	0.06–0.10

NOTE:  
(1) The material shall have a columbium content of not less than 15 times the carbon content.

**Table 2  
Mechanical Property Requirements for  
Seamless Wrought Fittings, Plate, and Sheet  
(Room Temperature)**

Tensile strength, min., ksi (MPa)	75 (515)
Yield strength, 0.2% offset min., ksi (MPa)	30 (205)
Elongation, in 2 in. (50 mm), min. %	
Fittings to SA-182	30
Fittings to SA-403	28 longitudinal, 20 transverse
Plate and Sheet	40
Reduction in Area, min. %	
Fittings to SA-182	50

**Table 3  
Yield Strength,  $S_y$ , and Tensile Strength,  $S_u$ ,  
Values**

For Metal Temperature Not Exceeding, °F	Yield Strength Values, ksi [Note (1)]	Tensile Strength Values, ksi [Note (2)]
100	30.0	75.0
200	26.5	73.1
300	24.0	66.9
400	21.9	62.3
500	20.4	59.3
600	19.4	57.7
650	19.1	57.4
700	18.9	57.2
750	18.7	57.1
800	18.7	57.0
850	18.6	56.9
900	18.6	56.6
950	18.6	56.2
1,000	18.6	55.4
1,050	18.5	54.4
1,100	18.3	53.1
1,150	18.1	51.3
1,200	17.8	49.3
1,250	17.0	46.1

NOTES:

(1) See Note (B) of Table Y-1 in Section II, Part D.

(2) See Note (B) of Table U in Section II, Part D.

**Table 3M**  
Yield Strength,  $S_y$ , and Tensile Strength,  $S_u$ ,  
Values

For Metal Temperature Not Exceeding, °C	Yield Strength Values, MPa [Note (1)]	Tensile Strength Values, MPa [Note (2)]
40	207	517
65	192	517
100	180	498
125	172	478
150	165	461
175	158	445
200	152	432
225	147	421
250	142	412
275	138	405
300	135	400
325	133	397
350	131	395
375	130	394
400	129	394
425	129	393
450	129	392
475	129	391
500	128	389
525	128	385
550	128	380
575	127	372
600	126	363
625	124	352
650	123	339
675	117	319
700	116 [Note (3)]	300 [Note (3)]

## NOTES:

- (1) See Note (B) of Table Y-1 in Section II, Part D.  
 (2) See Note (B) of Table U in Section II, Part D.  
 (3) These values are provided for interpolation purposes only.  
 The maximum design temperature of this material is as stated  
 in (g).

**Table 4**  
Maximum Allowable Stresses

For Metal Temperature Not Exceeding, °F	Allowable Stress, ksi
100	20.0, 20.0
200	17.7, 20.0 [Note (1)]
300	16.0, 19.1 [Note (1)]
400	14.6, 17.8 [Note (1)]
500	13.6, 16.9 [Note (1)]
600	12.9, 16.5 [Note (1)]
650	12.7, 16.4 [Note (1)]
700	12.6, 16.3 [Note (1)]
750	12.5, 16.3 [Note (1)]
800	12.4, 16.3 [Note (1)]
850	12.4, 16.3 [Note (1)]
900	12.4, 16.2 [Note (1)]
950	12.4, 16.1 [Note (1)]
1,000	12.4, 15.8 [Note (1)]
1,050	12.3, 15.6 [Note (1)]
1,100	12.2, 12.9 [Note (2)]
1,150	9.56, 9.56 [Note (2)]
1,200	7.03, 7.03 [Note (2)]
1,250	5.11, 5.11 [Note (2)]

## NOTES:

- (1) See Note G5 of Section II, Part D, Table 1A.  
 (2) Values in italics are obtained from time dependent proper-  
 ties. See Note T8 of Table 1A of Section II, Part D.

**Table 4M**  
**Maximum Allowable Stresses**

For Metal	
Temperature Not Exceeding, °C	Allowable Stress, MPa
40	138, 138
65	128, 137 [Note (1)]
100	120, 137 [Note (1)]
125	115, 136 [Note (1)]
150	110, 131 [Note (1)]
175	105, 127 [Note (1)]
200	101, 123 [Note (1)]
225	97.7, 120 [Note (1)]
250	94.7, 117 [Note (1)]
275	92.2, 115 [Note (1)]
300	90.2, 114 [Note (1)]
325	88.6, 113 [Note (1)]
350	87.5, 112 [Note (1)]
375	86.7, 112 [Note (1)]
400	86.2, 112 [Note (1)]
425	85.9, 112 [Note (1)]
450	85.7, 112 [Note (1)]
475	85.7, 111 [Note (1)]
500	85.6, 111 [Note (1)]
525	85.4, 110 [Note (1)]
550	85.1, 108 [Note (1)]
575	84.7, 106 [Note (1)]
600	<i>83.0, 83.0</i> [Note (1)], [Note (2)]
625	63.2, 63.2 [Note (2)]
650	47.8, 47.8 [Note (2)]
675	35.9, 35.9 [Note (2)]
700	26.9, 26.9[Note (2)], [Note (3)]

## NOTES:

- (1) See Note G5 of Section II, Part D, Table 1A.  
 (2) Values in italics are obtained from time dependent properties. See Note T8 of Table 1A of Section II, Part D.  
 (3) This value is provided for interpolation purposes only. The maximum design temperature for this material is as stated in (g).

Approval Date: February 17, 2000

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2197-1**  
**18.5Cr-15.5Ni-4.5Mo-N Alloy (UNS S31726) Austenitic**  
**Stainless Steel**  
**Section VIII, Division 1**

*Inquiry:* May solution-annealed 18.5Cr-15.5Ni-4.5Mo-N alloy (UNS S31726) plate conforming to SA-240 be used in welded and unwelded construction under Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that solution annealed 18.5Cr-15.5Ni-4.5Mo-N alloy (UNS S31726) plate, as described in the Inquiry, may be used in Section VIII, Division 1 construction provided:

(a) The material meets the chemical analysis and minimum tensile requirements detailed in the specification.

(b) Heat treatment after forming is neither required nor prohibited. If heat treatment is used, the solution heat treatment shall consist of heating to a temperature of 1,900°F min. and quenching in water or rapidly cooling by other means.

(c) The maximum allowable design stress values are those given in Table 1.

(d) The welding procedure qualifications and performance qualifications shall be conducted as prescribed in Section IX. Welding shall be done by any process or combination of processes capable of meeting the requirements. The material shall be considered P-No. 8, Group 4. ENiCrMo-3 and ERNiCrMo-3 or similar corrosion resistant weld filler metals may be used.

(e) For external pressure design, use Section II, Part D, Fig. HA-1.

(f) The rules for austenitic stainless steels in Subsection C, Part UHA, shall apply.

(g) This Case number shall be included in the marking of the material and shall be shown on the Manufacturer's Data Report.

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**Table 1**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi [Note (1)]
100	22.9
200	18.8, 22.9 [Note (2)]
300	16.8, 22.6 [Note (2)]
400	15.6, 21.0 [Note (2)]
500	15.0, 20.3 [Note (2)]

## NOTES:

- (1) The revised criterion of 3.5 on tensile strength was used in establishing these values.  
 (2) Note G5 of Section II, Part D, Table 1A applies.

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Approval Date: September 8, 2015

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2199-8**  
**2.25Cr-1.6W-V-Cb Material**  
**Section I**

*Inquiry:* May 2.25Cr-1.6W-V-Cb material with the chemical analysis shown in Table 1, and minimum mechanical properties as shown in Table 2, that otherwise conform to the specifications listed in Table 3 be used for Section I construction?

*Reply:* It is the opinion of the Committee that 2.25Cr-1.6W-V-Cb material with the chemical analysis shown in Table 1, and minimum mechanical properties as shown in Table 2 that otherwise conform to the specifications listed in Table 3 may be used for Section I construction, provided the following requirements are met:

(a) The material shall be austenitized within the temperature range of 1,900°F to 1,975°F (1 040°C to 1 080°C), followed by air or accelerated cooling, and tempered within the range of 1,325°F to 1,425°F (720°C to 775°C).

(b) The material shall not exceed a Brinell Hardness Number of 220 (Rockwell B 97, 230 HV) after tempering.

(c) The maximum allowable stress values for the material shall be those given in Table 4.

(d) Separate weld procedure qualification shall be required for this material. The welding procedure qualification shall be conducted as prescribed in Section IX. Exemptions to postweld heat treatment for this material shall be in accordance with the rules for P-No. 5A materials in PW-39. When postweld heat treatment is required, the time requirements shall be in accordance with the rules for P-No. 5A materials in PW-39, and the PWHT temperature range shall be 1,325°F to 1,425°F (720°C to 775°C). For the purposes of performance qualification, the material shall be considered P-No. 5A. The performance qualification shall be conducted as prescribed in Section IX.

(e) All cold formed material with a thickness less than  $\frac{1}{2}$  in. (13 mm), which is designed for service at a nominal temperature of 900°F (480°C) or higher, shall be heat treated in accordance with the following rules. Cold bending or forming is defined as any method that produces

strain in the material and is performed at a temperature below 1,125°F (605°C). The calculations of cold strains shall be made as described in Section I, PG-19.

(1) For materials with greater than 20% strain, and all cold swages, flares, or upsets regardless of the amount of cold reduction, the cold formed areas, including the transition to the unstrained portion, shall be re-austenitized and retempered, in accordance with (a). This heat treatment shall not be performed locally. The material shall either be heat treated in its entirety, or the cold strained area (including the transition) shall be cut away from the balance of the tube or component, and heat treated separately or replaced.

(2) For materials with greater than 5% strain, and less than or equal to 20% strain, the cold strained portion of the part or component shall not be exposed to temperatures between 1,325°F and 1,900°F (720°C and 1 040°C) during fabrication or erection, whether purposefully or incidentally with other components. If such a cold strained area is so exposed during fabrication, the cold strained area shall be scrapped or may be salvaged by re-austenitizing and retempering, as described in (1).

(3) For material described in (2), if a weld is made to that portion of the material that is cold strained, the cold strained portion shall be re-austenitized and retempered, prior to or following welding, as described in (1) above.

(4) For materials with less than or equal to 5% strain, heat treatment is neither required nor prohibited.

(f) All bending or forming in excess of 5% strain that are performed at or above 1,125°F (605°C), or on material with a thickness equal to or greater than  $\frac{1}{2}$  in. (13 mm) shall be re-austenitized and retempered, in accordance with (a). This heat treatment shall not be performed locally. The material shall either be heat treated in its entirety, or the strained area (including the transition) shall be cut away from the balance of the tube or component, and heat treated separately or replaced. For material with less than or equal to 5% strain (e.g., as a consequence of final straightening of a component), heat treatment is neither required nor prohibited unless the hot forming temperature exceeds 1,425°F (775°C), in which case (g) is applicable.

(g) Except as provided in (h), if during the manufacturing any portion of the component is heated to a temperature greater than 1,425°F (775°C), then the component

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must be re-austenitized and retempered in its entirety in accordance with (a), or that portion of the component heated above 1,425°F (775°C), including the Heat-Affected Zone created by the local heating, must be replaced, or must be removed, re-austenitized, and retempered, and then replaced in the component.

(h) If the allowable stress values to be used are less than or equal to those provided in Table 1A of Section II, Part D for Grade 22 (SA-213 T22, SA-335 P22, or equivalent product specifications) at the design temperature, then the requirements of (g) may be waived provided that the portion of the component heated to a temperature greater than 1,425°F (775°C) is reheat treated within the temperature range 1,325°F to 1,425°F (720°C to 775°C).

(i) This Case number shall be shown in the documentation and marking of the material and on the Manufacturer's Data Report.

**Table 1**  
**Chemical Requirements**

Element	Composition Limits, %
Carbon	0.04-0.10
Manganese	0.10-0.60
Phosphorous, max.	0.030
Sulfur, max.	0.010
Silicon, max.	0.50
Chromium	1.90-2.60
Molybdenum	0.05-0.30
Tungsten	1.45-1.75
Vanadium	0.20-0.30
Columbium	0.02-0.08
Nitrogen, max.	0.010
Aluminum, max.	0.030
Boron	0.0020-0.006
Nickel, max.	0.40
Titanium	0.010-0.060

**Table 2**  
**Mechanical Property Requirements**

Tensile strength, min., ksi	74
Yield strength, min., ksi	58
Elongation in 2 in., min., % [Note (1)]	20

NOTE:

(1) For longitudinal strip tests, a deduction from the basic values of 1.00% for each  $\frac{1}{32}$  in. decrease in wall thickness below  $\frac{5}{16}$  in. shall be made. The following table gives the computed values.

Wall Thickness, in.	Elongation in 2 in., min., %
$\frac{5}{16}$ (0.312)	20.0
$\frac{9}{32}$ (0.281)	19.0
$\frac{1}{4}$ (0.250)	18.0
$\frac{7}{32}$ (0.219)	17.0
$\frac{3}{16}$ (0.188)	16.0
$\frac{5}{32}$ (0.156)	15.0
$\frac{1}{8}$ (0.125)	14.0
$\frac{3}{32}$ (0.094)	13.0
$\frac{1}{16}$ (0.062)	12.0
0.062 to 0.035, excl.	11.6
0.035 to 0.022, excl.	10.9
0.022 to 0.015, incl.	10.6

GENERAL NOTE: The above table gives the computed minimum elongation values for each  $\frac{1}{32}$  in. decrease in wall thickness. Where the wall thickness lies between two values shown above, the minimum elongation value shall be determined by the following equation:

$$E = 32t + 10.0$$

where

$E$  = elongation in 2 in., %

$t$  = actual thickness of specimen, in.

**Table 3**  
**Specification**

Forgings	SA-182
Pipe	SA-335
Plate	SA-1017
Tube	SA-213

**Table 4**  
**Maximum Allowable Stress Values**

Maximum Allowable Stress Values, ksi		
For Metal Temperature	[Note (1)]	
Not Exceeding, °F	Tubes	Forgings, Pipe, Plate
-20 to 100	21.1	21.1
200	21.1	21.1
300	21.1	21.1
400	21.1	21.1
500	21.1	21.1
600	20.9	20.9
650	20.7	20.7
700	20.5	20.5
750	20.3	20.3
800	19.9	19.9
850	19.5	19.5
900	18.9	18.9
950	17.8	16.2
1000	14.3	13.3
1050	11.2	10.7
1100	8.4	8.3
1150	5.5	5.0
1200	1.4	1.4

NOTE:

(1) The allowable stress values are based on the revised criterion of tensile strength of 3.5, where applicable.

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Approval Date: May 9, 2009

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2203-1**  
**Omission of Lifting Device Requirements for Pressure Relief Valves on Air, Water Over 140°F, or Steam Service Section VIII, Division 1; Section VIII, Division 2**

*Inquiry:* Under what conditions may the lifting device specified in Section VIII, Division 1, UG-136(a)(3) for each pressure relief valve on air, water over 140°F, or steam service be omitted?

*Reply:* It is the opinion of the Committee that the requirements for a lifting device as specified in UG-136(a)(3) may be omitted, provided:

(a) The user has a documented procedure and an associated implementation program for the periodic removal of the pressure relief valves for inspection and testing, and repair as necessary.

(b) The omission is specified by the user.

(c) The user shall obtain permission to omit the lifting device from the authority having jurisdiction over the installation of pressure vessels.

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**Approval Date: June 5, 1995**

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**Case 2205**  
**Alternate Rules for Heat Treatment of Repair Welds to Castings**  
**Section VIII, Division 1**

*Inquiry:* May a Certificate Holder apply Section VIII, Division 1 post weld heat treatment requirements to casting repairs in lieu of the requirements of UG-24(b)?

*Reply:* It is the opinion of the Committee that a Certificate Holder may apply the PWHT requirements of Section VIII, Division 1 to castings repaired by welding in lieu of the requirements of UG-24(b).

This Case number shall be identified on the Manufacturer's Data Report.

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Approval Date: June 17, 2003

*Code Cases will remain available for use until annulled by the applicable Standards Committee.***Case 2217-5  
Precipitation-Hardening Ni-Cr-Mo Alloy (UNS N07725)  
Section VIII, Division 1; Section VIII, Division 2; Section  
VIII, Division 3**

*Inquiry:* May precipitation-hardened Ni-Cr-Mo alloy (UNS N07725) wrought sheet, strip, plate, bar, rod, seamless pipe and tube, and forgings with chemical analyses per [Table 1](#) and minimum mechanical properties per [Table 2](#), and otherwise conforming to one of the specifications listed in [Table 3](#), be used in welded construction under the rules of Section VIII, Divisions 1, 2, and 3?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used for Section VIII, Division 1 construction at a design temperature of 1000°F or less, and Section VIII, Division 2 construction at a design temperature of 800°F or less, provided the following additional requirements are met.

(a) The rules in Section VIII, Division 1, Subsection C, Part UNF; Division 2, Part AM; or Division 3, Part KM, as applicable for nickel alloys, shall apply.

(b) The maximum allowable stress values for Division 1 shall be those given in [Table 4](#). The design stress intensity values and yield strength values for Division 2 shall be those listed in [Table 5](#). The yield strength values for Division 3 shall be those listed in [Table 6](#).

(c) Heat treatment of the alloy shall be per the following:

Solution Anneal:	1850–1950°F, air cool
Age Hardening:	1350°F (±25°F) hold for 5.5 to 8.5 hrs., furnace cool to 1150°F (±25°F) hold for 5.5 to 8.5 hrs., air cool

(d) Separate welding procedures and performance qualifications shall be conducted in accordance with Section IX.

(e) The use of filler metal that will deposit weld metal with practically the same composition as the material joined is recommended. When the Manufacturer is of the opinion that a physically better joint can be made by departure from these limits, filler metal of a different composition may be used provided the strength of the weld metal at the operating temperature is not appreciably less than that of the high alloy material to be welded, and the user is satisfied that its resistance to corrosion is satisfactory for the intended service.

(f) Heat treatment after welding is required and shall be per (c) above.

(g) For Divisions 1 and 2, the required thickness for external pressure shall be determined from the chart in Section II, Part D, Fig. NFN-17.

(h) This Case number shall be shown on the Manufacturer's Data Report.

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**Table 1  
 Chemical Requirements**

Element	Composition Limits, %
Nickel	55.0–59.0
Chromium	19.0–22.5
Iron [Note (1)]	Remainder
Manganese, max.	0.35
Carbon, max.	0.03
Silicon, max.	0.20
Columbium	2.75–4.00
Sulfur, max.	0.010
Phosphorus, max.	0.015
Aluminum, max.	0.35
Titanium	1.00–1.70
Molybdenum	7.00–9.50

NOTE:

(1) This element shall be determined arithmetically by difference.

**Table 4  
 Maximum Allowable Stress Values, Division 1**

For Metal Temperature Not Exceeding, °F	Allowable Stress Values, max., ksi [Note (1)]
100	42.9
200	42.9
300	42.9
400	42.9
500	42.9
600	41.9
650	41.5
700	41.1
750	40.8
800	40.6

NOTE:

(1) The revised criterion of 3.5 on tensile strength was used in establishing these values.

**Table 2  
 Mechanical Property Requirements (Room Temperature)**

Tensile strength, min., ksi	150.0
Yield strength, 0.2% offset, min., ksi	120.0
Elongation, 2 in. gage or 4D, min., %	20.0

**Table 3  
 Material Specifications**

SB-443	Plate, sheet, and strip
SB-444	Seamless pipe and tube
SB-446	Rod and bar
SB-564	Forgings

**Table 5  
 Design Stress Intensity and Yield Strength Values, Division 2**

For Metal Temperature Not Exceeding, °F	Design Stress Intensity Values, $S_m$ , ksi	Yield Strength Values, $S_y$ , ksi
100	50.0	120.0
200	50.0	118.1
300	50.0	114.9
400	50.0	112.1
500	50.0	110.1
600	48.9	108.8
650	48.4	108.4
700	48.0	108.0
750	47.6	107.6
800	47.4	107.2
850	...	106.6
900	...	106.3
950	...	106.0
1000	...	105.7

**Table 6**  
**Yield Strength Values, Division 3**

For Metal Temperature Not Exceeding, °F	
Exceeding, °F	Yield Strength Values, $S_v$ , ksi
100	120.0
200	118.1
300	114.9
400	112.1
500	110.1
600	108.8
650	108.4
700	108.0
750	107.6
800	107.2

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Approval Date: October 29, 1999

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2222-2**  
**Precipitation-Hardening Nickel Alloy (UNS N07718)**  
**Used as Pressure Retaining Component Material**  
**Section VIII, Division 1; Section VIII, Division 2**

*Inquiry:* May precipitation-hardened nickel alloy rod, bar, forgings, and forging stock (UNS N07718) conforming to SB-637 be used for the construction of parts for pressure retaining components in pressure vessels of Section VIII, Divisions 1 and 2 construction?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used for Section VIII, Division 1 construction at a design temperature of 1,000°F or less, and Section VIII, Division 2 construction at a design temperature of 800°F or less, provided the following additional requirements are met.

(a) The maximum allowable stress values for use in Section VIII, Division 1 shall be those listed in Table 1.

(b) The maximum design stress intensity values for use in Section VIII, Division 2 are shown in Table 2.

(c) The rules of Part UNF shall apply for Section VIII, Division 1 construction and the rules of Article M-4 for Section VIII, Division 2 construction.

(d) No welding is permitted.

(e) The limiting factors for bearing and shear shall be applied on  $S$ ,  $S_m$ , and  $S_y$  as applicable.

(f) Use for bolting is not permitted.

(g) This Case number shall be shown on the material certification, marking of the material, and on the Data Report.

**CAUTION:** Austenitic alloys are subject to stress corrosion cracking, intergranular attack, pitting, and crevice corrosion when used in boiler applications in aqueous environments. Factors that affect the susceptibility of these materials are applied or residual stress, water chemistry and deposition of solids, and material condition. Susceptibility to attack is enhanced when the material is used in the sensitized condition, or with residual cold work. Concentration of corrosive agents (e.g., chlorides, caustic or reduced sulfur species) can occur under deposits formed on the surface of these materials, and can result in severe underdeposit wastage or cracking. For successful operation in water environments, careful attention must be paid to continuous control of water chemistry.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values, ksi**

For Metal Temperature Not Exceeding, °F	Max. Allowable Stress Values, ksi [Note (1)]
100	52.9
200	52.9
300	52.9
400	52.9
500	52.9
600	52.9
650	52.9
700	52.6
750	52.5
800	52.3
850	52.2
900	52.0
950	51.6
1,000	51.0

## NOTE:

(1) The revised criterion of 3.5 on tensile strength was used in establishing these values.

**Table 2**  
**Design Stress Intensity Values and Yield Stress Values, ksi**

For Metal Temperature Not Exceeding, °F	Yield Stress, ksi	Max. Design Stress Intensity Values, ksi
100	150.0	61.7
200	144.4	61.7
300	140.6	61.7
400	138.2	61.7
500	136.6	61.7
600	135.5	61.7
650	135.0	61.7
700	134.5	61.4
750	133.8	61.2
800	133.1	61.1

Approval Date: June 20, 2002

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2223-3**  
**Use of SA-705 Type 630 Forgings (UNS S17400) and**  
**SA-693 Type 630 Plate (UNS S17400)**  
**Section VIII, Division 1; Section VIII, Division 2**

*Inquiry:* May martensitic precipitation hardened stainless steel, 17Cr-4Ni-4Cu (UNS S17400) forgings complying with SA-705 Type 630, and plate, sheet, and strip complying with SA-693 Type 630, be used for pressure vessels constructed under Section VIII, Divisions 1 and 2?

*Reply:* It is the opinion of the Committee that martensitic precipitation hardened stainless steel, 17Cr-4Ni-4Cu (UNS S17400) forgings, plate, sheet, and strip conforming to the requirements of SA-705 Type 630, and plate, sheet, and strip complying with SA-693 Type 630, may be used for pressure vessels constructed under Section VIII, Divisions 1 and 2, provided the following additional requirements are met.

(a) The material shall be in the H1100 or H1150 condition for Division 1 and in the H1150 condition for Division 2.

(b) The maximum allowable design stress values for Division 1 shall be those listed in [Table 1](#). The maximum design stress intensity values for Division 2 shall be those listed in [Table 2](#).

(c) No welding is permitted, except nonpressure parts may be welded to the pressure vessel provided the following rules are observed.

(1) Welding shall be performed on the UNS S17400 pressure part only in the H1150 condition.

(2) The weld metal shall be the same nominal composition as UNS S17400.

(3) After welding, the welded component shall be fully solution annealed and aged to the H1100 or H1150 condition, as applicable.

(4) The weldment shall be liquid penetrant examined per Section VIII, Division 1, Appendix 8 after final heat treatment.

(5) The depth of weld penetration into the pressure part shall be no more than 10% of the total pressure part thickness.

(6) Separate welding procedure and performance qualification in accordance with Section IX shall be conducted.

(d) Material in the H1100 condition shall be impact tested as prescribed in UHA-51, without exemption. Material in the H1150 condition is not required to be impact tested if the MDMT is  $-20^{\circ}\text{F}$  and warmer.

(e) This Case number shall be shown on the Manufacturer's Data Report.

**CAUTION: This material has reduced toughness at room temperature after exposure for about 5000 hours at  $600^{\circ}\text{F}$ .**

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**Table 1**  
**Maximum Allowable Stress Values for**  
**Section VIII Division 1**

For Metal Temperatures, Not Exceeding, °F	Allowable Stress Value, Max., ksi [Note (1)]	
	H1100 Condition	H1150 Condition
100	40.0	38.6
200	40.0	38.6
300	40.0	38.6
400	38.9	37.5
500	38.1	36.8
600	37.5	36.2

NOTE:

(1) The revised criterion of 3.5 on tensile strength was used in establishing these values.

**Table 2**  
**Maximum Design Stress Intensity Values**

For Metal Temperatures Not Exceeding, °F	Design Stress Intensity Value, Max., ksi
	H1150 Condition
100	45.0
200	45.0
300	45.0

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**Approval Date: September 18, 2006**

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2224-2  
Use of 304L Stainless Steel at Elevated Temperatures  
Section VIII, Division 1**

*Inquiry:* May Type 304L (UNS S30403) material conforming to SA-182, SA-213, SA-240, SA-249, SA-312, SA-403, SA-479, SA-965 Material Specifications be used in the construction of welded vessels designed to Section VIII, Division 1, at 850°F to 1200°F for internal pressures not greater than 175 psi, and for nonaqueous product applications?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used for welded construction under the rules of Section VIII, Division 1 within the limits listed in the Inquiry, provided the following additional requirements are met.

- (a) The allowable stresses shall be obtained from [Table 1](#).
- (b) This Case number shall be identified in the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Allowable Stress Values, Max., ksi [Notes (1)-(3)]	
850	12.8 [Note (1)]	9.5
900	12.6 [Note (1)]	9.3
950	11.3 [Note (1)]	9.0
1000	7.8	7.8
1050	6.3	6.3
1100	5.1	5.1
1150	4.0	4.0
1200	3.2	3.2

GENERAL NOTE: Material sensitized by exposure to long-time high-temperature operation may have reduced low-temperature notch toughness.

NOTES:

- (1) Due to the relatively low yield strength of these materials, these high stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed  $66\frac{2}{3}\%$ , but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.
- (2) Stress values for welded pipe and tube shall be the listed values multiplied by a factor of 0.85.
- (3) The revised criterion of 3.5 on tensile strength was used in establishing these values.

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Approval Date: May 21, 2003

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2226-2**  
**Ni-Cr-Mo Alloy UNS N06022 for Code Construction for**  
**Temperatures up to 1250°F**  
**Section I**

*Inquiry:* May solution annealed nickel-chromium-molybdenum alloy UNS N06022 for the products listed in [Table 1](#) be used in welded construction under the rules of Section I up to 1250°F?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used in the welded construction under the rules of Section I for temperatures up to 1250°F provided that the following additional requirements are met.

(a) The maximum allowable stress values for the material shall be those given in [Table 2](#).

(b) The P-Number for this alloy is 43.

(c) For welded products, the allowable stresses shown in [Table 2](#) shall be multiplied by 0.85.

(d) The  $y$  values (see Section I, para. PG-27.4, Note 6) shall be as follows:

1050°F and below	0.4
1100°F	0.5
1150°F	0.7
1200°F	0.7
1250°F	0.7

(e) This Case number shall be shown on the Manufacturer's Data Report.

**CAUTION:** Austenitic alloys are subject to stress corrosion cracking, intergranular attack, pitting, and crevice corrosion when used in boiler applications in aqueous environments. Factors that affect the susceptibility of these materials are applied or residual stress, water chemistry and deposition of solids, and material condition. Susceptibility to attack is enhanced when the material is used in the sensitized condition, or with residual cold work. Concentration of corrosive agents (e.g., chlorides, caustic or reduced sulfur species) can occur under deposits formed on the surface of these materials, and can result in severe underdeposit wastage or cracking. For successful operation in water environments, careful attention must be paid to continuous control of water chemistry.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Product Specifications**

Fittings	SB-366
Forgings	SB-564
Bar	SB-574
Sheet, plate, and strip	SB-575
Welded pipe	SB-619
Seamless pipe and tube	SB-622
Welded tube	SB-626

**Table 2**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F		
Exceeding, °F	Allowable Stress Values, Max., ksi	
-20-100	28.6	28.6
200	28.6	26.7
300	28.2 [Note (2)]	24.6
400	27.2 [Note (2)]	22.9
500	26.5 [Note (2)]	21.5
600	26.0 [Note (2)]	20.4
650	25.8 [Note (2)]	20.0
700	25.6 [Note (2)]	19.6
750	25.4 [Note (2)]	19.3
800	25.3 [Note (2)]	19.0
850	25.1 [Note (2)]	18.8
900	24.9 [Note (2)]	18.6
950	24.7 [Note (2)]	18.5
1000 [Note (1)]	24.4 [Note (2)]	18.3
1050 [Note (1)]	23.0 [Note (2)]	18.2
1100 [Note (1)]	17.5	17.5
1150 [Note (1)]	12.7	12.7
1200 [Note (1)]	9.6	9.6
1250 [Note (1)]	7.6	7.6

GENERAL NOTE: The revised criterion of 3.5 on tensile strength was used in establishing these values.

NOTES:

- (1) Alloy N06022 in the solution annealed condition is subject to severe loss of impact properties at room temperature after exposure in the range of 1000°F to 1250°F.
- (2) Due to the relatively low yield strength of these materials, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed 66<sup>2</sup>/<sub>3</sub>%, but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints.

Approval Date: October 29, 1999

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2230-2**  
**Use of Ni-Al Bronze C95820 Sand Castings for Pressure Vessels**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions may UNS C95820 sand cast tubesheets and other pressure parts meeting chemical and mechanical requirements listed in [Tables 1 and 2](#) of this Case, and otherwise conforming to all other requirements of ASTM B148-93a, be used in the construction of Section VIII, Division 1 pressure vessels?

*Reply:* It is the opinion of the Committee that UNS C95820 as described in the Inquiry may be used for the construction of Section VIII, Division 1 welded pressure vessels provided that the following additional requirements are met.

(a) The chemical composition and mechanical properties shall conform to the requirements of [Tables 1 and 2](#) below. The material is supplied in the as-cast condition only.

(b) The Design Temperature shall not exceed 500°F.

(c) The maximum allowable stress values shall be those listed in [Table 3](#).

(d) This material shall be considered as P-No. 35.

(e) The applicable rules of Section VIII, Division 1, Part UNF, for copper and copper alloys shall apply.

(f) The external pressure chart applicable to this material is Section VIII, Division 1, Fig. NFA-6.

(g) This Case number shall be identified in the documentation and marking of the material and shown on the Manufacturer's Data Report.

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**Table 1**  
**Chemical Requirements (UNS C95820)**

Element	Composition Limits, %
Copper, min.	77.5
Aluminum	9.0-10.0
Iron	4.0-5.0
Manganese, max.	1.5
Nickel	4.5-5.8
Silicon, max.	0.10
Lead, max.	0.02
Tin, max.	0.20

## GENERAL NOTES:

(a) Zinc shall not exceed 0.20%.

(b) Cu + Al + Fe + Mn + Ni &gt; 99.2%.

**Table 2**  
**Mechanical Property Requirements**

Tensile strength, min., ksi	94.0
Yield strength, min., ksi	39.0
Elongation, in 2 in., min., %	13.0

**Table 3**  
**Maximum Allowable Stress Values (UNS C95820)**

For Metal Temperature Not Exceeding, °F	Allowable Stress Values, max., ksi [Note (1)]
-20-100	26.0
150	26.0
200	25.8
250	25.5
300	25.2
350	24.9
400	24.5
450	24.0
500	23.5

## GENERAL NOTES:

(a) Stress values in restricted shear shall be 0.80 times the values in this table.

(b) Stress values in bearing shall be 1.60 times the values in this table.

## NOTE:

(1) The revised criterion of 3.5 on tensile strength was used in establishing these values.

Approval Date: December 12, 2018

(19)

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

### Case 2235-14 Use of Ultrasonic Examination in Lieu of Radiography Section I

*Inquiry:* Under what conditions and limitations may an ultrasonic examination be used in lieu of radiography, when radiography is required in accordance with Section I, PW-11?

*Reply:* It is the opinion of the Committee that all welds in material  $\frac{1}{2}$  in. (13 mm) or greater in thickness in pressure vessels and power boilers may be examined using the ultrasonic (UT) method in lieu of the radiography (RT) method, provided that all of the following requirements are met:

(a) The ultrasonic examination area shall include the volume of the weld, plus 2 in. (50 mm) on each side of the weld for material thickness greater than 8 in. (200 mm). For material thickness 8 in. (200 mm) or less, the ultrasonic examination area shall include the volume of the weld, plus the lesser of 1 in. (25 mm) or  $t$  on each side of the weld. Alternatively, examination volume may be reduced to include the actual heat affected zone (HAZ) plus  $\frac{1}{4}$  in. (6 mm) of base material beyond the heat affected zone on each side of the weld, provided the following requirements are met:

(1) The extent of the weld HAZ is measured and documented during the weld qualification process.

(2) The ultrasonic (UT) transducer positioning and scanning device is controlled using a reference mark (paint or low stress stamp adjacent to the weld) to ensure that the actual HAZ plus an additional  $\frac{1}{4}$  in. (6 mm) of base metal is examined.

(b) A documented examination strategy or scan plan shall be provided showing transducer placement, movement, and component coverage that provides a standardized and repeatable methodology for weld acceptance. The scan plan shall also include ultrasonic beam angle

used, beam directions with respect to weld centerline, and vessel volume examined for each weld. The documentation shall be made available to the Owner/User upon request.

(c) The ultrasonic examination shall be performed in accordance with a written procedure conforming to the requirements of Section V, Article 4.<sup>1</sup> The procedure shall have been demonstrated to perform acceptably on a qualification block(s). The qualification block(s) shall be prepared by welding or the hot isostatic process (HIP) and shall contain a minimum of three flaws, oriented to simulate flaws parallel to the production weld's fusion line as follows:

(1) one surface flaw on the side of the block representing the vessel O.D. surface

(2) one surface flaw on the side of the block representing the vessel I.D. surface

(3) one subsurface flaw

(4) If the block can be flipped during UT examination, then one flaw may represent both the I.D. and O.D. surfaces. Thus only two flaws may be required.

Flaw size shall be no larger than the flaw in Table 1, 2, or 3 for the thickness to be examined. Acceptable performance is defined as response from the maximum allowable flaw and other flaws of interest demonstrated to exceed the reference level. Alternatively, for techniques that do not use amplitude recording levels, acceptable performance is defined as demonstrating that all imaged flaws with recorded lengths, including the maximum allowable flaws, have an indicated length equal to or greater than the actual length of the flaws in the qualification block.

(d) The ultrasonic examination shall be performed using a device employing automatic computer based data acquisition. The initial straight beam material examination (T-472 of Section V, Article 4) for reflectors that could interfere with the angle beam examination shall be performed (1) manually, (2) as part of a previous

<sup>1</sup> Sectorial scans (S-scans) with phased arrays may be used for the examination of welds, provided they are demonstrated satisfactorily in accordance with para. (c). S-scans provide a fan beam from a single emission point, which covers part or all of the weld, depending on transducer size, joint geometry, and section thickness. While S-scans can demonstrate good detectability from side drilled holes, because they are omnidirectional reflectors, the beams can be misoriented for planar reflectors (e.g., lack of fusion and cracks). This is particularly true for thicker sections, and it is recommended that multiple linear passes with S-scans be utilized for components greater than 1 in. (25 mm) thick. An adequate number of flaws should be used in the demonstration block to ensure detectability for the entire weld volume.

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manufacturing process, or (3) during the automatic UT examination provided detection of these reflectors is demonstrated [subpara. (c)].

(e) Data is recorded in unprocessed form. A complete data set with no gating, filtering, or thresholding for response from examination volume in para. (a) above shall be included in the data record.

(f) Personnel performing and evaluating UT examinations shall be qualified and certified in accordance with their employer's written practice. ASNT SNT-TC-1A or CP-189 shall be used as a guideline. Only Level II or III personnel shall analyze the data or interpret the results.

(g) Contractor qualification records of certified personnel shall be approved by the Certificate Holder and maintained by their employer.

(h) In addition, personnel who acquire and analyze UT data shall be trained using the equipment in (d) above, and participate in the demonstration of (c) above.

(i) Data analysis and acceptance criteria shall be as follows:

(1) *Data Analysis Criteria.* Reflectors exceeding the limits in either (-a) or (-b) below, as applicable, shall be investigated to determine whether the indication originates from a flaw or is a geometric indication in accordance with para. (2) below. When a reflector is determined to be a flaw, it shall be evaluated for acceptance in accordance with para. (4), Flaw Evaluation and Acceptance Criteria.

(-a) For amplitude-based techniques, the location, amplitude, and extent of all reflectors that produce a response greater than 20% of the reference level shall be investigated.

(-b) For nonamplitude-based techniques, the location and extent of all images that have an indicated length greater than the limits in (-1), (-2), or (-3) below, as applicable, shall be investigated.

(-1) For welds in material equal to or less than  $1\frac{1}{2}$  in. (38 mm) thick at the weld, images with indicated lengths greater than 0.150 in. (3.8 mm) shall be investigated.

(-2) For welds in material greater than  $1\frac{1}{2}$  in. (38 mm) thick but less than 4 in. (100 mm) thick at the weld, images with indicated lengths greater than 0.200 in. (5 mm) shall be investigated.

(-3) For welds in material greater than 4 in. (100 mm) thick at the weld, images with indicated lengths greater than  $0.05t$  or 0.75 in. (19 mm), whichever is smaller, shall be investigated ( $t$  = nominal material thickness adjacent to the weld).

(2) *Geometric.* Ultrasonic indications of geometric and metallurgical origin shall be classified as follows:

(-a) Indications that are determined to originate from the surface configurations (such as weld reinforcement or root geometry) or variations in metallurgical structure of materials (such as cladding to base metal interface) may be classified as geometric indications, and

(-1) need not be characterized or sized in accordance with (3) below;

(-2) need not be compared to allowable flaw acceptance criteria of Table 1, 2, or 3;

(-3) the maximum indication amplitude and location shall be recorded, for example: internal attachments, 200% DAC maximum amplitude, 1 in. (25 mm) above the weld centerline, on the inside surface, from 90 to 95 deg.

(-b) The following steps shall be taken to classify an indication as geometric:

(-1) Interpret the area containing the reflector in accordance with the applicable examination procedure;

(-2) Plot and verify the reflector coordinates, provide a cross-sectional display showing the reflector position and surface discontinuity such as root or counterbore; and

(-3) Review fabrication or weld prep drawings.

(-c) Alternatively, other NDE methods or techniques may be applied to classify an indication as geometric (e.g., alternative UT beam angles, radiography, I.D. and/or O.D. profiling).

(3) *Flaw Sizing.* Flaws shall be sized in accordance with a procedure demonstrated to size similar flaws at similar material depths. Alternatively, a flaw may be sized by a supplemental manual technique so long as it has been qualified by the demonstration above. The dimensions of the flaw shall be determined by the rectangle that fully contains the area of the flaw, and the flaw shall be classified as either a surface or subsurface flaw. (Refer to Figures 1 – 5.)

(-a) The length ( $l$ ) of the flaw shall be drawn parallel to the inside pressure-retaining surface of the component.

(-b) The measured flaw through-wall dimension shall be drawn normal to the inside pressure retaining surface and shall be defined as  $a$  for a surface flaw or  $2a$  for a subsurface flaw.

(-c) Subsurface flaw(s) close to a surface shall be considered a surface flaw(s) if the distance between the flaw and the nearest surface is equal to or less than one half the flaw through-wall dimension, as shown in Figures 1 through 5.

(4) *Flaw Evaluation and Acceptance Criteria.* Flaws shall be evaluated for acceptance using the applicable criteria of Table 1, 2 or 3 and with the following additional requirements:

(-a) For surface connected flaws, the measured through-wall dimension,  $a$ , shall be compared to the value of  $a$  as determined from the applicable flaw acceptance criteria table.

(-b) For subsurface flaws, the measured through-wall dimension,  $2a$ , shall be compared to twice the value of  $a$  as determined from the applicable flaw acceptance criteria table.

(-c) *Surface Connected Flaws.* Flaws identified as surface flaws during the UT examination may or may not be surface connected, as shown in Figures 1 through 5. Therefore, unless the UT data analysis confirms that that flaw is not surface connected, it shall be considered surface connected or a flaw open to the surface, and is unacceptable unless a surface examination is performed in accordance with (-1), (-2), or (-3) below. If the flaw is surface connected, the requirements above still apply; however, in no case shall the flaw length,  $l$ , exceed the acceptance criteria in the applicable Construction Code for the method employed.

Acceptable surface examination techniques are:

(-1) Magnetic particle examination (MT) in accordance with Nonmandatory Appendix A, A-260 of Section I as applicable; or

(-2) Liquid penetrant examination (PT) in accordance with Nonmandatory Appendix A, A-270 of Section I as applicable; or

(-3) Eddy current examination (ET) in accordance with Supplement I of this Case. All relevant ET indications that are open to the surface are unacceptable regardless of length.

(-d) *Multiple Flaws*

(-1) Discontinuous flaws shall be considered a singular planar flaw if the distance between adjacent flaws is equal to or less than  $S$  as shown in Figure 2.

(-2) Discontinuous flaws that are oriented primarily in parallel planes shall be considered a singular planar flaw if the distance between the adjacent planes is equal to or less than  $\frac{1}{2}$  in. (13 mm). (Refer to Figure 3.)

(-3) Discontinuous flaws that are coplanar and nonaligned in the through-wall thickness direction of the component shall be considered a singular planar flaw if the distance between adjacent flaws is equal to or less than  $S$  as shown in Figure 4.

(-4) Discontinuous flaws that are coplanar in the through-wall direction within two parallel planes  $\frac{1}{2}$  in. (13 mm) apart (i.e., normal to the pressure-retaining surface of the component) are unacceptable if the additive flaw depth dimension of the flaws exceeds those shown in Figure 5.

(-e) *Subsurface Flaws.* Flaw length ( $l$ ) shall not exceed  $4t$ .

(j) The nameplate shall be marked under the Certification Mark by applying UT to indicate ultrasonic examination of welded seams required to be inspected in accordance with Section I.

(k) This Case number shall be shown on the Manufacturer's Data Report, and the extent of the UT examination shall be noted.

**Table 1**  
**Flaw Acceptance Criteria for  $\frac{1}{2}$  in. (13 mm)**  
**To Less than 1 in. (25 mm) Thick Weld**

	$a/t$	$l$
Surface flaw	$\leq 0.087$	$\leq 0.25$ in. (6.4 mm)
Subsurface flaw	$\leq 0.143$	$\leq 0.25$ in. (6.4 mm)

GENERAL NOTES:

(a)  $t$  = the thickness of the weld excluding any allowable reinforcement. For a butt weld joining two members having different thickness at the weld,  $t$  is the thinner of these two thicknesses. If a full penetration weld includes a fillet weld, the thickness of the throat of the fillet weld shall be included in  $t$ .

(b) A subsurface indication shall be considered as a surface flaw if the separation ( $S$  in Figure 1) of the indication from the nearest surface of the component is equal to or less than half the through dimension ( $2d$  in Figure 1, sketch [b]) of the subsurface indication.

**Table 2**  
**Flaw Acceptance Criteria for 1 in. (25 mm) To 12 in. (300 mm) Thick Weld**

Aspect Ratio, $a/\ell$	1 in. (25 mm) $\leq t \leq 2\frac{1}{2}$ in. (64 mm) [Note (1)]		4 in. (100 mm) $\leq t \leq 12$ in. (300 mm) [Note (1)]	
	Surface Flaw, $a/t$	Subsurface Flaw, $a/t$	Surface Flaw, $a/t$	Subsurface Flaw, $a/t$
0.00	0.031	0.034	0.019	0.020
0.05	0.033	0.038	0.020	0.022
0.10	0.036	0.043	0.022	0.025
0.15	0.041	0.054	0.025	0.029
0.20	0.047	0.066	0.028	0.034
0.25	0.055	0.078	0.033	0.040
0.30	0.064	0.090	0.038	0.047
0.35	0.074	0.103	0.044	0.054
0.40	0.083	0.116	0.050	0.061
0.45	0.085	0.129	0.051	0.069
0.50	0.087	0.143	0.052	0.076

GENERAL NOTES:

- (a)  $t$  = thickness of the weld excluding any allowable reinforcement. For a butt weld joining two members having different thickness at the weld,  $t$  is the thinner of these two thicknesses. If a full penetration weld includes a fillet weld, the thickness of the throat of the fillet weld shall be included in  $t$ .
- (b) A subsurface indication shall be considered as a surface flaw if separation ( $S$  in Figure 1) of the indication from the nearest surface of the component is equal to or less than half the through thickness dimension ( $2d$  in Figure 1, sketch [b]) of the subsurface indication.
- (c) If the acceptance criteria in this table results in a flaw length,  $\ell$ , less than 0.25 in. (6.4 mm), a value of 0.25 in. (6.4 mm) may be used.

NOTE:

- (1) For intermediate flaw aspect ratio  $a/\ell$  and thickness  $t$  ( $2\frac{1}{2}$  in. [64 mm]  $< t < 4$  in. [100 mm]) linear interpolation is permissible.

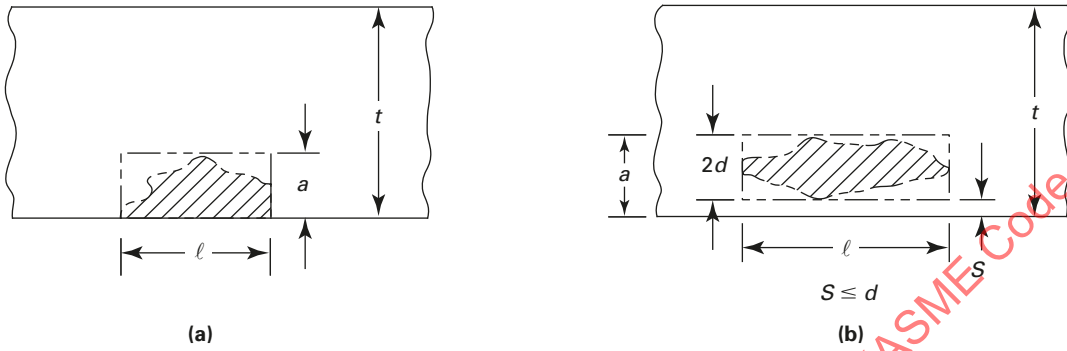
**Table 3**  
**Flaw Acceptance Criteria for Larger than 12 in. (300 mm) Thick Weld**

Aspect Ratio, $a/\ell$	Surface Flaw, $a$		Subsurface Flaw, $a$	
	in.	mm	in.	mm
0.00	0.228	5.79	0.240	6.10
0.05	0.240	6.10	0.264	6.71
0.10	0.264	6.71	0.300	7.62
0.15	0.300	7.62	0.348	8.84
0.20	0.336	8.53	0.408	10.4
0.25	0.396	10.1	0.480	12.2
0.30	0.456	11.6	0.564	14.3
0.35	0.528	13.4	0.648	16.5
0.40	0.600	15.2	0.732	18.6
0.45	0.612	15.5	0.828	21.0
0.50	0.624	15.8	0.912	23.2

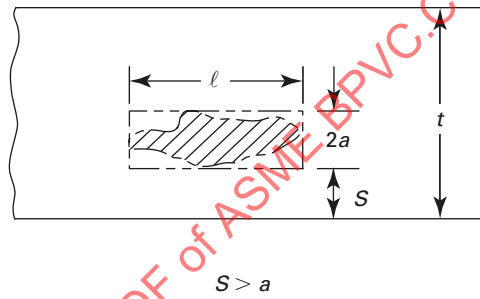
GENERAL NOTES:

- (a) For intermediate flaw aspect ratio,  $a/\ell$  linear interpolation is permissible.
- (b)  $t$  = the thickness of the weld excluding any allowable reinforcement. For a butt weld joining two members having different thickness at the weld,  $t$  is the thinner of these two thicknesses. If a full penetration weld includes a fillet weld, the thickness of the throat of the fillet weld shall be included in  $t$ .
- (c) A subsurface indication shall be considered as a surface flaw if separation ( $S$  in Figure 1) of the indication from the nearest surface of the component is equal to or less than half the through thickness dimension ( $2d$  in Figure 1, sketch [b]) of the subsurface indication.

Figure 1  
Single Indications

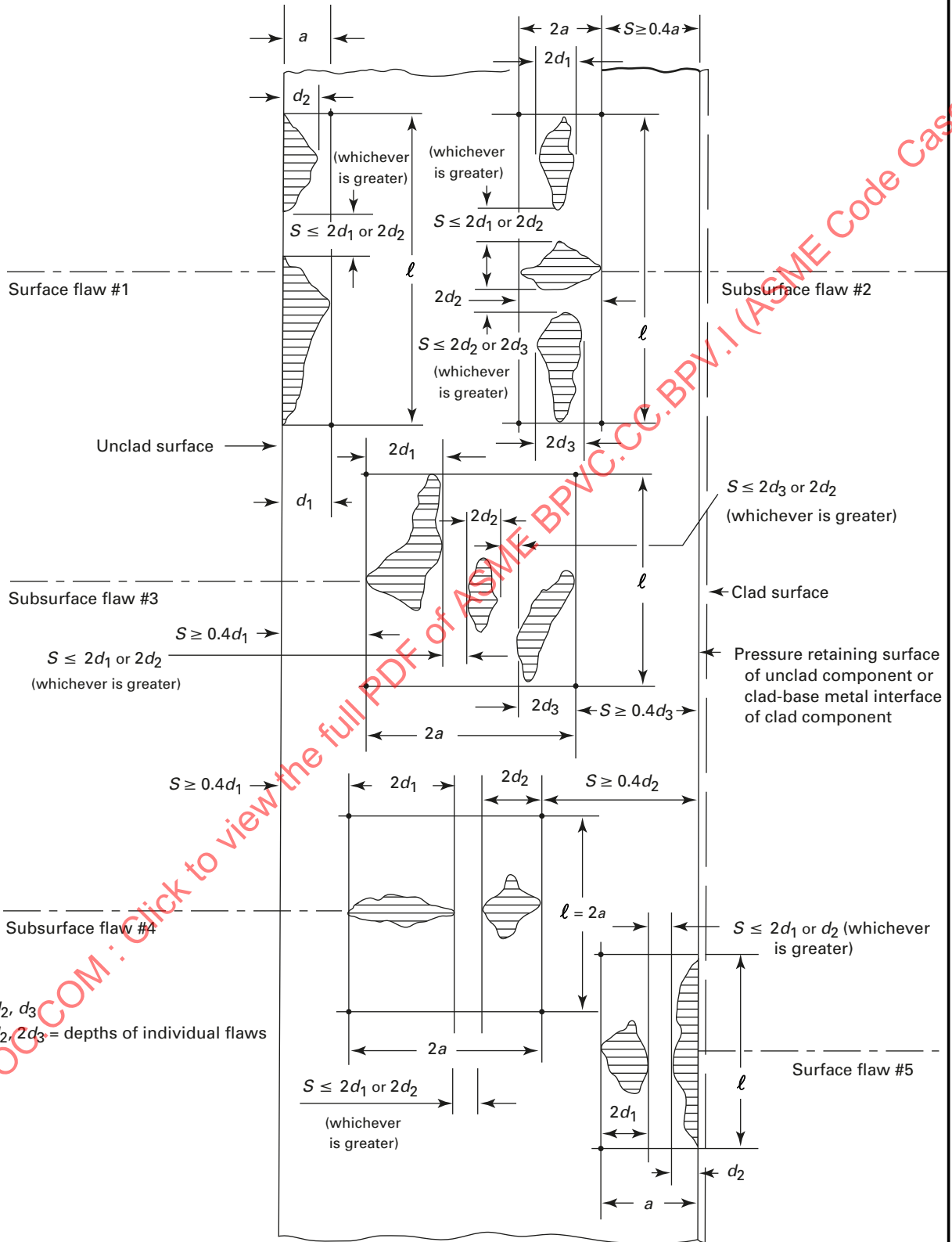


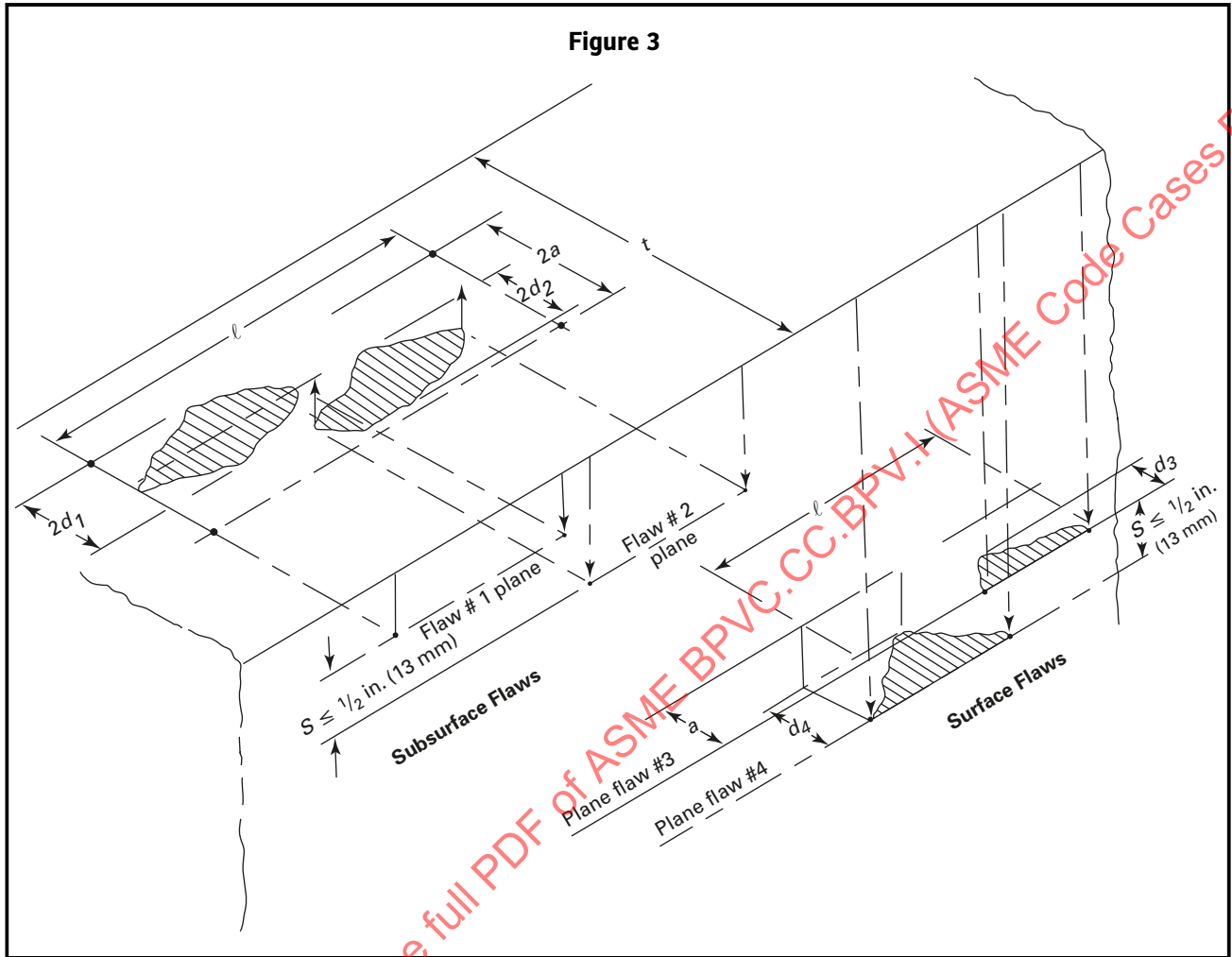
Surface Indications



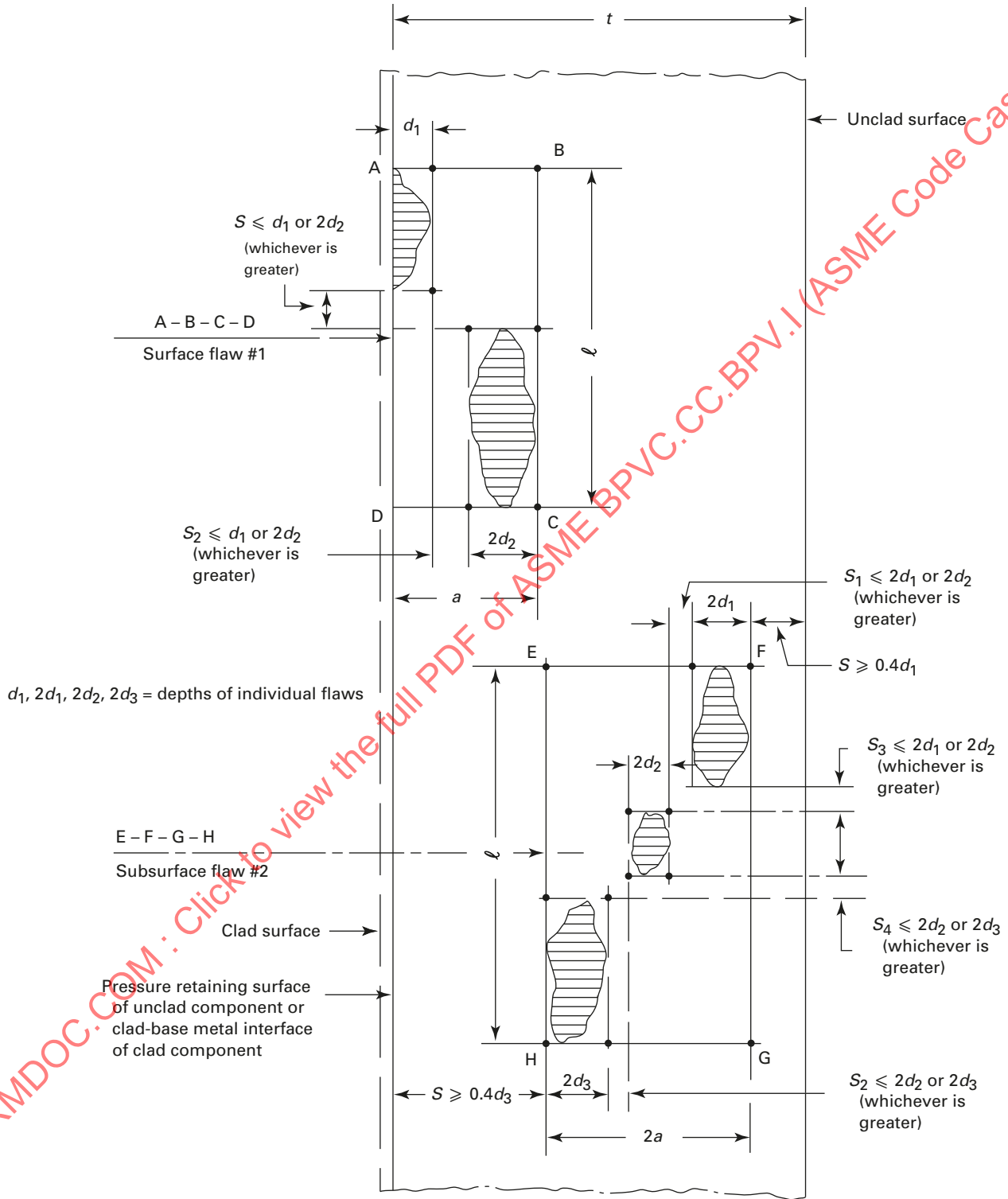
(c) Subsurface Indications

**Figure 2**  
**Multiple Planar Flaws Oriented in Plane Normal to Pressure Retaining Surface**

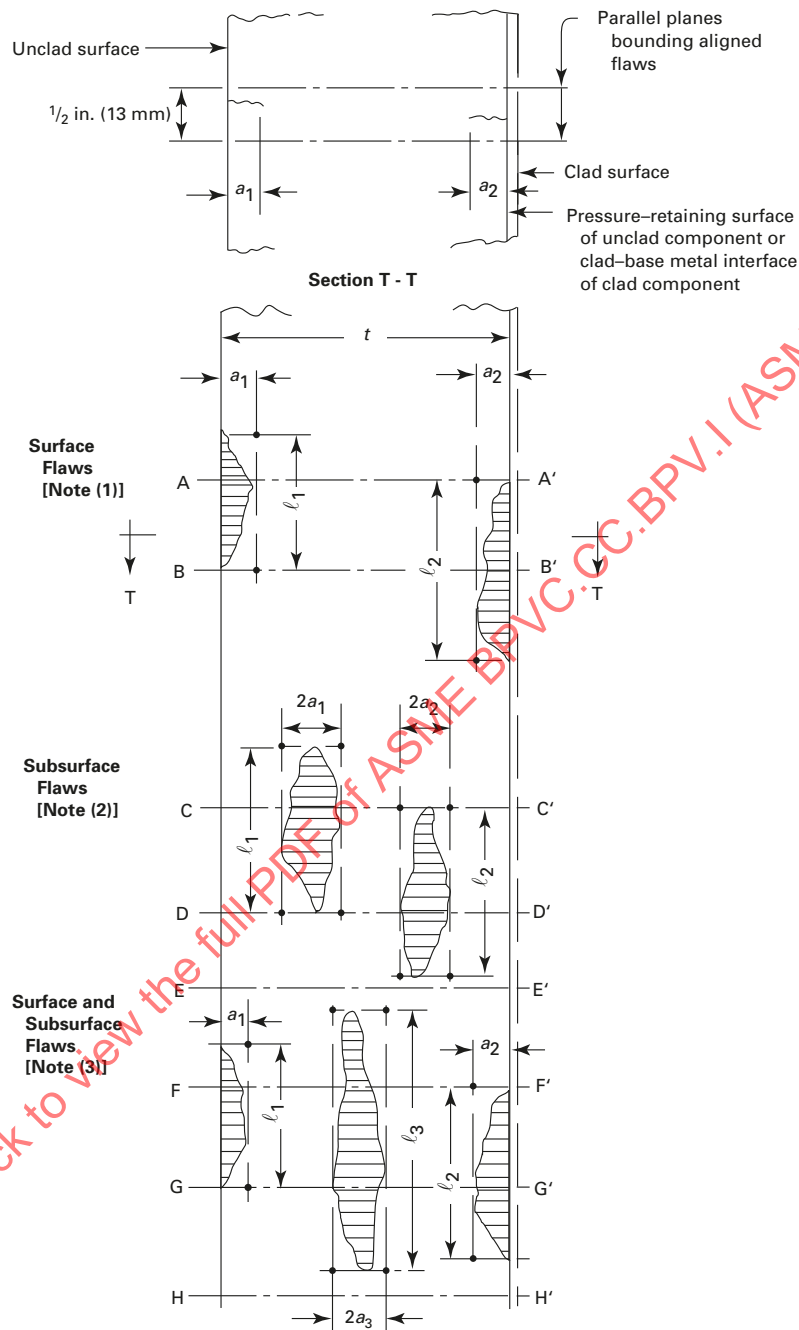




**Figure 4**  
**Nonaligned Coplanar Flaws in Plane Normal to Pressure Retaining Surface (Illustrative Flaw Configurations)**



**Figure 5**  
**Multiple Aligned Planar Flaws**



GENERAL NOTE: In the Notes below, the flaw depth dimensions  $a_s$  and  $a_e$  are the allowable flaw standards for surface and subsurface flaws, respectively.

NOTES:

- (1) This illustration indicates two surface flaws. The first,  $a_1$ , is on the outer surface of the component, and the second,  $a_2$ , is on the inner surface:  $(a_1 + a_2) \leq (a_s + a'_s)/2$  within planes A-A' and B-B'
- (2) This illustration indicates two subsurface flaws:  $(a_1 + a_2) \leq (a_e + a'_e)/2$  within planes C-C' and D-D'
- (3) This illustration indicates two surface flaws and one subsurface flaw:
  - (a)  $(a_1 + a_3) \leq (a_s + a'_e)/2$  within planes E-E' and F-F'
  - (b)  $(a_1 + a_2) \leq (a_s + a_e + a'_s)/3$  within planes F-F' and G-G'
  - (c)  $(a_2 + a_3) \leq (a'_s + a_e)/2$  within planes G-G' and H-H'

## SUPPLEMENT I: EDDY CURRENT SURFACE EXAMINATION PROCEDURE REQUIREMENTS

(a) *Procedure Requirements.* A written procedure shall be provided containing a statement of scope that specifically defines the limits of procedure applicability (e.g., material specification, grade, type, or class). The procedure shall reference a technique specification, delineating the essential variables, qualified in accordance with the requirements below.

### (b) *Procedure Specifications*

(1) The eddy current procedure shall specify the following regarding data acquisition:

- (-a) instrument or system, including manufacturer's name and model
- (-b) size and type of probe, including manufacturer's name and part number
- (-c) analog cable type and length
- (-d) examination frequencies, or minimum and maximum range, as applicable
- (-e) coil excitation mode (e.g., absolute or differential)
- (-f) minimum data to be recorded
- (-g) method of data recording
- (-h) minimum digitizing rate (samples per inch) or maximum scanning speed (for analog systems), as applicable
- (-i) scan pattern, when applicable (e.g., helical pitch and direction, rectilinear rotation, length, scan index, or overlap)
- (-j) magnetic bias technique, when applicable
- (-k) material type
- (-l) coating type and thickness, when applicable

(2) The eddy current procedure shall define the following regarding data analysis:

- (-a) method of calibration (e.g., phase angle or amplitude adjustments)
- (-b) channel and frequencies used for analysis
- (-c) extent or area of the component evaluated
- (-d) data review requirements (e.g., secondary data review, computer screening)
- (-e) reporting requirements (i.e., signal-to-noise threshold, voltage threshold, flaw depth threshold)
- (-f) methods of identifying flaw indications and distinguishing them from nonrelevant indications, such as indications from probe lift-off or conductivity and permeability changes in weld material
- (-g) manufacturer and model of eddy current data analysis equipment, as applicable
- (-h) manufacturer, title, and version of data analysis software, as applicable

(3) The procedure shall address requirements for system calibration. Calibration requirements include those actions required to ensure that the sensitivity and accuracy of the signal amplitude and time outputs of the examination system, whether displayed, recorded, or automatically processed, are repeatable and correct.

Any process of calibrating the system is acceptable; a description of the calibration process shall be included in the procedure.

(4) Data acquisition and analysis procedures may be combined or separate, provided the above requirements are met.

### (c) *Personnel Requirements*

(1) Personnel performing data acquisition shall have received specific training and shall be qualified by examination, in accordance with the employer's written practice, in the operation of the equipment, applicable techniques, and recording of examination results.

(2) Personnel performing analysis of data shall have received additional specific training in the data analysis techniques used in the procedure qualification and shall successfully complete the procedure qualification described below.

(3) American Society of Nondestructive Testing (ASNT) standards SNT-TC-1A or CP 189 shall be used as a guideline.

(4) Personnel qualifications may be combined provided all requirements are met.

### (d) *Procedure Qualification*

(1) Data sets for detection and sizing shall meet requirements shown below.

(2) The eddy current procedure and equipment shall be considered qualified upon successful completion of the procedure qualification.

(3) *Essential Variables.* An essential variable is a procedure, software, or hardware item that, if changed, could result in erroneous examination results. Further, any item that could decrease the signal to noise ratio to less than 2:1 shall be considered an essential variable.

(4) Any two procedures with the same essential variables are considered equivalent. Equipment with essential variables that vary within the demonstrated ranges identified in the Data Acquisition Procedure Specification shall be considered equivalent. When the procedure allows more than one value or range for an essential variable, the qualification test shall be repeated at the minimum and maximum value for each essential variable with all other variables remaining at their nominal values. Changing essential variables may be accomplished during successive procedure qualifications involving different personnel; each data analyst need not demonstrate qualification over the entire range of every essential variable.

### (e) *Qualification Requirements*

(1) Specimens to be used in the qualification test shall meet the requirements listed herein unless a set of test specimens is designed to accommodate specific limitations stated in the scope of the examination procedure (e.g., surface roughness or contour limitations). The same specimens may be used to demonstrate both detection and sizing qualification. For examination of vessels with coated surfaces, Section V, Article 8 shall apply.

(2) Specimens shall be fabricated from the same base material nominal composition (UNS Number) and heat treatment (e.g., solution annealed, precipitation hardened, solution heat treated and aged) as those to be examined.

(3) Specimen surface roughness and contour shall be generally representative of the surface roughness and contour of the component surface to be examined. The examination surface curvature need not be simulated if the ratio of the component diameter to the coil diameter exceeds 20:1.

(4) Welding shall be performed with the same filler material AWS classification and postweld heat treatment (e.g., as welded, solution annealed, stress relieved) as the welds to be examined.

(5) *Defect Conditions*

(-a) The qualification flaws shall be cracks or notches.

(-b) The length of cracks or notches open to the surface shall not exceed 0.125 in. (3.2 mm).

(-c) The maximum depth of a crack or compressed notch shall be 0.040 in. (1.02 mm).

(-d) Machined notches shall have a maximum width of 0.010 in. (0.25 mm) and a maximum depth of 0.020 in. (0.51 mm).

(6) *Demonstration Specimens.* The demonstration specimen shall include one crack or notch at each of the following locations:

(-a) on the weld

(-b) in the heat affected zone

(-c) at the fusion line of the weld

(-d) in the base material

(7) *Procedure Qualification Acceptance Criteria.* All flaws in each of the four identified areas shall be detected with a minimum 2:1 signal-to-noise ratio at the maximum digitization rate (for digital systems) or maximum scanning speed (for analog systems) permitted by the procedure.

(f) *Evaluation of Eddy Current Results.* Eddy current results are evaluated in accordance with the procedure described in para. (b)(2) above. For this Case, ET is used to simply confirm that a UT flaw is in fact, surface connected. If a UT flaw is determined by ET to be surface connected, it shall comply with Acceptance Standards in para. (g) below.

(g) *Acceptance Standards.* These acceptance standards apply unless other more restrictive standards are specified for specific materials or applications within the Construction Code. All surfaces examined shall be free of relevant ET surface flaw indications.

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Approval Date: October 29, 1999

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2239-1**  
**Use of Permanent Mold Cast Aluminum Alloys UNS**  
**A13560 and A03570**  
**Section VIII, Division 1**

*Inquiry:* May aluminum alloys UNS A13560 and A03570 in the overaged temper meeting the chemical composition and mechanical properties given in [Tables 1](#) and [2](#) and other requirements of SB-108 be used in Section VIII, Division 1 construction?

*Reply:* It is the opinion of the Committee that aluminum alloys UNS A13560 and A03570 as described in the above Inquiry may be used in Section VIII, Division 1 construction of pressure vessels, up to 300°F under the following conditions:

- (a) The maximum allowable stress values for the materials shall be those given in [Table 3](#).
- (b) Welding is not permitted.
- (c) External pressure applications are not permitted.
- (d) Applicable parts of Section VIII, Division 1 that shall apply are those given in Part UNF.
- (e) The castings shall be heat treated. The heat treatment shall be 980°F for 8 hours, followed by a water quench, then 440°F for 7.5 hours.
- (f) This Case number shall be shown on the data report and the marking of the material.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Chemical Composition**

UNS	Al	Si	Fe	Cu	Mn	Mg	Zn	Ti	Other Elements	
									Each	Total
A13560	Remainder	6.5-7.5	0.20	0.20	0.10	0.25-0.45	0.10	0.20	0.05	0.15
A03570	Remainder	6.5-7.5	0.15	0.05	0.03	0.45-0.65	0.05	0.20	0.05	0.15

GENERAL NOTE: When single units are shown, these amounts indicate the maximum permitted.

**Table 2**  
**Mechanical Properties**

Temper	Tensile Strength, min., ksi	Yield Strength (0.2% Offset), min., ksi	Elongation in 2 in. or 4 Diameters, min., %	UNS
				Overaged
Overaged	27	20	4.0	A03570

**Table 3**  
**Maximum Allowable Stress Values**

Temperature, °F	ksi (A13560) [Note (1)]	ksi (A03570) [Note (1)]
	100	7.4
200	6.9	7.4
300	6.4	6.5

NOTE:

(1) The revised criterion of 3.5 on tensile strength was used in establishing these values.

Approval Date: January 20, 2000

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2244-2**  
**UNS J93380 (CD3MWCuN)**  
**Section VIII, Division 1**

*Inquiry:* May solution annealed UNS J93380 (CD3MWCuN) casting material, with the chemical composition listed in [Table 1](#) and the tensile properties listed in [Table 2](#), otherwise conforming to the requirements of Specification SA-995, be used in the construction of vessels under the rules of Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used under the rules of Section VIII, Division 1, provided the following additional requirements are met.

(a) The maximum allowable design stress values in tension shall be those listed in [Table 3](#).

(b) For external pressure design, use [Figure 1](#) and [Table 4](#) of this Case.

(c) The material shall be considered as P-No. 10H, Group 1.

(d) Heat treatment after welding is neither required nor prohibited. However, if heat treatment is applied, the heat treatment shall consist of heating to a minimum temperature of 2010°F followed by water quenching or rapid cooling by other means.

(e) The rules that shall apply are those given in Subsection C, Part UHA for austenitic-ferritic duplex stainless steels.

(f) This Case number shall be included in the marking of the material and shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Chemical Requirements**

Element	Composition, %
Carbon, max.	0.03
Manganese, max.	1.00
Silicon, max.	1.00
Sulfur, max.	0.025
Phosphorus, max.	0.030
Chromium	24.0–26.0
Nickel	6.5–8.5
Molybdenum	3.0–4.0
Nitrogen	0.20–0.30
Copper	0.5–1.0
Tungsten	0.5–1.0

**Table 2**  
**Mechanical Property Requirements**

Tensile strength, min., ksi	100
Yield strength [Note (1)], min., ksi	65
Elongation in 2 in. or 50 mm	25.0

NOTE:  
(1) Determined by the 0.2% offset method.

**Table 3**  
**Maximum Allowable Design Stress Values in Tension**

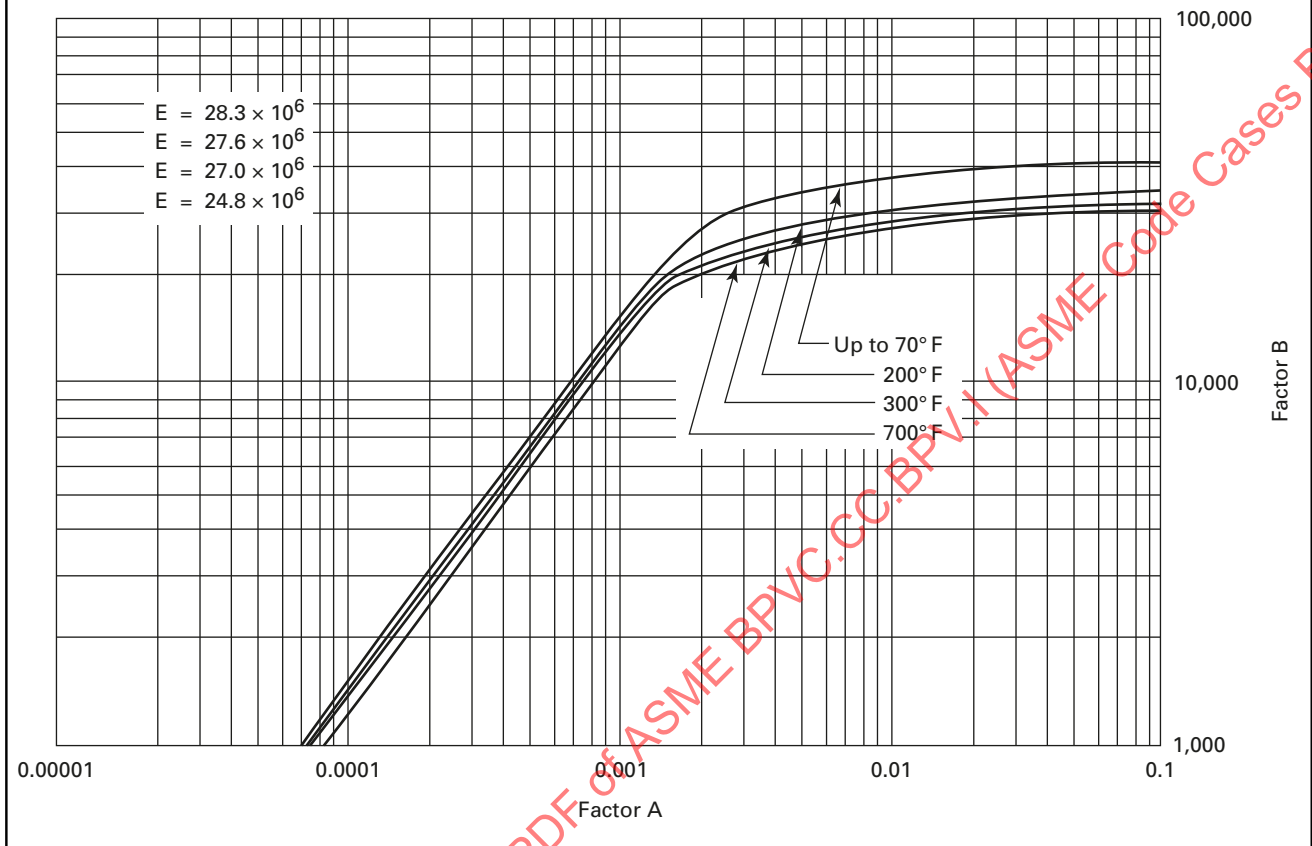
For Metal Temperature Not Exceeding,	
°F	ksi [Note (1)]
100	28.6
200	28.6
300	27.2
400	26.6
500	26.6
600	26.6

GENERAL NOTE: This material may embrittle after exposure at moderately elevated temperatures. See paras. A-340 and A-360 in Appendix A of Section II, Part D.

NOTE:

(1) The revised criterion of 3.5 on tensile strength was used in establishing these values.

**Figure 1**  
**Chart for Determining Shell Thickness of Cylindrical and Spherical Shells Under External Pressure When Constructed of High Alloy UNS S32760 And UNS J93380**



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**Table 4**  
**Chart for Determining Shell Thickness of Cylindrical and Spherical Shells Under External Pressure**  
**When Constructed of High Alloy UNS S32760 And UNS J93380**

Temperature	A	B, psi	Temperature	A	B, psi
70°F	7.07E-05	1000	300°F	7.41E-05	1000
	0.0005	7080		0.0005	6750
	0.00075	10600		0.00075	10100
	0.000992	14000		0.000923	12400
	0.00121	17100		0.00109	14400
	0.00143	20100		0.00128	16500
	0.00166	23100		0.00153	18600
	0.00197	26200		0.00198	20400
	0.00284	30100		0.00269	22000
	0.00491	33300		0.00392	23600
	0.00697	34500		0.00721	25700
	0.00849	35700		0.00893	26400
	0.0192	38700		0.019	28700
	0.05	40000		0.05	29600
	0.01	40000		0.1	29600
200°F	7.25E-05	1000	700°F	8.06E-05	1000
	0.0005	6900		0.0005	6200
	0.00075	10300		0.00075	9300
	0.000939	12900		0.000933	11600
	0.00112	15400		0.00108	13400
	0.00133	17800		0.00124	15200
	0.00163	20200		0.00143	17000
	0.00194	21500		0.00171	18800
	0.00272	24200		0.00277	21700
	0.00431	26600		0.00375	22900
	0.00683	27800		0.00701	24900
	0.00872	28800		0.00934	25800
	0.0187	31200		0.0192	27700
	0.05	32200		0.05	28600
	0.01	32200		0.1	28600

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Approval Date: July 9, 1998

Code Cases will remain available for use until annulled by the applicable Standards Committee.

### Case 2247

#### Alternative Pressure Test Procedure to UG-99 and UG-100 for the Construction of Multistream Aluminum Vacuum Brazed Plate-Fin Heat Exchangers Section VIII, Division 1

*Inquiry:* In Section VIII, Division 1, may an alternative pressure test procedure be implemented in the construction of multistream aluminum vacuum brazed plate-fin heat exchangers that differs from the testing requirements of UG-99 and UG-100?

*Reply:* It is the opinion of the Committee that multistream aluminum vacuum brazed plate-fin heat exchangers constructed to the rules of Section VIII, Division 1, may be pressure tested in accordance with the following procedure in lieu of the requirements of UG-99 and UG-100.

(a) As a minimum, the vessel shall receive two pressure tests:

- (1) first, a hydrostatic test in accordance with UG-99;
- (2) all subsequent tests are pneumatic pressure tests.

(b) The hydrostatic test shall be conducted in accordance with UG-99, including witness by the AI. All requirements of UG-99 shall be satisfied. To facilitate filling and draining of each vessel chamber (stream), vent holes shall be drilled into the header ends, as required, to purge each chamber of trapped air.

(c) Following the hydrostatic test, the vent holes shall be welded shut using procedures and welders qualified in accordance with Section IX.

(d) The exchangers are subsequently tested by a procedure employing both pneumatic and solution film leak tests to disclose leaks in the sheet to bar brazed joints that cannot be detected by the hydrotest. The test procedure shall be as follows:

(1) Prior to application of the pneumatic and solution film leak tests the vessel shall be dried.

(2) The pneumatic fill rate is computer controlled such that the pressure is gradually increased from zero to full pressure with a fill rate decrease starting at 80% of the final pneumatic pressure. There are no intermediate stop points during the filling process. The pneumatic test pressure shall satisfy UG-100(b).

(3) The pneumatic test (pressurization cycle) shall be automatically recorded on a strip chart.

(4) The AI is afforded the option but is not required to witness either the pneumatic test or the solution film leak test.

(5) Any leaks identified in brazed joints shall be repaired using a weld repair procedure pre-accepted by the AI. The existence of any such leaks requiring repair requires a repeat of the test procedure. The AI shall be advised of the repair and afforded the option to witness the retest at his discretion.

(6) The final pneumatic test pressure charts and film leak test records shall be certified by the Manufacturer and made available to the AI for his/her review.

(e) Under Item II of the Form U-1 (Manufacturer's Data Report) for Hydrostatic or Pneumatic Test Pressure, reference shall be made to Form U-4 where the hydrostatic test pressure and all pneumatic test pressures shall be listed for each independent pressure chamber of the heat exchanger.

(f) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: August 11, 1997

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**Case 2249**  
**Use of Furnace Brazing for Lethal Service**  
**Section VIII, Division 1**

*Inquiry:* May vessels intended for lethal service made of nickel (UNS N02200 and/or N02201) be fabricated by vacuum furnace brazing using nickel alloy brazing filler metal?

*Reply:* Vessels intended for lethal service may be fabricated by brazing under the following conditions:

(a) The design temperature shall not exceed 200°F and the design pressure shall not exceed 2000 psi. The diameter of the vessel shall not exceed NPS 8, and the volume of the vessel shall not exceed 5 ft<sup>3</sup>. The size limits of brazed joint members shall be as provided below.

(b) The components to be brazed shall be nickel alloy UNS N02200 or N02201 manufactured in accordance with Specification SB-160, SB-161, SB-162, SB-163, or SB-366.

(c) The brazing process shall be vacuum furnace brazing.

(d) The brazing filler metal shall be SFA5.8, BNi-5.

(e) Use of brazing shall be limited to Category D joints and heat exchanger tube joints. The joint shall consist of a pipe or tube not greater than 2.0 in. outside diameter inserted into a socket in another member or into or through a hole in another member. The lap length [as shown in Fig. UB-16(a)] shall be not less than four times the nominal thickness of the inserted pipe or tube, except that U-tube type heat exchanger tubes shall have a lap length that is not less than 1.5 times the thickness of the inserted tube.

(f) The brazing procedure specification (BPS) shall be qualified in accordance with UB-31. In addition, a workmanship sample shall be prepared for each joint configuration and combination of material thicknesses in accordance with QB-182, except that the unbrazed length may not exceed 5% of the joint overlap. The workmanship sample shall consist of not less than six tubes inserted into the joint to the maximum depth proposed for construction. The clearance between the tube and socket in two of these joints shall be the minimum clearance proposed for construction and the clearance in two additional joints shall be the maximum proposed for

construction. The minimum and maximum clearances permitted by the BPS shall not be greater than the minimum and maximum clearances used in the workmanship samples.

(g) Prior to assembly, each joint shall be verified as having the clearance specified in the BPS. Brazing paste or preform shall be applied only to one side of any joint. Each joint shall be visually examined prior to brazing for proper application of brazing paste or external braze metal preform. These inspections shall be conducted following a written procedure which shall provide for a written record of these inspections.

(h) In order to demonstrate full penetration of the braze metal, each joint shall be visually examined after brazing on both sides of each joint. The use of inspection mirrors, boroscopes, or fiber-optic devices, as necessary, is required to accomplish this inspection where both sides of the joint are not readily viewed without optical aid. All surfaces of all joints shall be free from cracks and voids. Any assembly that exhibits cracking of either the base metal or the braze metal shall be discarded.

All joints shall show braze metal around the entire circumference of the interface between the tube and the socket on the side opposite from that on which the brazing paste or preform was applied. It is not required that the braze metal be flush with the surface or that it form a fillet. Assemblies that do not show braze metal around the entire circumference of the interface shall be discarded.

Where preforms are used, fillets at joint intersections shall not be convex on the side that the preform was placed.

These inspections shall be conducted following a written procedure that is in accordance with Section V, Article 9, and a written report of these inspections shall be prepared.

(i) Additional work may be done on brazed joints to achieve the desired surface geometry (e.g., fill concavity, increase fillet size, etc.) after they have been accepted in accordance with (h) above. This may be done by mechanical methods (e.g., grinding, machining, etc.) or by additional furnace brazing with the addition of more filler metal to either side of the joint as necessary to achieve the desired surface geometry. Rebrazing to correct surface geometry conditions shall be limited to three cycles.

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Modification of surface geometry by torch brazing is not permitted. All joints that have been reheated to brazing temperature and those that are mechanically modified shall be visually examined in accordance with (h) above.

(j) After brazing and any surface geometry modifications are completed, the component shall be subjected to pressure testing in accordance with the requirements of Section VIII. After completion of pressure testing, the joints shall be subjected to a helium mass spectrometry

leak test. The testing shall be conducted in accordance with a written procedure and in accordance with the requirements and acceptance criteria of Section V, Article 10. A written record of the testing shall be prepared. Any assembly that fails the leak test shall be discarded.

(k) All other applicable rules of Section VIII shall apply.

(l) This Case number shall be shown on the Data Report Form.

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Approval Date: March 5, 1998

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**Case 2254**  
**Changeover Valves Installed Between Safety Valves or**  
**Safety Relief Valves and Boilers**  
**Section I**

*Inquiry:* Section I, PG-71.3, requires that no valve be placed between the safety valve and boiler. For boilers whose MAWP does not exceed 800 psi, under what conditions may a changeover valve be installed between safety valves or safety relief valves and the boiler or piping to be protected?

*Reply:* It is the opinion of the Committee that for boilers whose MAWP does not exceed 800 psi, changeover valves<sup>1</sup> may be installed between safety valves or safety relief valves and the boiler or piping to be protected (excluding Organic Fluid Vaporizers, Part PVG) under the following conditions.

(a) The stamped relieving capacity of the safety valve or safety relief valve shall be available whenever the boiler is in service.

(b) The changeover valve shall be designed such that there is no position where the internal plug, disc, or ball would isolate or block both safety valves or safety relief valves simultaneously.

(c) The changeover valve shall have an indicator that shows which safety valve or safety relief valve is in service. This may be accomplished by indicating which port of the changeover valve is open.

(d) The changeover valve shall have a positive locking device that permits it to be locked only when one of the outlet ports is fully open and the other outlet port is fully closed. Also, a warning tag shall be affixed to the changeover valve stating that the changeover valve is to be locked or sealed at all times except when being operated by a trained person who shall remain stationed at the changeover valve until it is again locked or sealed.

(e) The changeover valve shall be equipped with external valves to safely bleed off the pressure between the isolated safety valve or safety relief valve and the fully closed port of the changeover valve. Also, a warning tag shall be

affixed to the changeover valve stating that the bleed valve shall be fully opened prior to servicing the isolated safety valve or safety relief valve.

(f) The changeover valve shall meet the requirements for materials and design of ASME B16.34.

(g) Calculations demonstrating that the changeover valve, the mounting nozzle, and its supporting vessel or pipe are capable of sustaining reaction forces from the safety valve or safety relief valve discharge shall be made available to the Authorized Inspector.

(h) The changeover valve inlet shall be permanently and clearly marked with the word "inlet."

(i) The changeover valve shall be marked in accordance with the requirements of ASME B16.34. In addition, a nameplate shall be permanently affixed to the valve by the changeover valve manufacturer with the following information:

- (1) the number of this Code Case;
- (2) the actual orifice area of the safety valve or safety relief valve and coefficient of discharge  $K_d$ ;
- (3)  $C_v$  value of changeover valve; and
- (4) the name of the changeover valve manufacturer.

(j) The changeover valve flow path length may exceed the limit imposed by PG-71.2 provided the valve coefficient  $C_v$  meets the requirement of (k) below. The use of the Y-bases and intervening pipe or fittings as provided for in PG-71.1 and PG-71.2 respectively shall not be permitted when applying this Code Case.

(k) The changeover valve shall have a valve coefficient,  $C_v$ , equal to or greater than the following:

$$C_v = 5.69K_dK_S A \sqrt{\frac{P_r}{\delta}}$$

where

$K_d$  = actual coefficient of discharge of the safety or safety relief valve

$K_S$  = superheat correction factor for the safety or safety relief valve

$A$  = actual orifice area of the safety or safety relief valve (in.<sup>2</sup>)

<sup>1</sup> Changeover Valve: A three-way stop (or diverter) valve with one inlet port and two outlet ports designed to isolate either one of the two outlet ports from the inlet port, but not both simultaneously during any mode of operation.

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$P_r = (1.03 \times \text{set pressure of the safety or safety relief valve}) + 14.7 \text{ (psia)}$

$\delta = \text{density of steam @ } P_r \text{ (lb/ft}^3\text{)}$

(l) The manufacturer of the changeover valve shall provide to the certificate holder a certified test report determining the rated  $C_v$  for the valve model, type, and size. The tests shall be made under the supervision of and certified by the manufacturer. The testing facilities, methods, and procedures shall be in accordance with the applicable requirements of ANSI/ISA-S75.02-1988.

(m) This Case number and the changeover valve nameplate information shall be shown on the Manufacturer's Data Report.

NOTE: It is recommended that the changeover valve be operated under the following conditions. Personnel trained in the operation of boilers (ASME Code Section VII) should be present during the operation of a changeover valve. Care should be taken to protect personnel from elevated temperature, excessive noise levels, and escaping fluids. It is further recommended that the boiler be operating at a reduced pressure and steady state conditions when a changeover valve is operated and also during the time any servicing is done on the safety valve or safety relief valve that is isolated from the boiler.

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**Approval Date: August 11, 1997**

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2256  
Valve Markings  
Section IV**

*Inquiry:* HG-402.1 of Section IV permits the marking on the valve nameplate to be stamped, etched, impressed, or cast. May photosensitive imagery also be used to meet the requirements of HG-402.1?

*Reply:* It is the opinion of the Committee that photosensitive imagery may be used to meet the requirements of HG-402.1, provided the marking will not be obliterated in service.

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Approval Date: November 1, 2013

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**Case 2260-2**  
**Alternative Rules for Design of Ellipsoidal and**  
**Torispherical Formed Heads<sup>1</sup>**  
**Section VIII, Division 1**

*Inquiry:* For Section VIII, Division 1 vessels, may ellipsoidal and torispherical formed heads subjected to internal pressure be designed to rules other than those given in UG-32(d), 1-4(c) and UG-32(e), 1-4(d) respectively?

*Reply:* It is the opinion of the Committee that Section VIII, Division 1 vessel ellipsoidal and torispherical formed heads subjected to internal pressure may be designed using the following rules in lieu of those given in UG-32(d), 1-4(c), and UG-32(e), 1-4(d) respectively.

(a) *Nomenclature*

$E_T$  = modulus of elasticity at maximum design temperature, psi. The value of  $E_T$  for all materials shall be taken from Section II, Part D, Tables TM-1, TM-2, TM-3, TM-4, or TM-5. If the maximum design temperature is greater than that shown in the above tables, then use the value of  $E_T$  corresponding to the maximum temperature given in the above tables.

$E_{RT}$  = modulus of elasticity at 70°F, psi. The value of modulus of elasticity for all materials shall be taken from Section II, Part D, Tables TM-1, TM-2, TM-3, TM-4, or TM-5.

$h$  = one-half of the length of the inside minor axis of the ellipsoidal head, or the inside depth of the ellipsoidal head measured from the tangent line (head-bend line), in.

$D/2h$  = ratio of the major to the minor axis of ellipsoidal heads, which equals the inside diameter of the head skirt divided by twice the inside height of the head.

See UG-32(c) for other nomenclature.

(b) *Torispherical Heads.* The minimum required thickness of a torispherical head having  $0.002 \leq t/L \leq 0.06$  shall be larger of the thicknesses calculated by eq. (1) and eq. (2) below.

$$t = \frac{PLM}{2SE - 0.2P} \quad (1)$$

$$t = \frac{3PLKE_{RT}}{4S_a E_T} \quad (2)$$

The value of  $S_a$  shall be 115,000 psi for all ferrous and nonferrous materials except for aluminum, aluminum alloys, copper, copper alloys, titanium and zirconium, for which the value of  $S_a$  shall be calculated by eq. (3).

$$S_a = \frac{15,000 \times E_{RT}}{30 \times 10^6} \quad (3)$$

The value of  $M$  shall be obtained from Table 1. Interpolation may be used for  $r/D$  values which fall within the range of the tabulated values. No extrapolation of the values is permitted.

The value of  $K$  shall be obtained from Table 2. Interpolation may be used for  $r/D$  values which fall within the range of the tabulated values. No extrapolation of the values is permitted.

For designs where  $t/L > 0.06$ , the rules of UG-32(f) or 1-3 shall be used. In 1-3 equations (1) and (2),  $R$  shall be replaced with  $L$ .

(c) *Ellipsoidal Heads.* The minimum required thickness of an ellipsoidal head with  $D/2h$  ratio less than or equal to 2.0 shall be established as an equivalent torispherical head using the rules given in (b) above. An acceptable approximation of a 2:1 ellipsoidal head is one with a knuckle radius of  $0.17D$  and a spherical radius of  $0.9D$ .

(d) The requirement of UHT-32 does not apply.

(e) Size of the finished openings in the knuckle area shall not exceed the lesser of  $2\frac{3}{8}$  in. or  $0.5r$ . For an ellipsoidal head, the knuckle area is the area located outside a circle whose center coincides with the center of the head and whose diameter is equal to 80% of the head inside diameter.

(f) This Case has been developed for fatigue life of 400 full pressure range cycles with nonintegral attachments and 1000 full pressure range cycles with integral attachments. See U-2(g) for design of heads exceeding the above fatigue life.

<sup>1</sup> There is no change to this reinstated Case.

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(g) The rules of this Code Case may result in relatively high local strains in the knuckle. The effect of these high strains in areas where structural attachments are located shall be considered. See U-2(g).

(h) This Case shall not be used for Part UCI and Part UCD heads.

(i) The maximum design temperature shall not exceed the maximum temperature limit specified in Table 3.

(j) All other applicable Code requirements including those of UG-32 shall be met.

(k) This Case number shall be shown on the Manufacturer's Data Report.

<b>Table 1</b>				
<i>t/L</i>	<i>M</i> for			
	<i>r/D</i> = 0.06	<i>r/D</i> = 0.07	<i>r/D</i> = 0.08	0.08 < <i>r/D</i> ≤ 0.2
0.002	1.00	1.00	1.00	1.00
0.004	1.00	1.00	1.00	1.00
0.006	1.28	1.00	1.00	1.00
0.008	1.41	1.20	1.00	1.00
0.010	1.41	1.26	1.10	1.00
0.012	1.38	1.25	1.13	1.00
0.016	1.31	1.21	1.12	1.00
0.020	1.25	1.17	1.08	1.00
0.030	1.14	1.08	1.01	1.00
0.040	1.07	1.01	1.00	1.00
0.060	1.00	1.00	1.00	1.00

<b>Table 2</b>						
<i>t/L</i>	<i>K</i> for <i>r/D</i> = 0.06	<i>K</i> for <i>r/D</i> = 0.08	<i>K</i> for <i>r/D</i> = 0.10	<i>K</i> for <i>r/D</i> = 0.14	<i>K</i> for <i>r/D</i> = 0.17	<i>K</i> for <i>r/D</i> = 0.20
	0.002	7.87	6.29	5.24	3.95	3.31
0.004	6.77	5.60	4.69	3.49	2.93	2.50
0.006	6.04	5.14	4.38	3.27	2.73	2.33
0.008	5.51	4.78	4.14	3.13	2.60	2.21
0.010	5.11	4.49	3.93	3.02	2.51	2.13
0.012	4.79	4.25	3.76	2.93	2.44	2.06
0.016	4.31	3.87	3.47	2.77	2.33	1.97
0.020	3.96	3.58	3.24	2.63	2.24	1.91
0.030	3.48	3.10	2.84	2.37	2.07	1.79
0.040	3.32	2.97	2.69	2.23	1.95	1.72
0.060	3.12	2.80	2.56	2.17	1.92	1.71

<b>Table 3</b>	
<b>Maximum Metal Temperature</b>	
Table in Which Material is Listed	Temperature, °F
UCS-23	700
UNF-23.1	300
UNF-23.2	150
UNF-23.3	900
UNF-23.4	600
UNF-23.5	600
UHA-23	800
UHT-23	700

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Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2276-1**  
**Austenitic Ni-Cr-Mo-Nb Alloy (UNS N06626)**  
**Section VIII, Division 1**

*Inquiry:* May austenitic Ni-Cr-Mo-Nb alloy (UNS N06626), up to and including 0.100 in. in thickness, wrought sheet and strip, welded pipes, welded tubes, and welded fittings with the chemical analysis shown in [Table 1](#), the minimum mechanical properties shown in [Table 2](#), and the grain size requirements shown in [Table 3](#) be used in welded construction under the rules of Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used in Section VIII, Division 1 construction up to a design temperature of 800°F, provided the following additional requirements are met.

- (a) The rules in Section VIII, Division 1 that shall apply are those given in Part UNF for nickel alloys.
- (b) The maximum allowable stress values for the material shall be those given in [Table 4](#). For welded pipes, tubes, and fittings, a joint efficiency factor of 0.85 shall be used.
- (c) Material shall conform to all other requirements of SB-443, SB-704, SB-705, and SB-366, as applicable.
- (d) Material shall be considered as P-No. 43.
- (e) Heat treatment after forming or fabrication is neither required nor prohibited. However, if heat treatment is conducted, the resulting material must still comply with the requirements of [Tables 2](#) and [3](#).
- (f) The applicable external pressure chart shall be Fig. NFN-17 in Section II, Part D.
- (g) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1  
Chemical Requirements**

Element	Composition Limits, %
Nickel [Note (1)]	Remainder
Chromium	20.0–23.0
Molybdenum	8.0–10.0
Niobium	3.15–4.15
Iron	5.0 max.
Carbon	0.03 max.
Silicon	0.15 max.
Nitrogen	0.02 max.
Manganese	0.50 max.
Sulfur	0.015 max.
Aluminum	0.40 max.
Titanium	0.40 max.
Phosphorus	0.015 max.
Cobalt	1.0 max.

NOTE:

(1) This element shall be determined arithmetically by difference.

**Table 2  
Mechanical Property Requirements (Room Temperature)**

Tensile strength, min., ksi	120
Yield strength, 0.2%, offset min., ksi	60
Elongation in 2 in. gage or 4D min., %	40

**Table 3  
ASTM Grain Size No. Requirements**

Up to 0.010 in., incl.	8 or finer
0.010 to 0.050 in., incl.	6 or finer
0.050 to 0.100 in., incl.	5 or finer

**Table 4  
Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Allowable Stress Values, Max., ksi [Note (1)]
100	34.3
200	34.3
300	33.9, 34.3 [Note (2)]
400	32.6, 34.3 [Note (2)]
500	31.7, 34.3 [Note (2)]
600	31.1, 34.3 [Note (2)]
650	30.8, 34.3 [Note (2)]
700	30.5, 34.3 [Note (2)]
750	30.3, 34.3 [Note (2)]
800	30.1, 34.1 [Note (2)]

NOTES:

- (1) The revised criterion of 3.5 on tensile strength was used in establishing these values.
- (2) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short time tensile properties govern to permit the use of this alloy where slightly greater deformation is acceptable. The stress values in this range exceed  $66\frac{2}{3}\%$ , but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.

Approval Date: March 5, 1998

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2277**  
**Use of 17Cr-4Ni-4Cu (UNS S17400)**  
**Section VIII, Division 2**

*Inquiry:* May martensitic precipitation hardened stainless steel 17Cr-4Ni-4Cu (UNS S17400) forgings complying with SA-705 Type 630; plate, sheet, and strip complying with SA-693 Type 630; and bar complying with SA-564 Type 630, be used for pressure vessels constructed under Section VIII, Division 2?

*Reply:* It is the opinion of the Committee that martensitic precipitation hardened stainless steel, as described in the Inquiry, may be used for pressure vessels constructed under Section VIII, Division 2, provided the following additional requirements are met.

- (a) The material shall be in the H1100 condition.
- (b) The design stress intensity and yield strength values shall be those listed in [Table 1](#).
- (c) No welding is permitted.
- (d) Exemption from impact testing is not permitted.
- (e) This Case number shall be shown on the Manufacturer's Data Report.

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**Table 1**  
**Design Stress Intensity and Yield Strength**  
**Values**

For Metal Temperature Not Exceeding, °F	Stress Values, max., ksi	
	Design Intensity	Yield
100	46.7	115.0
200	46.7	106.3
300	46.7	101.9
400	45.5	98.3
500	44.4	95.2
600	43.8	92.8

GENERAL NOTE: CAUTION: This material has reduced toughness at room temperature after exposure for about 5000 hr at 600°F.

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Approval Date: October 30, 2015

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**Case 2286-6**  
**Alternative Rules for Determining Allowable External Pressure and Compressive Stresses for Cylinders, Cones, Spheres, and Formed Heads**  
**Section VIII, Division 1**

*Inquiry:* May alternative rules for determining allowable external pressure and compressive stresses for cylinders, cones, spheres, and formed heads be used for the design of these components in lieu of the rules of Section VIII, Division 1, UG-23, UG-28, UG-29, UG-33, and Appendix 1-8?

*Reply:* (a) It is the opinion of the Committee that cylinders, cones, spheres, and formed heads for pressure vessels otherwise designed and constructed in accordance with the rules of Section VIII, Division 1, may be designed using the following rules for calculation of allowable external pressure and compressive stresses in lieu of the rules stated in the Inquiry above.

(b) When used, this Case shall be made applicable to the entire vessel.

(c) This Case number shall be shown on the Manufacturer's Data Report.

## 1 SCOPE, DESIGN, METHOD, AND NOMENCLATURE

### 1.1 SCOPE

This Case provides alternative rules to those given in Section VIII, Division 1, UG-23(b), UG-28, UG-29, UG-33 and Appendix 1-8 for determining allowable compressive stresses for unstiffened and ring stiffened circular cylinders and cones, and for unstiffened spherical, ellipsoidal, and torispherical heads. The allowable stress equations are based upon theoretical buckling equations that have been reduced by knockdown factors and by plasticity reduction factors that were determined from tests on fabricated shells. (Nomenclature is provided in 1.4.)

This Case expands the coverage of load conditions and shell geometries, and includes equations for combinations of loads not considered in the Code paragraphs referenced above. These alternative rules are applicable to  $D_o/t$  ratios not exceeding 2,000, compared to the

$D_o/t = 1,000$  limit is Fig. G in Subpart 3 of Section II, Part D. The slenderness limit for these rules in  $KL_y/r \leq 200$ . Use of these alternative rules assumes the shell section to be axisymmetric with uniform thickness for unstiffened cylinders and formed heads. Stiffened cylinders and cones are also assumed to be of uniform thickness between stiffeners. Where nozzles with reinforcing plates or locally thickened shell sections exist, use the thinnest uniform thickness in the applicable unstiffened or stiffened shell section for calculation of allowable compressive stress.

The maximum temperature permitted for use of this Case is shown in Table 1.

Alternative equations for determination of allowable compressive stress due to loads specified in UG-22 are provided. A listing of the allowable stress cases, combinations of cases, requirements for tolerances, and reinforcement of openings by Case paragraph number is given in Table 2, with indication of present coverage in Division 1.

### 1.2 BUCKLING DESIGN METHOD

The buckling strength formulations presented in this Case are based on classical linear theory with simple support boundary conditions and Poisson's ratio of 0.3. The differences between elastic stresses obtained for buckling tests on fabricated shells and the theoretical buckling stresses are accounted for by knockdown factors. These factors are equivalent to the ratio of strain in a fabricated shell at buckling stress and the strain corresponding to the theoretical buckling stress. The design equations apply to shells with initial imperfections within the specified fabrication tolerances of 7 and 8.3.

The design of cylinders and cones for compressive loads is an iterative procedure. The first step in the design process is to assume a shell geometry and thickness and calculate the resulting stresses from dead and live (including pressure) loads. The next step is to calculate the allowable stresses for individual load cases and substitute these values into interaction equations for combined load cases. The shell thickness or geometry can be adjusted to give the desired agreement between applied and allowable stresses.

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Table 1

Table in Which Material is Listed,	
Division 1	Max. Temperature, °F
UCS-23.1	800
UNF-23.1	300
UNF-23.2	150
UNF-23.3	900
UNF-23.4	600
UNF-23.5	600
UHA-23	800
UHT-23	700

The next step is to determine the stiffener sizes if rings are used. The stiffener elements must satisfy the requirements of 6.4 to prevent local buckling of the stiffener.

Special consideration shall be given to ends of members (shell sections) or areas of load application where stress distribution may be in the inelastic range and localized stresses may exceed those predicted by linear theory. When the localized stresses extend over a distance equal to one half the length of a buckle node (approximately  $1.2\sqrt{D_o t}$ ), the localized stresses should be considered as a uniform stress around the full circumference. Additional stiffening may be required.

### 1.3 GEOMETRY

Allowable stress equations are given for the following geometries:

- (a) Unstiffened cylindrical, conical, and spherical shells
- (b) Ring stiffened cylindrical and conical shells
- (c) Unstiffened spherical, ellipsoidal, and torispherical heads

The cylinder and cone geometries are illustrated in Figures 1.4.1 and 1.4.3 and the stiffener geometries in Figure 1.4.4. The effective sections for ring stiffeners are shown in Figure 1.4.2. The maximum cone angle  $\alpha$  shall not exceed 60 deg.

### 1.4 NOMENCLATURE

NOTE: The terms not defined here are uniquely defined in the sections in which they are first used. The word "hoop" used in this Case is synonymous with the term "circumferential."

$A$  = cross-sectional area of cylinder

$$= \pi(D_o - t)t, \text{ in.}^2$$

$A_F$  = cross-sectional area of a large ring stiffener that acts as a bulkhead,  $\text{in.}^2$

$A_S$  = cross-sectional area of a ring stiffener,  $\text{in.}^2$

$c$  = distance from neutral axis of cross-section to point under consideration, in.

$D_e$  = outside diameter of assumed equivalent cylinder for design of cones or conical sections, in.

$D_i$  = inside diameter of cylinder, in.

$D_L$  = outside diameter at large end of cone, or conical section between lines of support, in.

$D_o$  = outside diameter of cylinder, in.

$D_S$  = outside diameter at small end of cone, or conical section between lines of support, in.

$E$  = modulus of elasticity of material at design temperature, determined from the applicable material chart in Subpart 2 of Section II, Part D, ksi. The applicable material chart is given in Tables 1A and 1B, Subpart 1, Section II, Part D. Use linear interpolation for intermediate temperatures.

$E_t$  = tangent modulus, ksi

$f_a$  = axial (longitudinal) compressive membrane stress resulting from applied axial load,  $Q$ , ksi

$F_{aha}$  = allowable axial compressive membrane stress of a cylinder due to axial compression load in the presence of hoop compression with  $\lambda_c > 0.15$ , ksi

$f_b$  = axial (longitudinal) compressive membrane stress resulting from applied bending moment,  $M$ , ksi

$F_{ba}$  = allowable axial compressive membrane stress of a cylinder due to bending moment,  $M$ , in the absence of other loads, ksi

$F_{bha}$  = allowable axial compressive membrane stress of a cylinder due to bending in the presence of hoop compression, ksi

$F_{ca}$  = allowable compressive membrane stress of a cylinder due to axial compression load with  $\lambda_c > 0.15$ , ksi

$F_{cha}$  = allowable axial compressive membrane stress of a cylinder due to axial compression load in the presence of hoop compression for  $0.15 < \lambda_c < 1.2$ , ksi.  $F_{cha} = F_{aha}$  when  $f_q = 0$ .

$f_h$  = hoop compressive membrane stress resulting from applied external pressure,  $P$ , ksi

$F_{ha}$  = allowable hoop compressive membrane stress of a cylinder or formed head under external pressure alone, ksi

$F_{hba}$  = allowable hoop compressive membrane stress of a cylinder in the presence of longitudinal compression due to a bending moment, ksi

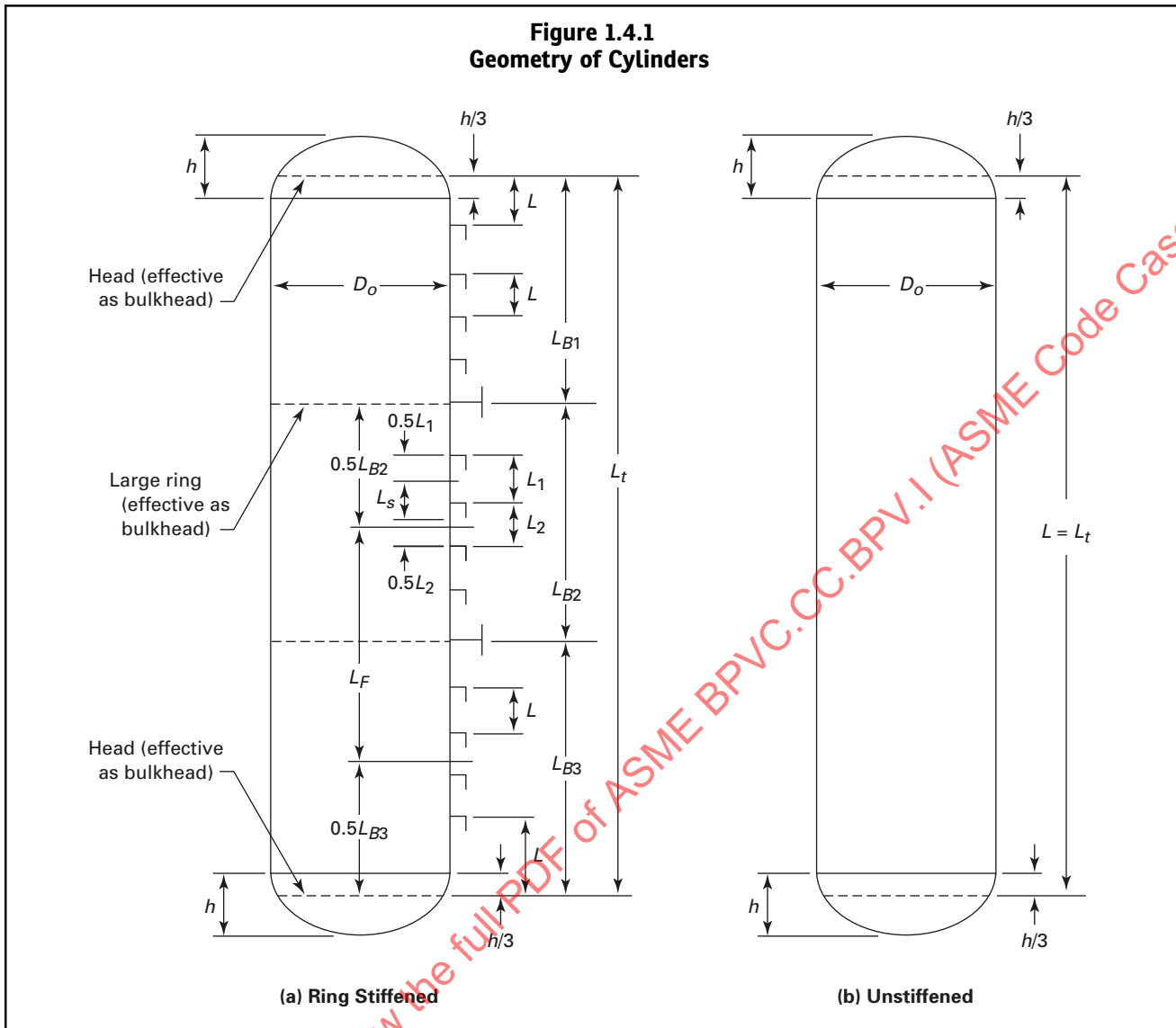
$F_{he}$  = elastic hoop compressive membrane failure stress of a cylinder or formed head under external pressure alone, ksi

$F_{hva}$  = allowable hoop compressive membrane stress in the presence of shear stress, ksi

Table 2

Para. No.	Subject	Covered in Div. 1
3	Allowable Compressive Stresses for cylindrical shells	Yes, in part
3.1	External Pressure	Yes
3.2	Uniform axial compression	Yes
3.2.1	Local buckling	Yes
3.2.2	Column buckling	No
3.3	Axial compression due to bending	No
3.4	Shear	No
4	Allowable Compressive Stresses for Cones	Yes, in part
4.1	External pressure	Yes
4.1.1	Allowable Circumferential Compression Stresses	Yes
4.1.2	Intermediate Stiffener Rings	No
4.1.3	Cone-Cylinder Junction Rings	Yes
4.2	Uniform Axial Compression and Bending	Yes, in part
4.2.1	Allowable Longitudinal and Bending Stresses	Yes
4.2.2	Unstiffened Cone-Cylinder Junctions	Yes
4.2.3	Cone-Cylinder Junction Rings	Yes
4.3	Shear	No
4.4	Local Stiffener Geometry Requirements	No
5	Allowable Stress Equations for Unstiffened and Ring Stiffened Cylinders and Cones Under Combined Loads	No
5.1	Combination of Uniform Axial Compression & Hoop Compression	No
5.2	Combination of Axial Compression Due to Bending Moment, M, and Hoop Compression	No
5.3	Combination of Hoop Compression and Shear	No
5.4	Combination of Uniform Axial Compression, Axial Compression Due to Bending Moment, M, and Shear in the Presence of Hoop Compression	No
5.5	Combination of Uniform Axial Compression, Axial Compression Due to Bending Moment, M, and Shear in the Absence of Hoop Compression	No
6	Sizing of Rings (General Instability)	Yes, in part
6.1	External pressure	Yes, but only (b)
6.2	Uniform Axial Compression and Axial Compression — Bending	No
6.3	Shear	No
6.4	Local Stiffener Geometry Requirements	No
7	Tolerances for Cylindrical & Conical Shells	Yes, in part
7.1	Shells Subjected to Internal Pressure	Yes, in part
7.2	Shells Subjected to Uniform Axial Compression and Axial Compression Due to Bending Moment	No
7.3	If Tolerances are Exceeded, Allowable Buckling Stress Adjustment	No
7.4	Measurements for Deviation	Yes, in part
7.5	Shells Subjected to Shear	Yes
8	Allowable Compressive Stresses for Spherical Shells and Formed Heads, with Pressure on Convex Side	Yes, in part
8.1.1	Spherical Shells with Equal Biaxial Stresses	Yes
8.1.2	Spherical Shells with Unequal Biaxial Stresses, both Compressive	No
8.1.3	Spherical Shells with Unequal Biaxial, one stress compressive and the other tensile	No
8.1.4	Shear	No
8.2	Toroidal and Ellipsoidal Heads	Yes, in part
8.3	Tolerances for Formed Heads	Yes, in part
9	Reinforcement for Openings	Yes, in part

**Figure 1.4.1  
 Geometry of Cylinders**



$F_{hxa}$  = allowable hoop compressive membrane stress of a cylinder in the presence of axial compression, for  $\lambda_c \leq 0.15$ , ksi

$f_q$  = axial (longitudinal) compressive membrane stress resulting from pressure load,  $Q_p$ , on end of cylinder, ksi

$F_{ta}$  = allowable stress in tension, from applicable table in Subpart 1 of Section II, Part D, ksi

$f_v$  = shear stress from applied loads, ksi

$F_{va}$  = allowable shear stress of a cylinder subjected only to shear stress, ksi

$F_{ve}$  = elastic shear buckling stress of a cylinder subjected only to shear stress, ksi

$F_{vha}$  = allowable shear stress of a cylinder subjected to shear stress in the presence of hoop compression, ksi

$$f_x = f_a + f_q, \text{ ksi}$$

$F_{xa}$  = allowable compressive membrane stress of a cylinder due to axial compression load with  $\lambda_c \leq 0.15$ , ksi

$F_{xe}$  = elastic axial compressive membrane failure (local buckling) stress of a cylinder in the absence of other loads, ksi

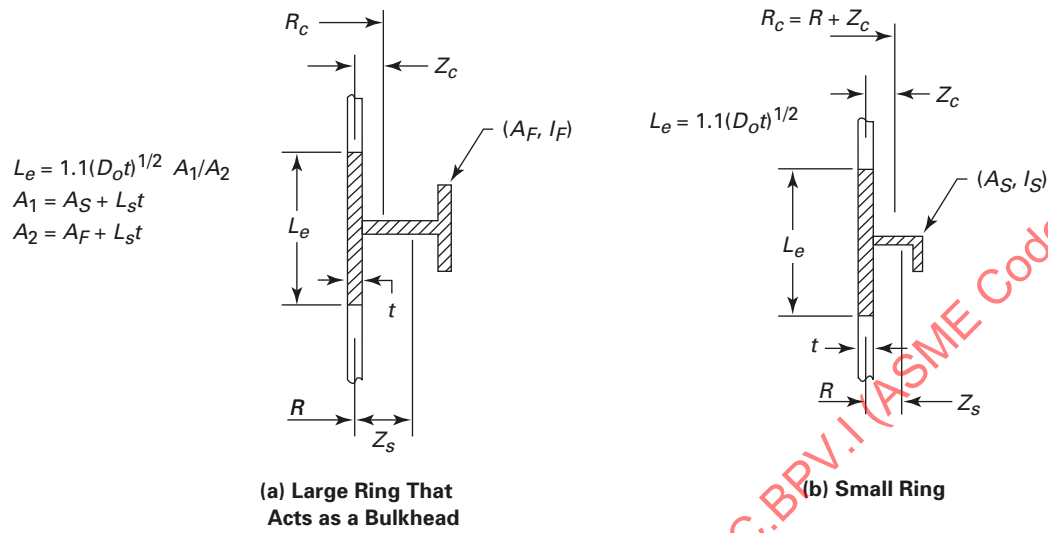
$F_{xha}$  = allowable axial compressive membrane stress of a cylinder in the presence of hoop compression for  $\lambda_c \leq 0.15$ , ksi.

$F_y$  = yield strength of material at design metal temperature from applicable table in Subpart 1 of Section II, Part D, ksi. For values of  $F_y$  not provided in Section II, Part D, use UG-28(c)(2), Steps (3)(a) and (3)(b).

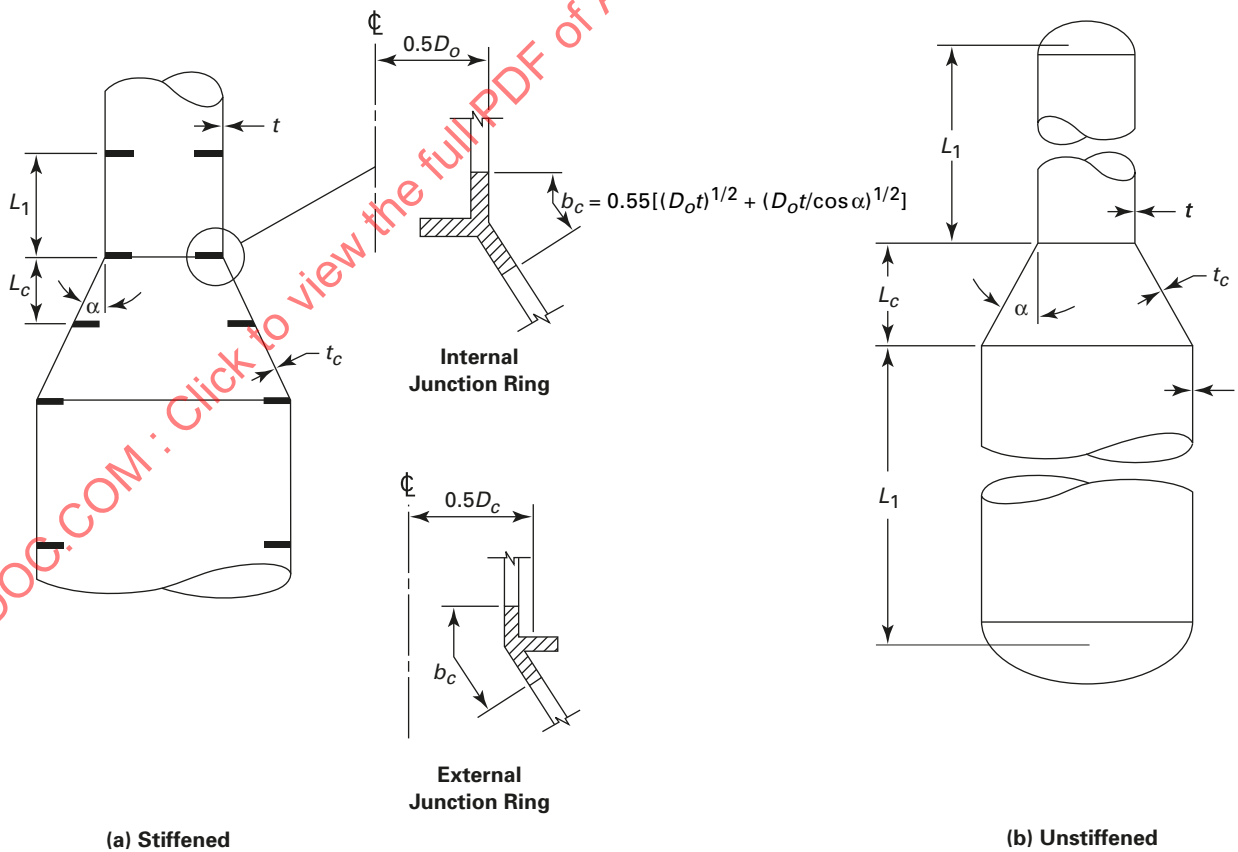
$FS$  = stress reduction factor or design factor

$I_s$  = moment of inertia of ring stiffener about its centroidal axis, in.<sup>4</sup>

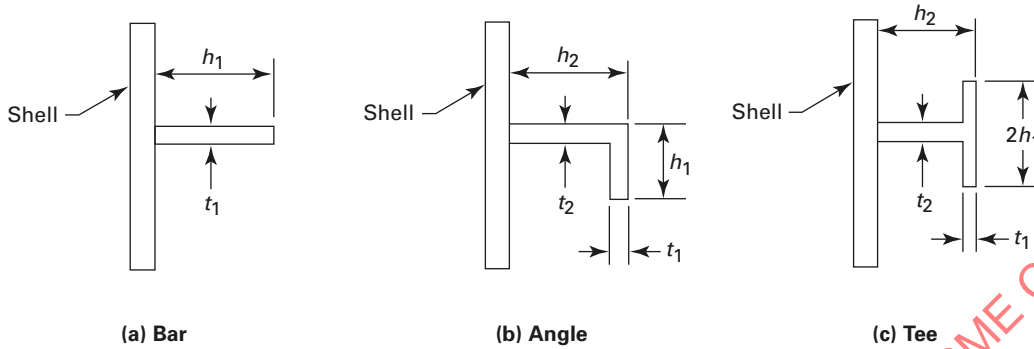
**Figure 1.4.2**  
**Sections Through Rings**



**Figure 1.4.3**  
**Geometry of Conical Sections**



**Figure 1.4.4**  
**Stiffener Geometry for Eqs. 6.4(a)(6-6) and 6.4(b)(6-7)**



$I_s'$  = moment of inertia of ring stiffener plus effective length of shell about centroidal axis of combined section, in.<sup>4</sup>

$$I_s' = I_s + A_s z_s^2 \frac{L_e t}{A_s + L_e t} + \frac{L_e t^3}{12}$$

$I$  = moment of inertia of full cross-section,

$$I = \pi R^3 t, \text{ in.}^4$$

$K$  = effective length factor for column buckling; refer to 3.2 for further definition

$L_B, L_{B1},$

$L_{B2}, L_{B...}$  = length of cylinder between bulkheads or large rings designed to act as bulkheads, in.

$L_c$  = axial length of cone or conical section, in. (see Figure 1.4.3)

$L_e$  = effective length of shell, in. (see Figure 1.4.2)

$L_F$  = one-half of the sum of the distances,  $L_B$ , from the centerline of a large ring to the next large ring or head line of support on either side of the large ring, in. (see Figure 1.4.1)

$L_s$  = one-half of the sum of the distances from the center line of a stiffening ring to the next line of support on either side of the ring, measured parallel to the axis of the cylinder, in. A line of support is described in the definition for  $L$  (see Figure 1.4.1), in.

$L_t$  = overall length of vessel as shown in Figure 1.4.1, in.

$L_u$  = laterally unbraced (laterally unsupported) length of a cylindrical member that is subject to column buckling, in. This applies to supports for pressure vessels or pedestal type vessels. Stiffening rings are not points of support unless they are externally supported. (Refer also to additional explanation at the end of this nomenclature section.)

$L, L_1,$

$L_2, L...$  = design length of unstiffened vessel section between lines of support or the total length of tube between tube sheets, in. A line of support is:

(a) a circumferential line on a head (excluding conical heads) at one-third the depth of the head from the head tangent line as shown on Figure 1.4.1

(b) a stiffening ring that meets the requirements of eq. 6.1(a)(6-1)

(c) a tubesheet

$M$  = applied bending moment across the vessel cross-section, in.-kips

$$M_s = L_s / \sqrt{R_o t}$$

$$M_x = L / \sqrt{R_o t}$$

$P$  = applied external pressure, ksi

$P_a$  = allowable external pressure in the absence of other loads, ksi

$Q$  = applied axial compression load, kips

$Q_p$  = axial compression load on end of cylinder resulting from applied external pressure, kips

$R$  = radius to centerline of shell, in.

$r$  = radius of gyration of cylinder, in.

$$r = \frac{(D_o^2 + D_i^2)^{1/2}}{4}$$

$R_c$  = radius to centroid of combined ring stiffener and effective length of shell, in.

$$R_c = R + Z_c$$

$R_o$  = radius to outside of shell, in.

$S$  = elastic section modulus of full shell cross-section, in.<sup>3</sup>

$$S = \frac{\pi(D_o^4 - D_i^4)}{32D_o}$$

- $t$  = thickness of shell, less corrosion allowance, in.  
 $t_c$  = thickness of cone, less corrosion allowance, in.  
 $V$  = shear force from applied loads at cross-section under consideration, kips  
 $Z_c$  = radial distance from centerline of shell to centroid of combined section of ring and effective length of shell, in.

$$Z_c = \frac{A_s Z_s}{A_s + L_e t}$$

- $Z_s$  = radial distance from centerline of shell to centroid of ring stiffener (positive for outside rings), in.  
 $\alpha$  = one-half of the apex angle of a conical section  
 $\beta$  = capacity reduction factor to account for shape imperfections  
 $\lambda_c$  = slenderness factor for column buckling

$$\lambda_c = \frac{KL_u}{\pi r} \sqrt{\frac{F_{xa} FS}{E}}$$

- $\Phi$  = angle measured around the circumference from the direction of applied shear force to the point under consideration

In the equation for  $\lambda_c$  above, a laterally unsupported length,  $L_u$ , for a free-standing pressure vessel without guide wires or other bracing should be measured from the top head tangent line to the base of the vessel support skirt. For  $\lambda_c$  values  $\leq 0.15$ , consideration for column instability (column buckling) is not required for either the vessel shell or the vessel skirt for any of the load combinations in 5. For  $\lambda_c > 0.15$ , consideration for column buckling is required, see 5 and specifically 5.1.2.

For load combinations including external pressure, the load on the end of a cylinder due to external pressure does not contribute to instability of the pressure vessel as a free standing column (column buckling). The axial compressive stress due to external pressure load does, however, lower the effective yield stress of the pressure shell [see eq. 5.1.2(5-3)], and the quantity in the parentheses  $(1 - f_q/F_y)$  accounts for this reduction. The reduced effective yield stress does not apply to parts that are not part of the pressure shell.

## 2 GENERAL DESIGN INFORMATION

### 2.1 MATERIALS

The allowable stress equations apply directly to shells fabricated from carbon and low alloy steel materials listed in Table UCS-23 of Section VIII at temperatures below the creep range. These equations can also be applied

to other materials for which a chart or table is provided in Subpart 3 of Section II, Part D. The method for calculating the allowable stresses for shells constructed from these materials is determined by the following procedure.

*Step 1.* Calculate the value of factor  $A$  using the following equations. The terms  $F_{xe}$ ,  $F_{he}$ , and  $F_{ve}$  are defined in the Nomenclature (1.4).

$$A = \frac{F_{xe}}{E} \quad A = \frac{F_{he}}{E} \quad A = \frac{F_{ve}}{E}$$

*Step 2.* Using the value of  $A$  calculated in Step 1, enter the applicable material chart in Subpart 3 of Section II, Part D for the material under consideration. Move vertically to an intersection with the material temperature line for the design temperature. Use interpolation for intermediate temperature values.

*Step 3.* From the intersection obtained in Step 2, move horizontally to the right to obtain the value of  $B$ .  $E_t$  is given by the following equation:

$$E_t = \frac{2B}{A}$$

When values of  $A$  fall to the left of the applicable material/temperature line in Step 2,  $E_t = E$ .

*Step 4.* Calculate the allowable stresses from the following equations:

$$F_{xa} = \frac{F_{xe} E_t}{FS E} \quad F_{ba} = F_{xa} \quad F_{ha} = \frac{F_{he} E_t}{FS E} \quad F_{va} = \frac{F_{ve} E_t}{FS E}$$

### 2.2 STRESS REDUCTION FACTORS

Allowable stresses in this Case for design and test conditions are determined by applying a stress reduction factor,  $FS$ , to predicted buckling stresses calculated in this Case. The required values of  $FS$  are 2.0 when the buckling stress is elastic and 1.67 when the buckling stress equals yield stress at design temperature. A linear variation shall be used between these limits. The equations for  $FS$  are given below.

$$\begin{aligned} FS &= 2.0 && \text{if } F_{ic} \leq 0.55F_y \\ FS &= 2.407 - 0.741F_{ic}/F_y && \text{if } 0.55F_y < F_{ic} < F_y \\ FS &= 1.667 && \text{if } F_{ic} \geq F_y \end{aligned}$$

$F_{ic}$  is the predicted buckling stress, which is determined by letting  $FS = 1$  in the allowable stress equations. For combinations of earthquake loading or wind loading with other load cases listed in UG-22, the allowable stresses may be increased as permitted by UG-23(c).

### 2.3 CAPACITY REDUCTION FACTORS ( $\beta$ )

Capacity reduction factors that account for shape imperfections are built into the allowable stress equations in this Case. These factors are in addition to the stress reduction factors in 2.2.

(a) For unstiffened or ring stiffened cylinders under axial compression:

$$\beta = 0.207 \text{ for } \frac{D_o}{t} \geq 1,247$$

$$\beta = \frac{338}{389 + \frac{D_o}{t}} \text{ for } \frac{D_o}{t} < 1,247$$

(b) Unstiffened and ring stiffened cylinders and cones under external pressure:  $\beta = 0.8$

(c) Spherical, torispherical, and ellipsoidal heads under external pressure:  $\beta = 0.124$

**2.4 STRESS COMPONENTS FOR STABILITY ANALYSIS AND DESIGN**

Stress components that control the buckling of a cylindrical shell consist of longitudinal, circumferential, and in-plane shear membrane stresses.

**3 ALLOWABLE COMPRESSIVE STRESSES FOR CYLINDRICAL SHELLS**

The maximum allowable stresses for cylindrical shells subjected to loads that produce compressive stresses are given by the following equations. For stress components acting alone, the maximum values shall be used. For combined stress components, the concurrent (coexisting) stress values shall be used.

In no case shall the allowable primary membrane compressive stresses exceed the maximum allowable tensile stress listed in Section II, Part D.

**3.1 EXTERNAL PRESSURE**

The allowable circumferential compressive stress for a cylinder under external pressure is given by  $F_{ha}$  and the allowable external pressure is given by the following equation.

$$P_a = 2F_{ha} \frac{t}{D_o}$$

$$F_{ha} = \frac{F_y}{FS} \text{ for } \frac{F_{he}}{F_y} \geq 2.439 \tag{3-1a}$$

$$F_{ha} = \frac{0.7F_y}{FS} \left( \frac{F_{he}}{F_y} \right)^{0.4} \text{ for } 0.552 < \frac{F_{he}}{F_y} < 2.439 \tag{3-1b}$$

$$F_{ha} = \frac{F_{he}}{FS} \text{ for } \frac{F_{he}}{F_y} \leq 0.552 \tag{3-1c}$$

where

$$F_{he} = 1.6C_h E \frac{t}{D_o} \tag{3-2}$$

$$C_h = 0.55 \frac{t}{D_o} \text{ for } M_x \geq 2 \left( \frac{D_o}{t} \right)^{0.94} \tag{3-2a}$$

$$C_h = 1.12M_x^{-1.058} \text{ for } 13 < M_x < 2 \left( \frac{D_o}{t} \right)^{0.94} \tag{3-2b}$$

$$C_h = \frac{0.92}{M_x - 0.579} \text{ for } 1.5 < M_x \leq 13 \tag{3-2c}$$

$$C_h = 1.0 \text{ for } M_x \leq 1.5 \tag{3-2d}$$

**3.2 UNIFORM AXIAL COMPRESSION**

Allowable longitudinal stress for a cylindrical shell under uniform axial compression is given by  $F_{xa}$  for values of  $\lambda_c \leq 0.15$  and by  $F_{ca}$  for values of  $\lambda_c > 0.15$ .

$$\lambda_c = \frac{KL_u}{\pi r} \sqrt{\frac{F_{xa} FS}{E}}$$

where  $KL_u$  is the effective length.  $L_u$  is the unbraced length. Minimum values for  $K$  are:

(a) 2.1 for members with one end free and the other end fixed (i.e., "free standing" pressure vessels supported at grade)

(b) 1.0 for members with both ends pinned

(c) 0.8 for members with one end pinned and the other end fixed

(d) 0.65 for members with both ends fixed

In this case, "member" is the unbraced cylindrical shell or cylindrical shell section as defined in the Nomenclature, 1.4.

**3.2.1 Local Buckling (for  $\lambda_c \leq 0.15$ ).**  $F_{xa}$  is the smaller of the values given by eqs. (3-3a) through (3-3c) and (3-4).

$$F_{xa} = \frac{F_y}{FS} \text{ for } \frac{D_o}{t} \leq 135 \tag{3-3a}$$

$$F_{xa} = \frac{466F_y}{\left( 331 + \frac{D_o}{t} \right) FS} \text{ for } 135 < \frac{D_o}{t} < 600 \tag{3-3b}$$

$$F_{xa} = \frac{0.5F_y}{FS} \text{ for } \frac{D_o}{t} \geq 600 \tag{3-3c}$$

or

$$F_{xa} = \frac{F_{xe}}{FS} \tag{3-4}$$

where

$$F_{xe} = \frac{C_x Et}{D_o} \quad (3-5)$$

$$\gamma = \frac{F_y D_o}{E t} \quad (3-8e)$$

$$C_x = \frac{409\bar{c}}{389 + \frac{D_o}{t}} \quad \text{not to exceed } 0.9 \quad \text{for } \frac{D_o}{t} < 1247$$

$$C_x = 0.25\bar{c} \quad \text{for } \frac{D_o}{t} \geq 1247$$

$$\bar{c} = 2.64 \quad \text{for } M_x \leq 1.5$$

$$\bar{c} = \frac{3.13}{M_x^{0.42}} \quad \text{for } 1.5 < M_x < 15$$

$$\bar{c} = 1.0 \quad \text{for } M_x \geq 15$$

$$M_x = \frac{L}{(R_o t)^{1/2}} \quad (3-6)$$

### 3.2.2 Column Buckling ( $\lambda_c > 0.15$ and $KL_u/r < 200$ ).

$$F_{ca} = F_{xa} [1 - 0.74(\lambda_c - 0.15)]^{0.3} \quad (3-7a)$$

$$\text{for } 0.15 < \lambda_c < 1.2$$

$$F_{ca} = \frac{0.88F_{xa}}{\lambda_c^2} \quad \text{for } \lambda_c \geq 1.2 \quad (3-7b)$$

### 3.3 AXIAL COMPRESSION DUE TO BENDING MOMENT

Allowable longitudinal stress for a cylinder subjected to a bending moment acting across the full circular cross-section is given by  $F_{ba}$ .

$$F_{ba} = F_{xa} \quad (\text{see } 3.2.1) \quad \text{for } \frac{D_o}{t} \geq 135 \quad (3-8a)$$

$$F_{ba} = \frac{466F_y}{FS \left( 331 + \frac{D_o}{t} \right)} \quad \text{for } 100 \leq \frac{D_o}{t} < 135 \quad (3-8b)$$

$$F_{ba} = \frac{1.081F_y}{FS} \quad \text{for } \frac{D_o}{t} < 100 \quad \text{and } \gamma \geq 0.11 \quad (3-8c)$$

$$F_{ba} = \frac{(1.4 - 2.9\gamma)F_y}{FS} \quad \text{for } \frac{D_o}{t} < 100 \quad \text{and } \gamma < 0.11 \quad (3-8d)$$

where

### 3.4 SHEAR

Allowable in-plane shear stress for a cylindrical shell is given by  $F_{va}$ .

$$F_{va} = \frac{\eta_v F_{ve}}{FS} \quad (3-9)$$

where

$$F_{ve} = \alpha_v C_v E \frac{t}{D_o} \quad (3-10)$$

$$C_v = 4.454 \quad \text{for } M_x \leq 1.5 \quad (3-11a)$$

$$C_v = \left( \frac{9.64}{M_x^2} \right) (1 + 0.0239M_x^3)^{1/2} \quad \text{for } 1.5 < M_x < 26 \quad (3-11b)$$

$$C_v = \frac{1.492}{M_x^{1/2}} \quad \text{for } 26 \leq M_x < 4.347 \frac{D_o}{t} \quad (3-11c)$$

$$C_v = 0.716 \left( \frac{t}{D_o} \right)^{1/2} \quad \text{for } M_x \geq 4.347 \frac{D_o}{t} \quad (3-11d)$$

$$\alpha_v = 0.8 \quad \text{for } \frac{D_o}{t} \leq 500 \quad (3-11e)$$

$$\alpha_v = 1.389 - 0.218 \log_{10} \left( \frac{D_o}{t} \right) \quad \text{for } \frac{D_o}{t} > 500 \quad (3-11f)$$

$$\eta_v = 1.0 \quad \text{for } \frac{F_{ve}}{F_y} \leq 0.48 \quad (3-11g)$$

$$\eta_v = 0.43 \frac{F_y}{F_{ve}} + 0.1 \quad \text{for } 0.48 < \frac{F_{ve}}{F_y} < 1.7 \quad (3-11h)$$

$$\eta_v = 0.6 \frac{F_y}{F_{ve}} \quad \text{for } \frac{F_{ve}}{F_y} \geq 1.7 \quad (3-11i)$$

### 4 ALLOWABLE COMPRESSIVE STRESSES FOR CONES

Unstiffened conical transitions or cone sections between rings of stiffened cones with an angle  $\alpha \leq 60$  deg shall be designed for local buckling as an equivalent cylinder according to the following procedure. See [Figure 1.4.3](#) for cone geometry.

**4.1 EXTERNAL PRESSURE**

**4.1.1 Allowable Circumferential Compression Stresses.** Assume an equivalent cylinder with diameter,  $D_e$ , equal to  $0.5(D_L + D_S)/\cos \alpha$ ,  $L_{ce} = L_c/\cos \alpha$ . The value  $D_e$  is substituted for  $D_o$ ,  $L_{ce}$  for  $L$ , and  $D_e/2$  for  $R_o$  in the equations given in 3.1 to determine  $F_{ha}$ . The allowable stress must be satisfied at all cross-sections along the length of the cone.

**4.1.2 Intermediate Stiffening Rings.** If required, circumferential stiffening rings within cone transitions shall be sized using eq. 6.1(a)(6-1).

**4.1.3 Cone-Cylinder Junction Rings.** A junction ring is not required for buckling due to external pressure if  $f_h < F_{ha}$  where  $F_{ha}$  is determined from eqs. 3.1(3-1a) through 3.1(3-1c) with  $F_{he}$  computed using  $C_h$  equal to  $0.55(\cos \alpha)(t/D_o)$  in eq. 3.1(3-2).  $D_o$  is the cylinder diameter at the junction. The hoop stress may be calculated from the following equation.

$$f_h = \frac{P D_o}{2 t_c \cos \alpha}$$

If  $t_c \cos \alpha$  is less than  $t$ , then substitute  $t$  for  $t_c$  to determine  $C_h$  and  $f_h$ .

Circumferential stiffening rings required at the cone-cylinder junctions shall be sized such that the moment of inertia of the composite ring section satisfies the following equation:

$$I_c \geq \frac{D^2}{16E} \left\{ t L_1 F_{he} + \frac{t_c L_c F_{hec}}{\cos^2 \alpha} \right\} \quad (4-1)$$

where

- $D$  = cylinder outside diameter at junction
- $F_{he}$  = elastic hoop buckling stress for cylinder [see eq. 3.1(3-2)]
- $F_{hec} = F_{he}$  for cone section treated as an equivalent cylinder
- $L_1$  = distance to first stiffening ring in cylinder section or line of support
- $L_c$  = distance to first stiffening ring in cone section along cone axis as shown in Figure 1.4.3
- $t$  = cylinder thickness
- $t_c$  = cone thickness

**4.2 UNIFORM AXIAL COMPRESSION AND BENDING**

**4.2.1 Allowable Longitudinal and Bending Stresses.** Assume an equivalent cylinder with diameter  $D_e$  equal to  $D/\cos \alpha$ , where  $D$  is the outside diameter at the cross-section under consideration and length equal to  $L_c$ .  $D_e$  is substituted for  $D_o$  in the equations given in 3.2 and 3.3 to find  $F_{xa}$  and  $F_{ba}$  and  $L_c$  for  $L$  in eq. 3.2.1(3-6). The radius  $R_o$  is equal to  $D_e/2$  at the large end of the cone. The allowable stress must be satisfied at all cross-sections along the length of the cone.

**4.2.2 Unstiffened Cone-Cylinder Junctions.** Cone-cylinder junctions are subject to unbalanced radial forces (due to axial load and bending moment) and to localized bending stresses caused by the angle change. The longitudinal and hoop stresses at the junction may be evaluated as follows:

(a) *Longitudinal Stress.* In lieu of detailed analysis, the localized bending stress at an unstiffened cone-cylinder junction may be estimated by the following equation.

$$f'_b = \frac{0.6t\sqrt{D(t+t_c)}}{t_e^2} (f_x + f_b) \tan \alpha \quad (4-2)$$

where

- $D$  = outside diameter of cylinder at junction to cone
- $f_b$  = longitudinal stress in cylinder section at the cone-cylinder junction resulting from bending moment
- $f_x$  = uniform longitudinal stress in cylinder section at the cone-cylinder junction resulting from pressure and/or applied axial loads, see Nomenclature, 1.4
- $t$  = thickness of cylinder
- $t_c$  = thickness of cone
- $t_e = t_c$  to find stress in cone section
- $t_e = t$  to find stress in cylinder section
- $\alpha$  = cone angle as defined in Figure 1.4.3

For strength requirements, the total stress ( $f_x + f_b + f'_b$ ) in the cone and cylinder sections shall be limited to 3 times the allowable stress at temperature listed in Section II, Part D, Tables 1A and 1B. The combined stress ( $f_x + f_b$ ) shall not exceed the allowable stress at temperature listed in Section II, Part D, Tables 1A and 1B.

(b) *Hoop Stress.* The hoop stress caused by the unbalanced radial line load may be estimated from:

$$f'_h = 0.45\sqrt{D/t} (f_x + f_b) \tan \alpha \quad (4-3)$$

For hoop tension,  $f'_h$  shall be limited to 1.5 times the tensile allowable per (a) above. The applicable joint efficiency shall be included when determining the allowable tensile stress. For hoop compression,  $f'_h$  shall be limited to  $F_{ha}$  where  $F_{ha}$  is computed from eqs. 3.1(3-1a) through 3.1(3-1c) with

$$F_{he} = 0.4E(t/D)$$

A cone-cylinder junction that does not satisfy the above criteria may be strengthened either by increasing the cylinder and cone wall thickness at the junction, or by providing a stiffening ring at the junction.

**4.2.3 Cone-Cylinder Junction Rings.** If stiffening rings are required, the section properties shall satisfy the following requirements:

$$A_c \geq \frac{tD}{F_y}(f_x + f_b) \tan \alpha \quad (4-4)$$

$$I_c \geq \frac{tD(D_c)^2}{8E}(f_x + f_b) \tan \alpha \quad (4-5)$$

where

- $A_c$  = cross-sectional area of composite ring section
- $D$  = cylinder outside diameter at junction =  $D_L$  or  $D_s$  in Fig. UG-33.1
- $D_c$  = diameter to centroid of composite ring section for external rings  
=  $D_i$  for internal rings
- $I_c$  = moment of inertia of composite ring section

In computing  $A_c$  and  $I_c$ , the effective length of shell wall acting as a flange for the composite ring section shall be computed from:

$$b_e = 0.55(\sqrt{Dt} + \sqrt{Dt_c/\cos \alpha}) \quad (4-6)$$

The nearest surface of the stiffening ring shall be located within a distance of  $t_r$  or 1 in., whichever is greater, from the cone junction. The thickness of the ring,  $t_r$ , is defined by  $t_1$  or  $t_2$  in Figure 1.4.4.

### 4.3 SHEAR

**4.3.1 Allowable In-Plane Shear Stress.** Assume an equivalent cylinder with a length equal to the slant length between rings ( $L_c/\cos \alpha$ ) and a diameter  $D_e$  equal to  $D/\cos \alpha$ , where  $D$  is the outside diameter of the cone at the cross-section under consideration. This length and diameter shall be substituted into the equations given in 3.4 to determine  $F_{va}$ .

**4.3.2 Intermediate Stiffening Rings.** If required, circumferential stiffening rings within cone transition shall be sized using eq. 6.4(a)(6-6) where  $L_s$  is the average distance to adjacent rings along the cone axis.

### 4.4 LOCAL STIFFENER GEOMETRY REQUIREMENTS

To preclude local buckling of a stiffener, the requirements of 6.4 must be met.

### 4.5 TOLERANCES

The tolerances specified in 7 shall be met.

## 5 ALLOWABLE STRESS EQUATIONS FOR UNSTIFFENED AND RING-STIFFENED CYLINDERS AND CONES UNDER COMBINED LOADS

The following rules do not apply to cylinders and cones under load combinations that include external pressure for values of  $\lambda_c \geq 1.2$ . For  $\lambda_c \geq 1.2$ , this Case is not applicable.

For load combinations that include uniform axial compression, the longitudinal stress to use in the interaction equations is  $f_x$  for local buckling equations ( $\lambda_c \leq 0.15$ ) and  $f_a$  for column buckling equations ( $\lambda_c > 0.15$ ). The stress component,  $f_q$ , which results from pressure on the ends of the cylinder, does not contribute to column buckling.

### 5.1 FOR COMBINATION OF UNIFORM AXIAL COMPRESSION AND HOOP COMPRESSION

**5.1.1** For  $\lambda_c \leq 0.15$  the allowable stress in the longitudinal direction is given by  $F_{xha}$  and the allowable stress in the circumferential direction is given by  $F_{hxa}$ .

$$f_x \leq F_{xha}$$

$$F_{xha} = \left( \frac{1}{F_{xa}^2} - \frac{C_1}{C_2 F_{xa} F_{ha}} + \frac{1}{C_2^2 F_{ha}^2} \right)^{-0.5} \quad (5-1)$$

where

$$C_1 = \frac{(F_{xa}FS + F_{ha}FS)}{F_y} - 1.0 \quad (5-1a)$$

and

$$C_2 = \frac{f_x}{f_h} \quad (5-1b)$$

$$f_x = f_a + f_q = \frac{Q}{A} + \frac{Q_p}{A} \quad \text{and} \quad f_h = \frac{PD_o}{2t}$$

Equation (5-1) should not be used (does not apply) if either  $f_h$  is not present (or not being considered), or  $f_x = 0$ .  $F_{xa}$   $FS$  is given by the smaller of eqs. 3.2.1(3-3a) through 3.2.1(3-3c) or eq. 3.2.1(3-4), and  $F_{ha}$   $FS$  is given by eqs. 3.1(3-1a) through 3.1(3-1c). To determine  $F_{xa}$  and  $F_{ha}$  the values of  $FS$  are obtained from 2.2.

$$F_{hxa} = \frac{F_{xha}}{C_2} \quad (5-2)$$

The values of  $FS$  are to be determined independently for the axial and hoop directions.

**5.1.2** For  $0.15 < \lambda_c < 1.2$ , the allowable stress in the longitudinal direction is given by  $F_{aha}$ , and is determined from column buckling considerations. (The rules do not apply to values of  $\lambda_c \geq 1.2$  for shells under combined axial compression and external pressure.)

$$f_a \leq F_{aha} \quad \text{where} \quad F_{aha} = F_{cha} \left( 1 - \frac{f_q}{F_y} \right) \quad (5-3)$$

The load on the end of a cylinder due to external pressure does not contribute to column buckling and therefore  $F_{aha}$  is compared with  $f_a$  rather than  $f_x$ . The stress due to the pressure load does, however, lower the effective yield stress and the quantity in parentheses  $(1 - f_q/F_y)$  accounts for this reduction.  $F_{cha}$  is obtained from eqs. 3.2.2(3-7a) and 3.2.2(3-7b) by substituting  $F_{xha}$ , determined from eq. 5.1.1(5-1) for  $F_{xa}$ . The resulting equations are:

$$F_{cha} = F_{xha} \quad \text{for} \quad \lambda_c \leq 0.15 \quad (5-3a)$$

$$F_{cha} = F_{xha} [1 - 0.74(\lambda - 0.15)]^{0.3} \quad \text{for} \quad 0.15 < \lambda_c < 1.2 \quad (5-3b)$$

## 5.2 FOR COMBINATION OF AXIAL COMPRESSION DUE TO BENDING MOMENT, M, AND HOOP COMPRESSION

The allowable stress in the longitudinal direction is given by  $F_{bha}$ , and the allowable stress in the circumferential direction is given by  $F_{hba}$ .

$$F_b \leq F_{bha} \quad (5-4)$$

$$F_{bha} = C_3 C_4 F_{ba}$$

where  $C_3$  and  $C_4$  are given by the following equations and  $F_{ba}$  is given by eqs. 3.3(3-8a) through 3.3(3-8e).

$$C_4 = \frac{f_b F_{ha}}{f_h F_{ba}} \quad (5-4a)$$

$$C_3^2 (C_4^2 + 0.6C_4) + C_3^{2n} - 1 = 0 \quad (5-5)$$

$$f_b = \frac{Mc}{I} \quad \text{and} \quad f_h = \frac{PD_o}{2t} \quad \text{and} \quad n = 5 - 4 \frac{F_{ha} \cdot FS}{F_y}$$

Solve for  $C_3$  from eq. (5-5) by iteration.  $F_{ha}$  is given by eq. 3.1(3-1a).

$$F_{hba} = F_{bha} \frac{f_h}{f_b} \quad (5-6)$$

## 5.3 FOR COMBINATION OF HOOP COMPRESSION AND SHEAR

The allowable shear stress is given by  $F_{vha}$  and the allowable circumferential stress is given by  $F_{hva}$ .

$$F_{vha} = \left[ \left( \frac{F_{va}^2}{2C_5 F_{ha}} \right)^2 + F_{va}^2 \right]^{1/2} - \frac{F_{va}^2}{2C_5 F_{ha}} \quad (5-7)$$

where

$$C_5 = \frac{f_y}{f_h}$$

$$f_v = V \sin \phi / \pi R t$$

$F_{va}$  is given by eq. 3.4(3-9) and  $F_{ha}$  is given by eq. 3.1(3-1a).

$$F_{hva} = \frac{F_{vha}}{C_5} \quad (5-8)$$

## 5.4 FOR COMBINATION OF UNIFORM AXIAL COMPRESSION, AXIAL COMPRESSION DUE TO BENDING MOMENT, M, AND SHEAR, IN THE PRESENCE OF HOOP COMPRESSION ( $f_h \neq 0$ )

$$\text{Let} \quad K_s = 1 - \left( \frac{f_v}{F_{va}} \right)^2 \quad (5-9)$$

**5.4.1** For  $\lambda_c \leq 0.15$

$$\left( \frac{f_a}{K_s F_{aha}} \right)^{1.7} + \frac{f_b}{K_s F_{bha}} \leq 1.0 \quad (5-10)$$

$F_{xha}$  is given by eq. 5.1.1(5-1),  $F_{bha}$  is given by eq. 5.2(5-4) and  $F_{va}$  is given by eq. 3.4(3-9).

**5.4.2** For  $0.15 < \lambda_c < 1.2$

$$\frac{f_a}{K_s F_{aha}} + \frac{8}{9} \frac{\Delta f_b}{K_s F_{bha}} \leq 1.0 \quad (5-11)$$

$$\text{for} \quad \frac{f_a}{K_s F_{aha}} \geq 0.2 \quad (5-12)$$

$$\frac{f_a}{2K_s F_{aha}} + \frac{\Delta f_b}{K_s F_{bha}} \leq 1.0 \quad \text{for} \quad \frac{f_a}{K_s F_{aha}} < 0.2$$

where

$$\Delta = \frac{C_m}{1 - \frac{f_a FS}{F_e}} \quad (5-12a)$$

$$F_e = \frac{\pi^2 E}{(KL_u/r)^2} \quad (5-12b)$$

See 5.1 for  $F_{xha}$ .  $F_{bha}$  is given by eq. 5.2(5-4).  $K$  is the effective length factor (see 3.2).  $FS$  is determined from equations in 2.2, where  $F_{ic} = F_{xa} FS$  [see eqs. 3.2.1(3-3a) and 3.2.1(3-4)].

$C_m$  = coefficient whose value shall be taken as follows:

(a) For compression members in frames subject to joint translation (side sway),

$$C_m = 0.85$$

(b) For rotationally restrained compression members in frames braced against joint translation and not subject to transverse loading between their supports in the plane of bending,

$$C_m = 0.6 - 0.4(M_1/M_2)$$

where  $M_1/M_2$  is the ratio of the smaller to larger moments at the ends of that portion of the member unbraced in the plane of bending under consideration.  $M_1/M_2$  is positive when the member is bent in reverse curvature and negative when bent in single curvature.

(c) For compression members in frames braced against joint translation and subjected to transverse loading between their supports:

(1) for members whose ends are restrained against rotation in the plane of bending,

$$C_m = 0.85$$

(2) for members whose ends are unrestrained against rotation in the plane of bending, for example, an unbraced skirt supported vessel,

$$C_m = 1.0$$

## 5.5 FOR COMBINATION OF UNIFORM AXIAL COMPRESSION, AXIAL COMPRESSION DUE TO BENDING MOMENT, $M$ , AND SHEAR, IN THE ABSENCE OF HOOP COMPRESSION ( $f_h = 0$ )

5.5.1 For  $\lambda_c \leq 0.15$

$$\left(\frac{f_a}{K_s F_{xa}}\right)^{1.7} + \frac{f_b}{K_s F_{ba}} \leq 1.0 \quad (5-13)$$

$F_{xa}$  is given by the smaller of eqs. 3.2.1(3-3a) through 3.2.1(3-3c) or eq. 3.2.1(3-4),  $F_{ba}$  is given by eqs. 3.3(3-8a) through 3.3(3-8e) and  $K_s$  is given by eq. 5.4(5-9).

5.5.2 For  $0.15 < \lambda_c < 1.2$

$$\frac{f_a}{K_s F_{ca}} + \frac{8}{9} \frac{\Delta f_b}{K_s F_{ba}} \leq 1.0 \quad \text{for } \frac{f_a}{K_s F_{ca}} \geq 0.2 \quad (5-14)$$

$$\frac{f_a}{2K_s F_{ca}} + \frac{\Delta f_b}{K_s F_{ba}} \leq 1.0 \quad \text{for } \frac{f_a}{K_s F_{ca}} < 0.2 \quad (5-15)$$

$F_{ca}$  is given by eqs. 3.2.2(3-7a) through 3.2.2(3-7b),  $F_{ba}$  is given by eqs. 3.3(3-8a) through 3.3(3-8e), and  $K_s$  is given by eq. 5.4(5-9). See 5.4.2 for definition of  $\Delta$ .

## 6 SIZING OF RINGS (GENERAL INSTABILITY)

### 6.1 EXTERNAL PRESSURE

(a) Small rings

$$I'_s \geq \frac{1.5 F_{he} L_s R_c^2 t}{E(n^2 - 1)} \quad (6-1)$$

where

$F_{he}$  = stress determined from eq. 3.1(3-2) with  $M_x = M_s$

$$n^2 = \frac{2D_o^{3/2}}{3L_{pt}^{1/2}}$$

$$n = 2 \text{ for } n^2 \leq 4 \\ = 10 \text{ for } n^2 > 100$$

(b) Large rings that act as bulkheads

$$I'_s \geq I_F \quad (6-2)$$

$$I_F = \frac{F_{he} L_F R_c^2 t}{2E} \quad (6-2a)$$

where

$F_{heF}$  = average value of the hoop buckling stresses,  $F_{he}$ , over length  $L_F$  where  $F_{he}$  is determined from eq. 3.1(3-2), ksi

$I_F$  = the value of  $I'_s$ , which makes a large stiffener act as a bulkhead. The effective length of shell is

$$L_e = 1.1 \sqrt{D_o t} \left( A_1 / A_2 \right)$$

$A_1$  = cross-sectional area of small ring plus shell area equal to  $L_s t$ , in.<sup>2</sup>

$A_2$  = cross-sectional area of large ring plus shell area equal to  $L_s t$ , in.<sup>2</sup>

$R_c$  = radius to centroid of combined large ring and effective width of shell, in.

### 6.2 UNIFORM AXIAL COMPRESSION AND AXIAL COMPRESSION DUE TO BENDING

When ring stiffeners are used to increase the allowable longitudinal compressive stress, the following equations must be satisfied. For a stiffener to be considered,  $M_x$  shall be less than 15.

$$A_s \geq \left[ \frac{0.334}{M_s^{0.6}} - 0.063 \right] L_s t \quad \text{and} \quad A_s \geq 0.06 L_s t \quad (6-3)$$

$$\text{also} \quad I'_s \geq \frac{5.33 L_s t^3}{M_s^{1.8}} \quad (6-4)$$

### 6.3 SHEAR

$$I'_s \geq 0.184 C_v M_s^{0.8} t^3 L_s \quad (6-5)$$

where

$C_v$  = value determined from eqs. 3.4(3-11a) through 3.4(3-11i) with  $M_x = M_s$ .

### 6.4 LOCAL STIFFENER GEOMETRY REQUIREMENTS

Stiffener geometry requirements are as follows. See Figure 1.4.4 for stiffener geometry and definition of terms.

(a) Flat bar stiffener, flange of a tee stiffener, and out-standing leg of an angle stiffener

$$\frac{h_1}{t_1} \leq 0.375 \left( \frac{E}{F_y} \right)^{1/2} \quad (6-6)$$

where  $h_1$  is the full width of a flat bar stiffener or out-standing leg of an angle stiffener and one-half of the full width of the flange of a tee stiffener and  $t_1$  is the thickness of the bar, leg of angle, or flange of tee.

(b) Web of tee stiffener or leg of angle stiffener attached to shell

$$\frac{h_2}{t_2} \leq 1.0 \left( \frac{E}{F_y} \right)^{1/2} \quad (6-7)$$

where  $h_2$  is the full depth of a tee section or full width of an angle leg and  $t_2$  is the thickness of the web or angle leg.

## 7 TOLERANCES FOR CYLINDRICAL AND CONICAL SHELLS

### 7.1 SHELLS SUBJECTED TO EXTERNAL PRESSURE

Cylindrical and conical shells shall meet the tolerances as specified herein. These tolerance requirements replace some portions of those specified in UG-80(b). All requirements of UG-80(a) are applicable. In place of the maximum deviation requirements specified in UG-80(b)(2), the following requirements apply.

The maximum deviation from a true circular form,  $e$ , shall not exceed the value given by the following equations.

$$e = 0.0165t(M_x + 3.25)^{1.069} \quad (7-1)$$

$e$  need not be less than  $0.2t$ , and shall not exceed the smaller of  $0.0242R$  or  $2t$ .

### 7.2 SHELLS SUBJECTED TO UNIFORM AXIAL COMPRESSION AND AXIAL COMPRESSION DUE TO BENDING MOMENT

Cylindrical and conical shells shall meet the out-of-roundness limitations specified in UG-80(a). Additionally, the local deviation from a straight line,  $e$ , measured along a meridian over a gauge length  $L_x$  shall not exceed the maximum permissible deviation  $e_x$  given below.

$$e_x = 0.002R$$

$$L_x = 4\sqrt{Rt} \quad \text{but not greater than } L \quad \text{for cylinders}$$

$$= 4\sqrt{Rt/\cos\alpha} \quad \text{but not greater than } L_c/\cos\alpha \quad \text{for cones}$$

$$= 25t \quad \text{across circumferential welds}$$

Also  $L_x$  is not greater than 95% of the meridional distance between circumferential welds.

### 7.3 IF TOLERANCES ARE EXCEEDED, ALLOWABLE BUCKLING STRESS ADJUSTMENT

The maximum deviation,  $e$ , can exceed  $e_x$  if the maximum axial stress is less than  $F_{xa}$  for shells designed for axial compression only or less than  $F_{xha}$  for shells designed for combinations of axial compression and external pressure. The change in buckling stress is given in eq. (7-2), and the reduced allowable buckling stress,  $F_{xa}$  (reduced), is determined as shown by eq. (7-3a) using the values for  $F_{xa}$  and  $FS_{xa}$  from eqs. 3.2.1(3-3a) through 3.2.1(3-3c) and eq. 3.2.1(3-4).

$$F'_{xe} = \left[ 0.944 - 0.286 \log \left( \frac{e}{e_x} 0.0005 \right) \right] E \frac{t}{R} \quad (7-2)$$

where  $e$  is the new maximum deviation. The quantity

$$0.286 \log \left( \frac{e}{e_x} 0.0005 \right)$$

is an absolute number (i.e., the log of a very small number is negative). See example for  $e = 2e_x$  below.

For example, when  $e = 2e_x$ , the reduction in allowable buckling stress can be calculated by the following formula:

$$F'_{xe} = 0.086E \frac{t}{R} \quad (7-3)$$

$$\text{Then } F_{xa(\text{reduced})} = \frac{F_{xa} * FS_{xa} - F'_{xe}}{FS_{xa}} \quad (7-3a)$$

## 7.4 MEASUREMENTS FOR DEVIATIONS

Measurements to determine  $e$  shall be made from a segmental circular template having the design outside radius, and placed on outside of the shell. The chord length  $L_c$  is given by the following equation

$$L_c = 2R \sin(\pi/2n) \quad (7-4)$$

$$n = c \left( \frac{\sqrt{R/t}}{L/R} \right)^d \quad \text{and } 2 \leq n \leq 1.41(R/t)^{0.5} \quad (7-5)$$

where

$$c = 2.28(R/t)^{0.54} \leq 2.80$$

$$d = 0.38(R/t)^{0.44} \leq 0.485$$

The requirements of UG-80(b)(3), (4), (6), (7), (8), and UG-80(b)(10) remain applicable.

## 7.5 SHELLS SUBJECTED TO SHEAR

Cylindrical and conical shells shall meet the tolerances specified in UG-80(a).

## 8 ALLOWABLE COMPRESSIVE STRESSES FOR SPHERICAL SHELLS AND FORMED HEADS, WITH PRESSURE ON CONVEX SIDE

### 8.1 SPHERICAL SHELLS

**8.1.1 With Equal Biaxial Stresses.** The allowable compressive stress for a spherical shell under uniform external pressure is given by  $F_{ha}$  and the allowable external pressure is given by  $P_a$ .

$$F_{ha} = \frac{F_y}{FS} \quad \text{for } \frac{F_{he}}{F_y} \geq 6.25 \quad (8-1a)$$

$$F_{ha} = \frac{1.31F_y}{FS \left( 1.15 + \frac{F_y}{F_{he}} \right)} \quad \text{for } 1.6 < \frac{F_{he}}{F_y} < 6.25 \quad (8-1b)$$

$$F_{ha} = \frac{0.18F_{he} + 0.45F_y}{FS} \quad \text{for } 0.55 < \frac{F_{he}}{F_y} \leq 1.6 \quad (8-1c)$$

$$F_{ha} = \frac{F_{he}}{FS} \quad \text{for } \frac{F_{he}}{F_y} \leq 0.55 \quad (8-1d)$$

$$F_{he} = 0.075E \frac{t}{R_o} \quad (8-2)$$

$$P_a = 2F_{ha} \frac{t}{R_o} \quad (8-3)$$

where  $R_o$  is the radius to the outside of the spherical shell and  $F_{ha}$  is given by eqs. (8-1a) through (8-1d).

**8.1.2 With Unequal Biaxial Stresses — Both Stresses Are Compressive.** The allowable compressive stresses for a spherical shell subjected to unequal biaxial stresses,  $\sigma_1$  and  $\sigma_2$ , where both  $\sigma_1$  and  $\sigma_2$  are compression stresses resulting from applied loads, are given by the following equations.

$$F_{1a} = \frac{0.6}{1 - 0.4k} F_{ha} \quad (8-4)$$

$$F_{2a} = kF_{1a} \quad (8-5)$$

where  $k = \sigma_2/\sigma_1$  and  $F_{ha}$  is given by eqs. 8.1.1(8-1a) through 8.1.1(8-1d).  $F_{1a}$  is the allowable stress in the direction of  $\sigma_1$  and  $F_{2a}$  is the allowable stress in the direction of  $\sigma_2$ .  $\sigma_1$  is the larger of the compression stresses.

**8.1.3 With Unequal Biaxial Stresses — One Stress Is Compressive and the Other Is Tensile.** The allowable compressive stress for a spherical shell subjected to unequal biaxial stresses  $\sigma_1$  and  $\sigma_2$ , where  $\sigma_1$  is a compression stress and  $\sigma_2$  is a tensile stress, is given by  $F_{1a}$ .

$F_{1a}$  is the value of  $F_{ha}$  determined from eqs. 8.1.1(8-1a) through 8.1.1(8-1d) With  $F_{he}$  given by eq. (8-6).

$$F_{he} = (C_o + C_p)E \frac{t}{R_o} \quad (8-6)$$

$$C_o = \frac{102.2}{195 + R_o/t} \quad \text{for } \frac{R_o}{t} < 622 \quad (8-6a)$$

$$C_o = 0.125 \quad \text{for } \frac{R_o}{t} \geq 622 \quad (8-6b)$$

$$C_p = \frac{1.06}{3.24 + \frac{1}{\bar{p}}}, \quad \bar{p} = \frac{\sigma_o^2 R_o}{E t} \quad (8-6c)$$

**8.1.4 Shear.** When shear is present, the principal stresses shall be calculated and used for  $\sigma_1$  and  $\sigma_2$ .

### 8.2 TOROIDAL AND ELLIPSOIDAL HEADS

The allowable compressive stresses for formed heads is determined by the equations given for spherical shells where  $R_o$  is defined below.

$h_o$  = outside height of the ellipsoidal head measured from the tangent line (head-bend line), in.

$K_o$  = factor depending on the ellipsoidal head proportions  $D_o/2h_o$  (see Table 3)

$R_o$  = for torispherical heads, the outside radius of the crown portion of the head, in.

= for ellipsoidal heads, the equivalent outside spherical radius taken as  $K_o D_o$ , in.

**Table 3**  
**Factor  $K_o$**

Use Interpolation for Intermediate Values						
$D_o/2h_o$	...	3.0	2.8	2.6	2.4	2.2
$K_o$	...	1.36	1.27	1.18	1.08	0.99
$D_o/2h_o$	2.0	1.8	1.6	1.4	1.2	1.0
$K_o$	0.90	0.81	0.73	0.65	0.57	0.50

### 8.3 TOLERANCES FOR FORMED HEADS

Formed heads shall meet the tolerances specified in UG-81. Additionally, the maximum local deviation from true circular form,  $e$ , for spherical shells and any spherical portion of a formed head designed for external pressure shall not exceed the shell thickness. Measurements to determine  $e$  shall be made with a gage or template with the chord length  $L_e$  given by the following equation:

$$L_e = 3.72\sqrt{Rt} \quad (8-7)$$

### 9 REINFORCEMENT FOR OPENINGS

The reinforcement for openings in vessels that do not exceed 25% of the cylinder diameter or 80% of the ring spacing into which the opening is placed may be designed in accordance with the following rules. Openings in shells that exceed these limitations require a special design that considers critical buckling performed in accordance with the rules of Division 1, U-2(g) as applicable, in addition to the rules provided in this Case. Small nozzles that do not exceed the size limitations in UG-36(b)(3) are exempt from reinforcement calculations.

#### 9.1

Reinforcement for nozzle openings in vessels designed for external pressure alone shall be in accordance with the requirements of UG-37(d)(1) as applicable. The required thickness shall be determined in accordance with 3.1 or 4.1.

Openings that exceed dimensional limits given in UG-36(b)(1) shall meet the requirements of Appendix 1-7.

#### 9.2

For cylinders designed for axial compression (which includes axial load and/or bending moment) without external pressure, the reinforcement of openings shall be in accordance with the following:

$$\text{Where } \gamma_n = \left( \frac{d}{2\sqrt{Rt}} \right)$$

$$\text{For } d \leq 0.4\sqrt{Rt}$$

$$A_r = 0 \quad (9-1)$$

$$\text{For } d > 0.4\sqrt{Rt} \text{ and } \gamma_n \leq \left( \frac{R/t}{291} + 0.22 \right)^2$$

$$A_r = 0.5dt_r \quad (9-2)$$

$$\text{For } d > 0.4\sqrt{Rt} \text{ and } \gamma_n > \left( \frac{R/t}{291} + 0.22 \right)^2$$

$$A_r = 1.0dt_r \quad (9-3)$$

and  $A_r$  is the area of reinforcement required,  $d$  is the inside diameter of the opening and  $t_r$  is the thickness of shell required for the axial compression loads without external pressure. The reinforcement shall be placed within a distance of  $0.75\sqrt{Rt}$  from the edge of the opening. Reinforcement available from the nozzle neck shall be limited to a thickness not exceeding the shell plate thickness at the nozzle attachment, and be placed within a limit measured normal to the outside surface of the vessel shell of  $0.5\sqrt{(d/2)t_n}$  (but not exceeding  $2.5 \times t_n$ ), where  $t_n$  is the nozzle wall thickness.

#### 9.3

For cylinders designed for axial compression in combination with external pressure, the reinforcement shall be the larger of that required for external pressure alone 9.1 or axial compression alone 9.2. Required reinforcement shall be placed within the limits described in 9.2 above.

### 10 REFERENCES

API 2U (1987), API Bulletin 2U (BUL 2U), "Bulletin on Stability Design of Cylindrical Shells," prepared under the jurisdiction of the API Committee on Standardization of Offshore Structures, First Edition, May 1987.

"ASME Code Case N-284: Metal Containment Shell Buckling Design Methods," Revision 1, May 1991.

Welding Research Council Bulletin 406, "Proposed Rules for Determining Allowable Compressive Stresses for Cylinders, Cones, Spheres, and Formed Heads," C.D. Miller and K. Mokhtarian, November 1995, ISSN 0043-2326.

Miller, C.D. and Mokhtarian, K., (1996), "A Comparison of Proposed Alternative Rules with ASME Code Rules for Determining Allowable Compressive Stresses," The Eighth International Conference on Pressure Vessel Technology, Montreal, Canada, July 25, 1996.

Miller, C.D. and Saliklis, E.P. (1993), "Analysis of Cylindrical Shell Database and Validation of Design Formulations," API Project 90-56, October 1993.

Miller, C.D., "Experimental Study of the Buckling of Cylindrical Shells With Reinforced Openings," ASME/ANS Nuclear Engineering Conference, Portland, Oregon, July 1982.

Miller, C.D., "The Effect of Initial Imperfections on the Buckling of Cylinders Subjected to External Pressure," PVRC Grant 94-28. Welding Research Council Bulletin 443, Report No. 1, July 1999.

"Commentary on the Alternative Rules for Determining Allowable Compressive Stresses for Cylinders, Cones, Spheres, and Formed Heads for Section VIII, Divisions 1 and 2," PVRC Grant 99-07, Welding Research Council Bulletin 462, June 2001.

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Approval Date: November 30, 1999

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2297**

**F-Number Grouping for 9Cr-1Mo-V FCAW Consumable Section I; Section II, Part A; Section II, Part B; Section II, Part C; Section II, Part D; Section IV; Section VIII, Division 1; Section VIII, Division 2; Section VIII, Division 3; Section IX; Section X; Section XII; Section III, Division 1; Section III, Division 2; Section III, Division 3; Section III, Division 5; Section XI, Division 1**

*Inquiry:* What alternative rules may be applied to grouping welding filler metal meeting the chemical requirements of [Table 1](#) and mechanical properties of [Table 2](#) but otherwise conforming to AWS A5.29 to reduce the number of performance qualifications?

*Reply:* It is the opinion of the Committee that welding filler metal meeting the chemical requirements of [Table 1](#) and mechanical properties of [Table 2](#) but otherwise conforming to AWS A5.29 may be considered as an F-No. 6 for performance qualifications only. Separate procedure qualifications are required.

This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Chemical Requirements**

Element	Composition, %
Carbon	0.08-0.13
Manganese	0.70-1.3
Phosphorus, max.	0.015
Sulfur, max.	0.015
Silicon	0.15-0.25
Chromium	8.5-10.5
Molybdenum	0.85-1.20
Vanadium	0.18-0.30
Nickel, max.	0.40
Columbium	0.02-0.040
Aluminum, max.	0.01
Copper, max.	0.40
Nitrogen	0.03-0.055
Cobalt, max.	0.6

**Table 2**  
**Mechanical Property Requirements (All Weld  
Metal Tension Test)**

Tensile strength, min., ksi	90
Elongation in 2 in., min. %	17

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**Case 2300**  
**Use of SA-372 Grade E Class 55, Grade J Class 55, and**  
**Grade F, G, and H Class 55 and 65 Forgings, Quenched**  
**and Tempered**  
**Section VIII, Division 1**

*Inquiry:* May liquid-quenched and tempered forging material complying with SA-372 Grade E Class 55, Grade J Class 55, and Grade F, G, and H Class 55 or 65 be used for pressure vessels fabricated by forging in construction under Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that liquid-quenched and tempered forging material as described in the inquiry may be used for pressure vessels fabricated by forging in construction under Section VIII, Division 1, provided the following additional requirements are met:

(a) The rules in Section VIII, Division 1, Subsection B, that apply are those given in Part UF.

(b) The maximum allowable stress values for the materials shall be those given in Table 1. The stress values apply to quenched and tempered material only, as per the specification.

(c) This material shall not be used for external pressure design.

(d) This Case number shall be referenced in the documentation of the material and recorded on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values**

Nominal Composition	Grade	Specified Min. Yield, ksi	Specified Min. Tensile, ksi	Maximum Allowable Stress
				Values, ksi for Metal Temperatures of 100–600°F
1Cr- $\frac{1}{5}$ Mo	E, Class 55	55	85	24.3
1Cr- $\frac{1}{5}$ Mo	F, Class 55	55	85	24.3
1Cr- $\frac{1}{5}$ Mo	F, Class 65	65	105	30.0
$\frac{1}{2}$ Cr- $\frac{1}{2}$ Mo	G, Class 55	55	85	24.3
$\frac{1}{2}$ Cr- $\frac{1}{2}$ Mo	G, Class 65	65	105	30.0
$\frac{1}{2}$ Cr- $\frac{1}{2}$ Mo	H, Class 55	55	85	24.3
$\frac{1}{2}$ Cr- $\frac{1}{2}$ Mo	H, Class 65	65	105	30.0
1Cr- $\frac{1}{5}$ Mo	J, Class 55	55	85	24.3

GENERAL NOTE: The revised criterion of 3.5 on tensile strength was used in establishing these values.

Approval Date: May 12, 2004

*Code Cases will remain available for use until annulled by the applicable Standards Committee.***Case 2304-2  
Austenitic Fe-35Ni-27Cr Alloy (UNS S35045)  
Section I; Section VIII, Division 1**

*Inquiry:* May annealed austenitic Fe-35Ni-27Cr alloy (UNS S35045) wrought sheet, strip, plate, rod, bar, seamless and welded pipe and tube, fittings, and forgings, with the chemical analysis shown in [Table 1](#) and minimum mechanical properties shown in [Table 2](#) and otherwise conforming to one of the specifications given in [Table 3](#), be used in welded construction under the rules of Section I and Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that material described in the Inquiry may be used in Section I and Section VIII, Division 1 construction at a design temperature of 1,650°F (900°C) or less, provided the following additional requirements are met:

(a) The rules in Section VIII, Division 1 that shall apply are those given in Part UNF for nickel alloys.

(b) For Section I design the  $y$  values (see PG-27.4 notes) used for PG-27.2.2 shall be as follows:

$\leq 1150^{\circ}\text{F}$ (620°C)	$y = 0.4$
1200°F (650°C)	$y = 0.5$
$\geq 1250^{\circ}\text{F}$ (675°C)	$y = 0.7$

(c) The maximum allowable stress values for the material shall be those given in [Tables 4](#) (U.S. Customary Units) and [4M](#) (SI Metric Units). The maximum design temperature shall be 1,650°F (900°C). For welded pipe and tube products, a joint efficiency factor of 0.85 shall be used.

(d) Separate welding procedures and performance qualifications shall be conducted for the material in accordance with Section IX.

(e) Heat treatment after forming or fabrication is neither required nor prohibited.

(f) For external pressure values, use Fig. NFN-9 of Section II, Part D.

(g) This Case number shall be shown on the material certification, on the material, and on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1  
 Chemical Requirements**

Element	Composition Limits, %
Nickel	32.0–37.0
Chromium	25.0–29.0
Iron [Note (1)]	Balance
Manganese, max.	1.5
Carbon	0.06–0.10
Silicon, max.	1.0
Sulfur, max.	0.015
Aluminum	0.15–0.60
Titanium	0.15–0.60
Copper, max.	0.75

NOTE:  
 (1) This element shall be determined arithmetically by difference.

**Table 2  
 Mechanical Property Requirements (Room  
 Temperature)**

Tensile strength min. (ksi)	70
Yield strength 0.2% offset min. (ksi)	25
Elongation in 2 in. gage or 4D min. (%)	35

**Table 3  
 Product Specifications**

Fittings	SA-403
Forgings	SA-182
Plate, sheet, and strip	SA-240
Rod and bar	SA-479
Seamless and welded pipe	SA-312
Seamless tubing	SA-213
Welded tubing	SA-249

**Table 4  
 Maximum Allowable Stress Values, U.S.  
 Customary Units [Note (1)]**

For Metal Temperature			
Not Exceeding, °F	Allowable Stress Values, Max., ksi		
	-20–100	16.7	16.7
200	14.6	16.7	[Note (2)]
300	13.6	16.7	[Note (2)]
400	12.3	16.7	[Note (2)]
500	12.1	16.4	[Note (2)]
600	11.7	15.8	[Note (2)]
650	11.5	15.5	[Note (2)]
700	11.3	15.3	[Note (2)]
750	11.2	15.1	[Note (2)]
800	11.1	15.1	[Note (2)]
850	11.0	14.9	[Note (2)]
900	10.9	14.7	[Note (2)]
950	10.8	14.6	[Note (2)]
1,000	10.7	14.5	[Note (2)]
1,050	10.6	13.7	[Note (2)]
1,100	10.5	10.9	[Note (2)]
1,150	8.8	8.8	...
1,200	7.1	7.1	...
1,250	5.8	5.8	...
1,300	4.7	4.7	...
1,350	3.8	3.8	...
1,400	3.1	3.1	...
1,450	2.5	2.5	...
1,500	2.0	2.0	...
1,550	1.5	1.5	...
1,600	1.2	1.2	...
1,650	0.90	0.90	...

NOTES:  
 (1) The revised criterion of 3.5 on tensile strength was used in establishing these values.  
 (2) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed 66<sup>2</sup>/<sub>3</sub>% but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.

**Table 4M**  
**Maximum Allowable Stress Values, SI Metric**  
**Units [Note (1)]**

For Metal Temperature			
Not Exceeding, °C	Allowable Stress Values, Max., MPa		
-30-40	115	115	...
65	115	101.2	[Note (2)]
100	115	99.6	[Note (2)]
150	115	93.1	[Note (2)]
200	115	88.0	[Note (2)]
250	114	84.1	[Note (2)]
300	109	81.1	[Note (2)]
325	108	79.9	[Note (2)]
350	106	78.8	[Note (2)]
375	105	77.9	[Note (2)]
400	104	77.1	[Note (2)]
425	103	76.4	[Note (2)]
450	102	75.2	[Note (2)]
475	102	75.2	[Note (2)]
500	101	74.6	[Note (2)]
525	100	74.0	[Note (2)]
550	99.1	73.4	...
575	87.4	72.7	...
600	71.8	71.8	...
625	58.9	58.9	...
650	48.5	48.5	...
675	40.1	40.1	...
700	33.3	33.3	...
725	27.8	27.8	...
750	23.2	23.2	...
775	19.2	19.2	...
800	15.7	15.7	...
825	12.6	12.6	...
850	9.8	9.8	...
875	7.6	7.6	...
900	6.4	6.4	...

## NOTES:

- (1) The revised criterion of 3.5 on tensile strength was used in establishing these values.
- (2) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed  $66\frac{2}{3}\%$  but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.

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Approval Date: December 14, 2009

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2305-1**  
**Exemption From Postweld NDE Requirements of**  
**UG-93(d)(4)(-b) on Fig. UW-13.2(d) Construction**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions may vessels constructed to Fig. UW-13.2(d) be exempted from the postweld NDE requirements of UG-93(d)(4)(-b)?

*Reply:* It is the opinion of the Committee that vessels constructed to Fig. UW-13.2(d) may be exempted from the postweld NDE requirements of UG-93(d)(4)(-b) provided the following requirements are met:

(a)  $t_s$  shall not be thicker than  $\frac{3}{16}$  in.

(b) The flat plate pre-machined nominal thickness shall not be thicker than  $1\frac{1}{2}$  in.

(c) Materials for construction are limited to P-No. 1, Groups 1 and 2, and P-No. 8, Group 1.

(d) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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(19)

**Case 2309  
Alternative Rules for Ultrasonic Examination  
of Cladding and Base Metal Clad Interfaces  
Section V**

**ANNULLED**

Annulment Date: December 30, 2018

Reason: No longer needed.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: May 4, 1999

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2313**  
**Electric Resistance and Autogenous Welded Tubing**  
**With 100% Longitudinal Weld Joint Factor for Use in**  
**Feedwater Heaters**  
**Section VIII, Division 1**

*Inquiry:* May electric resistance or autogenous welded tubing be used in Section VIII, Division 1, feedwater heaters with a 100% longitudinal weld joint factor at temperatures up to the maximum values listed in Tables 1A and 1B of Section II, Part D, but not higher than 850°F?

*Reply:* It is the opinion of the Committee that electric resistance or autogenous welded tubing may be used in Section VIII, Division 1, feedwater heaters with a 100% longitudinal weld joint factor at temperatures up to the maximum values listed in Tables 1A and 1B of Section II, Part D, but not higher than 850°F, provided the following additional requirements are met:

(a) This Case shall be limited to the tube specifications and materials listed in Table 1.

(b) The tubing shall be installed in the shell of a feedwater heater. Heating medium shall be water or steam.

(c) This Case shall be limited to tube nominal outside diameters from  $\frac{5}{8}$  in. to 1 in. and average wall thicknesses from 0.028 in. to 0.120 in.

(d) The longitudinal weld joint of each tube shall be subjected to an ultrasonic examination in accordance with para. S1 of SA-557. Calibration notches shall be provided in the weld of the reference standard at the Type A and Type B locations.

(e) Each tube shall also be subjected to an eddy current examination in accordance with para. S1 of SA-688. External calibration notches shall be located in the weld of the reference standard.

(f) Calibration notches shall be formed by electrical discharge machining. The reference standard shall be visually inspected on the inside and outside surfaces to ensure absence of defects.

(g) A baseline (noise level) signal shall be established for the reference standard. If the baseline signal level of the production tube exceeds the baseline signal level of the reference tube by more than 40% of the calibration notch signal level, a sufficient quantity of production tubing shall be examined by other (destructive or nondestructive) methods to ensure that the high baseline signal level of the production tubing is not caused by defects in the tubing.

(h) Tube ends that cannot be evaluated by the examinations of (d) and (e) shall be discarded.

(i) Each tube shall be subjected to an air-under-water leak test in accordance with para. 10.6.1.2 of SA-688.

(j) Each tube shall be subjected to a hydrostatic test after U-bending and heat treatment (if applicable). Minimum test pressures shall be  $P = 32000 t/D$ , where  $t$  is the specified wall thickness and  $D$  is the specified outside diameter. For tubing grades with specified minimum yield strengths greater than 35,000 psi, the minimum specified yield strength should be used instead of the value of 32,000 in the calculation of hydrostatic test pressure.

(k) Maximum allowable tensile stress shall be determined by dividing by 0.85 the Tables 1A and 1B tabulated values for welded tubing.

(l) This Case number shall be shown in the documentation and marking for the material and on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Permitted Tube Specifications and Materials**

Specification	Grade	UNS Number
SA-557	A2, B2, C2	K01807, K03007, K03505
SA-688	TP304, TP304L, TP304N, TP316, TP316L, TPXM-29	S28300, S30400, S30403, S30451, S31600, S31603
SA-803	TP409, TP439, 26-3-3, 18-2, 29-4C	S40900, S43035, S44400, S44660, S44735
SB-676	...	N08367

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Approval Date: September 23, 1999

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2318**  
**Alternative Flanged Joint Design for Nuclear Material**  
**Fluidized Bed Reactors**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions may a vessel for nuclear material fluidized bed reactors intended for lethal service use a slip-on flange as a body flange?

*Reply:* It is the opinion of the Committee that a vessel for nuclear material fluidized bed reactors intended for lethal service may use a slip-on flange as a body flange provided all of the following conditions are met:

- (a) The vessel does not exceed NPS 6 or 0.280-in. nominal wall thickness.
- (b) The material is limited to N06600.
- (c) Final weld surfaces are liquid penetrant examined in accordance with Appendix 8 of UW-2(a)(1)(-b).
- (d) The flange is welded as shown in Appendix 2, Fig. 2-4(10a) of UW-2(a)(1)(-b).
- (e) The maximum allowable working pressure does not exceed 150 psig.
- (f) The maximum allowable working pressure shall not exceed 1000°F.
- (g) The User shall stipulate to the Manufacturer that
  - (1) the vessel is operated within an engineered enclosure providing secondary containment

- (2) the enclosure shall be maintained at a negative pressure during all modes of operation

- (3) the enclosure shall be equipped with redundant leak detectors inside with both local and remote alarms

- (4) the process shall be shut down if a detector is actuated

- (h) The User shall stipulate to the Manufacturer that a hazard analysis will be conducted by an engineer experienced in the applicable analysis methodology that examines all credible scenarios that could result in a leak. The User shall also stipulate to the Manufacturer that the enclosure shall be designed to contain the contents from a leak. The results of the analysis shall be documented and signed by the individual identified to be in charge of the operation of the vessel.

- (i) The User shall stipulate to the Manufacturer that documentation of the hazard analysis shall be made available to the regulatory and enforcement authorities having jurisdiction at the site where the vessel will be installed. The User of this Case is cautioned that prior jurisdictional acceptance may be required.

- (j) Pressure testing in accordance with UG-99(c) is required.

- (k) Provisions of this Case apply only to nonreactor nuclear facilities.

- (l) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: February 20, 2002

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2321-1**  
**Exemption From Postweld Heat Treatment for P-No. 4**  
**or P-No. 5A Tube-to-Tubesheet Seal Welds**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions may tube-to-tubesheet seal welds between P-No. 4 or P-No. 5A tubes and P-No. 8 or P-No. 4X cladding on P-No. 1 tubesheets be exempt from postweld heat treatment requirements of UCS-56?

*Reply:* It is the opinion of the Committee that tube-to-tubesheet seal welds between P-No. 4 or P-No. 5A tubes and P-No. 8 or P-No. 4X cladding on P-No. 1 tubesheets may be exempted from postweld heat treatment requirements of UCS-56 under the following limitations:

(a) The P-No. 4 or P-No. 5A tubes shall have a wall thickness less than or equal to 0.150 in.

(b) The tubes are seal welded to the face of the cladding using the GTAW process.

(c) The cladding is deposited using F-No. 4X filler metal or deposited using F-No. 6 filler metal having a deposit chemistry of A-No. 8.

(d) The filler metal used to weld the tubes to P-No. 4X cladding is F-No. 4X filler metal. The filler metal used to weld the tubes to the P-No. 8 cladding is F-No. 4X or F-No. 6 filler metal having a deposit chemistry of A-No. 8.

(e) The vessel is not for lethal [UW-2(a)] service applications.

(f) This Case number shall be shown on the Manufacturer's Data Report.

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Approval Date: March 21, 2012

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**Case 2324-1**  
**Use of Automated Ultrasound Leak Detection System in**  
**Lieu of Visual Inspections Required by UG-100(d)**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions may an automated ultrasound monitored leak detection system be used in lieu of the visual inspections required by UG-100(d)?

*Reply:* It is the opinion of the Committee that an automated ultrasound monitored leak detection system may be used in lieu of the visual inspections required by UG-100(d), provided that all of the following requirements are met:

(a) The materials of construction shall be P-No. 1 Group 1 or Group 2 and the weld thickness shall not exceed  $\frac{3}{8}$  in. The vessel will not contain a "lethal" substance.

(b) The vessel design pressure shall not exceed 350 psi. The vessel shall be pressurized pneumatically, and the pressure in the vessel during the leak test shall meet the requirements of UG-100(d). All weld seams, which will be hidden by assembly, shall be given a visual examination for workmanship prior to assembly.

(c) The test shall be performed in an acoustically sealed chamber that is monitored by an array of ultrasound transducers capable of detecting the high-frequency emissions (20 kHz and higher) produced by a leak in the pressure vessel being tested. The ultrasound sensors

shall be positioned so that the entire pressure vessel is monitored following the pressurization to detect leakage. The detection of any leakage shall be cause for rejection.

(d) The automated ultrasound leak inspection shall be monitored in accordance with a written procedure that includes the following:

(1) Calibrations of the airborne ultrasound leak detection system shall be conducted in accordance with methods and criteria of ASTM E1002-11 test method A, pressurization.

(2) A test shall be performed once each shift to verify the operation of the entire system. The test must confirm the ultrasound arrays are working properly and confirm the operability of any vessel routing sensors, conveyors, and related devices. This test shall be performed using a white noise to simulate a leak. Date, time, and operator initials confirming acceptance shall be recorded.

(3) The white noise calibration shall be validated at least once per month by demonstrating the system's ability to detect a leak through a 0.001 in. test orifice installed in a vessel.

(4) The manufacturer shall certify that personnel performing the calibration testing have been qualified and certified in accordance with their employer's written practices. The qualification records of certified personnel shall be maintained by their employer.

(e) This Case number shall be shown on the Manufacturer's Data Report Form.

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Approval Date: January 29, 2009

*Code Cases will remain available for use until annulled by the applicable Standards Committee.***Case 2327-2**  
**9Cr-1Mo-1W-Cb Material**  
**Section I**

*Inquiry:* May seamless tubes, seamless pipes, forged and bored pipes, fittings, forgings, and plates, with the chemical analysis shown in Table 1, the minimum mechanical properties shown in Table 2, and otherwise conforming to the specifications listed in Table 3, be used in Section I construction?

*Reply:* It is the opinion of the Committee that 9Cr-1Mo-1W-Cb seamless tubes, seamless pipes, forged and bored pipes, fittings, forgings, and plates, with the chemical analysis shown in Table 1, the minimum mechanical properties shown in Table 2, and otherwise conforming to the specifications listed in Table 3 may be used in Section I construction, provided the following additional requirements are met:

(a) The material shall be austenitized within the temperature range of 1,900°F to 1,975°F (1 040°C to 1 080°C), followed by air or accelerated cooling, and tempered within the range of 1,365°F to 1,435°F (740°C to 780°C).

(b) The maximum allowable stress values for the material shall be those shown in Table 4.

(c) Separate weld procedure and performance qualifications, conducted in accordance with Section IX, shall be required for this material. Postweld heat treatment for this material is mandatory, and the following rules shall apply:

(1) The time requirements shall be those given for P-No. 15E, Group 1 materials in Table PW-39.

(2) The PWHT temperature range shall be 1,350°F to 1,470°F (730°C to 800°C).

(d) Material cold worked to strains greater than 10% to and including 20%,<sup>1</sup> and intended for use 1,000°F, shall be stress relieved at 1,365–1,435°F (740–780°C). Stress relief may be combined with the PWHT. Material cold worked to strains greater than 20%,<sup>1</sup> and intended for use above 1,000°F, shall be re-austenitized and retempered, per (a).

(e) Except as provided in (f), if during the manufacturing any portion of the component is heated to a temperature greater than 1,470°F (800°C), then the component must be re-austenitized and retempered in its entirety in accordance with (a) above, or that portion of the component heated above 1,470°F (800°C), including the Heat-Affected Zone created by the local heating, must be replaced, or must be removed, re-austenitized, and retempered, and then replaced in the component.

(f) If the allowable stress values to be used are less than or equal to those provided in Table 1A of Section II, Part D for Grade 9 (SA-213 T9, SA-335 P9, or equivalent product specifications) at the design temperature, then the requirements of (e) may be waived, provided the portion of the component heated to a temperature greater than 1,470°F (800°C) is reheat treated within the temperature range 1,350°F to 1,470°F (730°C to 800°C).

(g) This Case number shall be shown in the marking and documentation of the material and in the Manufacturer's Data Report.

<sup>1</sup> See PG-19 for applicable strain definitions.

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**Table 1  
 Chemical Requirements**

Element	Composition Limits, %
Carbon	0.09–0.13
Manganese	0.30–0.60
Phosphorous, max.	0.020
Sulfur, max.	0.010
Silicon	0.10–0.50
Chromium	8.5–9.5
Molybdenum	0.90–1.10
Tungsten	0.90–1.10
Nickel, max.	0.40
Vanadium	0.18–0.25
Columbium	0.060–0.100
Nitrogen	0.040–0.090
Aluminum, max.	0.02
Boron	0.0003–0.006
Titanium, max.	0.01
Zirconium, max.	0.01

**Table 2  
 Mechanical Property Requirements**

Product Form	Tensile Strength, ksi	Yield Strength, ksi	Elongation in 2 in., min%	
			[Note (1)]	Hardness, max. [Note (2)]
Seamless tubes	90 min.	64 min.	20	238 HB/250 HV (99.5 HRB)
Seamless pipe	90 min.	64 min.	20	238 HB/250 HV (99.5 HRB)
Forged and bored pipe	90 min.	64 min.	20	238 HB/250 HV (99.5 HRB)
Fittings	90–115	64 min.	20	...
Forgings [Note (3)]	90 min.	64 min.	20	238 HB/250 HV (99.5 HRB)
Forgings [Note (4)]	90–115	64 min.	20	...
Plate	90–115	64 min.	20	...
	Wall Thickness (in.)		Elongation in 2 in., min., %	
	$\frac{5}{16}$ (0.312)		20.0	
	$\frac{9}{32}$ (0.281)		19.0	
	$\frac{1}{4}$ (0.250)		18.0	
	$\frac{7}{32}$ (0.219)		17.0	
	$\frac{3}{16}$ (0.188)		16.0	
	$\frac{5}{32}$ (0.156)		15.0	
	$\frac{1}{8}$ (0.125)		14.0	
	$\frac{3}{32}$ (0.094)		13.0	

GENERAL NOTE: The above table gives the computed minimum elongation values for each  $\frac{1}{32}$  in. decrease in wall thickness. Where the wall thickness lies between two values shown above, the minimum elongation value shall be determined by the following equation:

$$E = 32t + 10.0$$

where

$E$  = elongation in 2 in., %

$t$  = actual thickness of specimen, in.

NOTES:

- (1) For longitudinal strip tests of tubes and pipes, a deduction from the basic minimum elongation values of 1.00% for each  $\frac{1}{32}$  in. decrease in wall thickness below  $\frac{5}{16}$  in. shall be made. The table above gives the computed value.
- (2) Where ellipses (...) appear in this table, there is no requirement.
- (3) Otherwise meeting SA-182.
- (4) Otherwise meeting SA-336.

**Table 3  
Specifications**

Seamless tubes	SA-213
Seamless pipes	SA-335
Forged and bored pipes	SA-369
Fittings	SA-234
Forgings	SA-182, SA-336
Plates	SA-1017

**Table 4  
Material Property Values**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi [Note (1)]	Yield Strength Values, ksi [Note (2)]	Tensile Strength Values, ksi [Note (3)]
-20 to 100	25.7	64.0	90.0
200	25.7	60.2	90.0
300	25.1	57.5	87.7
400	24.1	55.6	84.5
500	23.6	54.5	82.5
600	23.2	53.9	81.1
650	23.0	53.5	80.3
700	22.7	53.1	79.3
750	22.3	52.5	77.9
800	21.7	51.5	76.0
850	21.0	50.3	73.5
900	20.1	48.6	70.3
950	19.0	46.5	66.5
1,000	17.7	44.0	62.0
1,050	14.9	41.1	56.9
1,100	11.4	37.9	51.4
1,150	6.7	34.5	45.8
1,200	...	31.0	40.3

## NOTES:

- (1) These allowable stress values have been established using the factor of 3.5 on tensile strength.
- (2) The tabulated values of yield strength are those the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the yield strength values correspond to the yield strength trend curve adjusted to the minimum specified room temperature yield strength. The yield strength values do not correspond exactly to minimum, as this term is applied to a statistical treatment of a homogeneous set of data.  
Neither the ASME Material Specifications nor the rules of Section I require elevated temperature testing for yield strengths of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated yield strength values for ASME Code acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.
- (3) The tabulated values of tensile strength tend toward an average or expected value that may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. The tensile strength values do not correspond exactly to "average," as this term is applied to a statistical treatment of a homogeneous set of data.  
Neither the ASME Material Specifications nor the rules of Section I require elevated temperature testing for tensile strengths of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile strength values for ASME Code acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

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Approval Date: September 18, 2010

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2328-2**  
**Austenitic Stainless Steel Tubes, SA-213/SA-213M, UNS**  
**S30432, 18Cr-9Ni-3Cu-Cb-N**  
**Section I**

*Inquiry:* May SA-213/SA-213M, UNS S30432, tubes be used for steam service in Section I construction?

*Reply:* It is the opinion of the Committee that SA-213/SA-213M, UNS S30432, tubes may be used for steam service in Section I construction, provided that the following requirements are met.

(a) The material shall be reheated to the solution treatment temperature specified in SA-213/SA-213M for the required time before quenching.

(b) The maximum allowable stress values for the material shall be those given in Tables 1 and 1M. The maximum design temperature is 1,500°F (815°C).

(c) The rules of PG-19 for TP347H shall apply for this material.

(d) Separate welding procedure and performance qualifications shall be conducted for the material in accordance with Section IX. Postweld heat treatment is neither required nor prohibited.

(e) This Case number shall be referenced in the documentation and marking of the material and recorded on the Manufacturer's Data Report.

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**Table 1**  
**Maximum Allowable Stress Values, U.S.**  
**Customary Units**

For Metal Temperature Not Exceeding, °F		Stress Values, ksi
-20 to 100		22.7, 22.7
200		19.8, 22.7 [Note (1)]
300		18.2, 22.7 [Note (1)]
400		17.1, 22.7 [Note (1)]
500		16.3, 21.9 [Note (1)]
600		15.6, 21.1 [Note (1)]
650		15.3, 20.7 [Note (1)]
700		15.1, 20.4 [Note (1)]
750		14.9, 20.1 [Note (1)]
800		14.6, 19.8 [Note (1)]
850		14.4, 19.5 [Note (1)]
900		14.2, 19.2 [Note (1)]
950		14.0, 18.9 [Note (1)]
1,000		13.8, 18.6 [Note (1)]
1,050		13.6, 18.3 [Note (1)]
1,100		13.4, 18.1 [Note (1)]
1,150		13.2, 14.7 [Note (1)]
1,200		11.4, 11.4
1,250		8.7, 8.7
1,300		6.5, 6.5
1,350		4.7, 4.7
1,400		3.3, 3.3
1,450		2.2, 2.2
1,500		1.5, 1.5

NOTE:

(1) Due to the relatively low yield strength of these materials, these higher stress values were established at temperatures where the short time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed 66<sup>2</sup>/<sub>3</sub>% but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.

**Table 1M**  
**Maximum Allowable Stress Values, SI Metric**  
**Units**

For Metal Temperature Not Exceeding, °C		Stress Values, MPa
-30 to 40		157, 157
65		144, 157 [Note (1)]
100		135, 157 [Note (1)]
150		126, 157 [Note (1)]
200		119, 157 [Note (1)]
250		113, 153 [Note (1)]
300		109, 147 [Note (1)]
325		107, 145 [Note (1)]
350		106, 143 [Note (1)]
375		104, 140 [Note (1)]
400		103, 139 [Note (1)]
425		101, 137 [Note (1)]
450		99.9, 135 [Note (1)]
475		98.5, 133 [Note (1)]
500		97.2, 131 [Note (1)]
525		95.9, 129 [Note (1)]
550		94.6, 128 [Note (1)]
575		93.4, 126 [Note (1)]
600		92.3, 121 [Note (1)]
625		91.3, 97.9 [Note (1)]
650		78.0, 78.0
675		61.1, 61.1
700		46.9, 46.9
725		35.3, 35.3
750		25.9, 25.9
775		18.5, 18.5
800		12.9, 12.9
825		8.9, 8.9

NOTE:

(1) Due to the relatively low yield strength of these materials, these higher stress values were established at temperatures where the short time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed 66<sup>2</sup>/<sub>3</sub>% but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.

Approval Date: July 10, 2000

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2334**  
**Single Fillet Lap Joints in the Shell of a Shell-and-Tube Heat Exchanger**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions may a single fillet lap joint weld be used to join a cast tubesheet with flange extension to the shell in a shell-and-tube heat exchanger?

*Reply:* It is the opinion of the Committee that a single fillet lap joint weld may be used to join a cast tubesheet with flange extension to the shell in a shell-and-tube heat exchanger provided the following requirements are met.

(a) Outside diameter of the shell shall not exceed 12 in., and the nominal thickness of the shell ( $t_s$ ) shall not exceed  $\frac{1}{4}$  in.

(b) The fillet weld shall be attached on the outside and shall be examined by either magnetic particle or liquid penetrant methods after welding. The fillet weld shall meet the minimum cross-sectional requirements shown in [Figure 1](#). A joint efficiency of 0.45 shall be used for this joint.

(c) MAWP on the shell side or the tube side shall not exceed 250 psig.

(d) Maximum design metal temperature (MDMT) shall not exceed 450°F.

(e) MDMT stamped on the nameplate shall not be colder than -20°F.

(f) Cyclic loading is not a controlling design requirement (see UG-22).

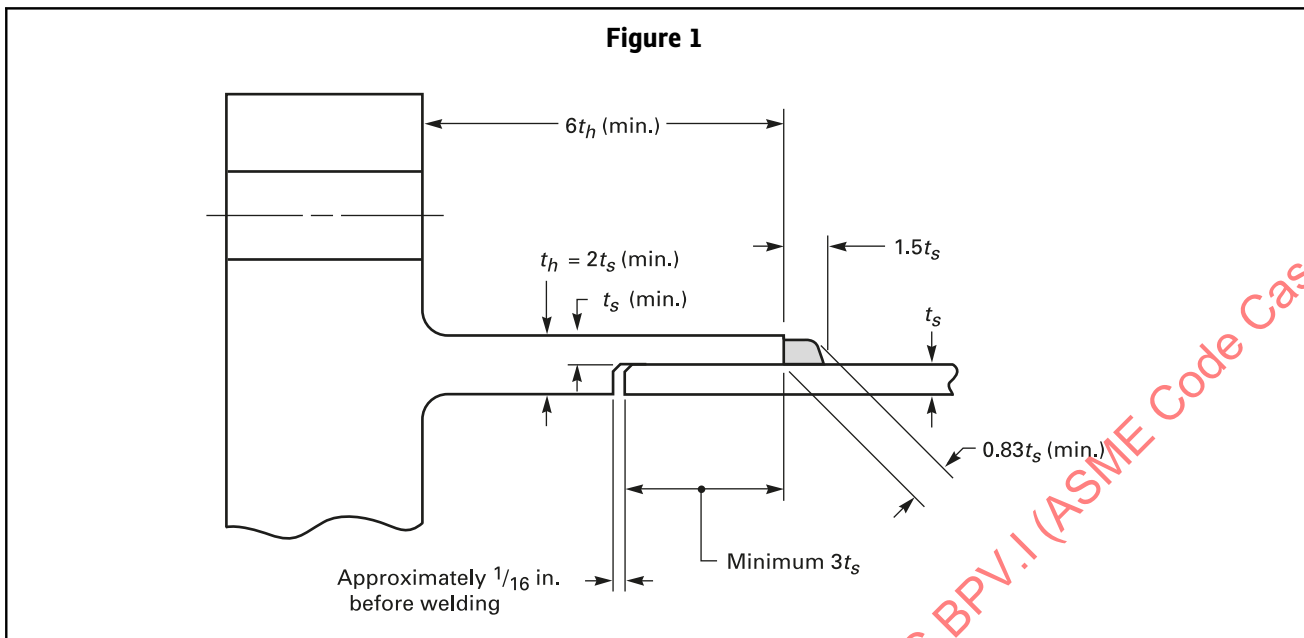
(g) The heat exchanger is not in lethal service (see UW-2).

(h) The tubesheet shall be supported such that at least 80% of the pressure load on the tubesheet is carried by tubes, stays, or braces.

(i) The tubesheet shall be a casting that has an integral flange and shell hub. The shell hub shall extend at least six times the nub thickness beyond the back of the tubesheet and meet the dimensional requirements of [Figure 1](#). The casting material shall be either P-No. 1 or 8, or per UNF-8.

(j) This Case number shall be shown on the Manufacturer's Data Report.

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Approval Date: February 14, 2003

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2346-1**  
**Alternative Rules for Ellipsoidal or Torispherical Heads**  
**Having Integral Backing Strip Attached to Shells**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions may ellipsoidal or torispherical heads having an integral backing strip be attached to shells?

*Reply:* It is the opinion of the Committee that an ellipsoidal or torispherical head having an integral backing strip be attached to shells provided the following requirements are met.

- (a) MAWP on the vessel shall not exceed 470 psig.
- (b) Maximum design metal temperature shall not exceed 400°F.
- (c) MDMT stamped on the nameplate shall not be colder than -20°F.
- (d) Cyclic loading is not a controlling design requirement (see UG-22).
- (e) The vessel is not in lethal service (see UW-2).
- (f) The straight flange (skirt) of the head is machined to form an integral backing strip meeting the requirements of [Figure 1](#).

(g) Outside diameter of the formed head and shell shall not exceed 30 in. and the overall vessel length shall not exceed 96 in.

(h) The required thickness of the formed head shall not exceed  $\frac{5}{8}$  in. The thickness of the head straight flange shall be at least that required for a seamless shell of the same outside diameter.

(i) The required thickness of the shell shall not exceed  $\frac{7}{16}$  in.

(j) Heads shall have a driving force fit before welding.

(k) The joint efficiency of the head-to-shell joint shall be determined from Table UW-12 for a Type 2 joint depending on the degree of radiographic examination. The limitations in Table UW-12 for the Type 2 joints do not apply.

(l) The materials of construction shall be P-No. 1, Group 1 or 2.

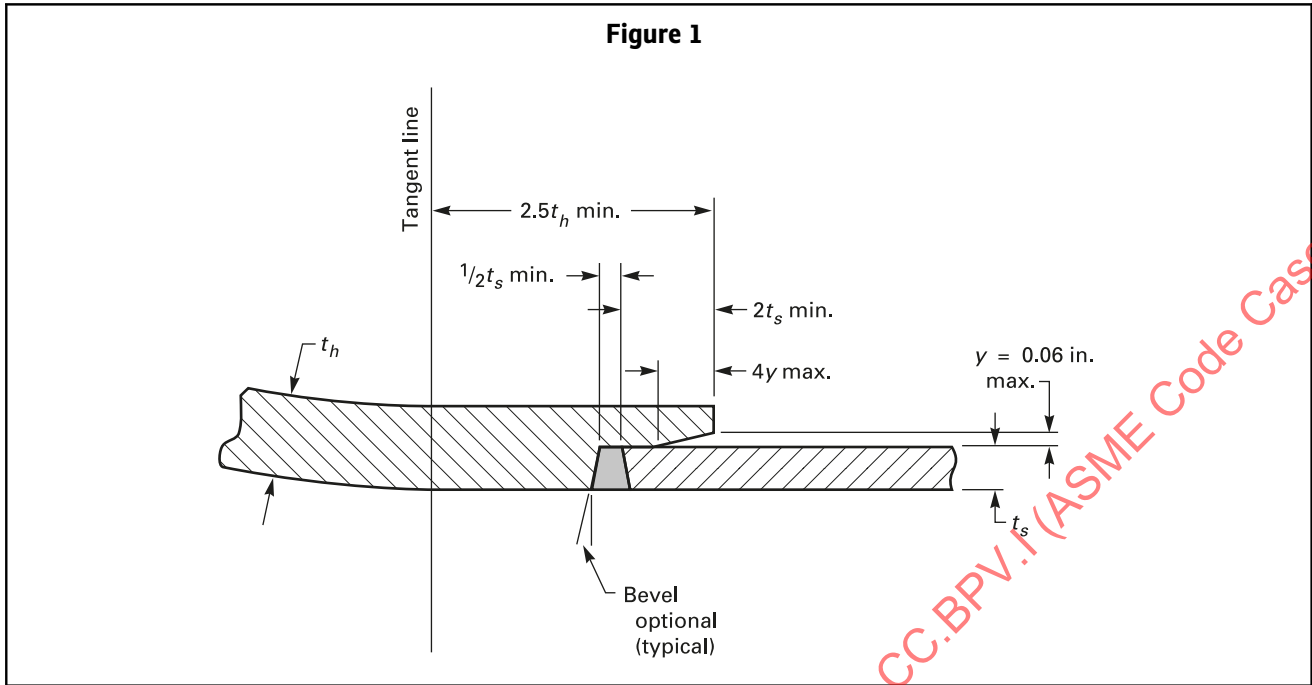
(m) If this Case is used for vessels in chlorine services the requirements of the Chlorine Institute Pamphlet 17<sup>1</sup> shall apply.

(n) This Case number shall be shown on the Manufacturer's Data Report.

<sup>1</sup> Pamphlet 17 can be obtained from The Chlorine Institute, Inc., 2001 L Street NW, Suite 506, Washington, DC 20036

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**Figure 1**



ASME Code Cases BPV) 2019  
ASME BPVC.CC.BPV.1

Approval Date: February 26, 2001

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2350**  
**Strength of Aluminum Brazed Joints Up to 400°F**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions may the upper temperature limit of 350°F shown in column 2 of Table UB-2 be increased to 400°F for brazed joints between aluminum alloy 3003 when BAlSi-7 filler metal is used for the construction of brazed plate-fin heat exchangers?

*Reply:* It is the opinion of the Committee that the upper temperature limit of 350°F shown in Column 2 of Table UB-2 may be increased to 400°F for brazed joints between aluminum alloy 3003 when BAlSi-7 filler metal is used for the construction of brazed plate-fin heat exchangers under the following conditions:

(a) The brazing process shall be furnace brazed using braze metal clad sheet or preplaced shim stock brazing filler metal fully covering one surface to be joined.

(b) The minimum time at brazing temperature shall be 15 min.

(c) The joint designs shall be either a plate-fin or a sealing bar (lap) joint.

(d) The width of the brazed joint shall be a minimum of 2.5 times the thickness of the fin.

(e) Above 350°F, the stress in the brazed joint shall not exceed one-half of the allowable stress for the 3003 alloy base material in the "O" temper. The stress in the brazed joint is defined as the force (due to pressure) supported by the joint divided by the area of the joint.

(f) The braze procedure specification shall be qualified in accordance with UB-12 using the minimum holding time that will be used in production.

(g) All other applicable Code requirements shall be met.

(h) This Case number shall be shown on the Data Report.

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Approval Date: November 30, 2017

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

## Case 2351-1 Alternative Rules for Brazing Qualifications<sup>1</sup> Section VIII, Division 1

*Inquiry:* In lieu of the specified rules in Section IX, what alternative rules for brazing procedure and performance qualifications may be used in fabricating furnace brazed plate-fin heat exchangers in compliance with Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that, in lieu of the specified rules in Section IX, the following alternative rules for brazing procedure and performance qualifications may be used in fabricating furnace brazed plate-fin heat exchangers in compliance with Section VIII, Division 1.

## 1 ALTERNATIVE TESTS AND EXAMINATIONS

### 1.1 TENSION TEST OF BASE METAL

**1.1.1 Purpose.** Tension tests are used to verify that the ultimate strength of the base material subjected to heating in a brazing cycle meets minimum tensile requirements.

**1.1.2 Specimens.** Test specimens of the same material specifications and thickness as used in the brazed vessel shall be processed through a complete brazing temperature cycle. Each tension test specimen shall consist of a single piece of the material (without braze joints) and conform to the dimensions shown in QB-462.1(a) of Section IX.

**1.1.3 Test Procedure.** The tension test specimen shall be tested to failure under tensile load and the tensile strength measured.

**1.1.4 Acceptance Criteria.** The test shall be acceptable if the resulting tensile strength is not more than 5% below the minimum specified tensile strength of the base metal in the annealed condition.

<sup>1</sup> There is no change to this reinstated Case.

## 1.2 STRENGTH TESTS

**1.2.1 Purpose.** A test panel shall be brazed and tested to failure to verify that the strength of the braze joint exceeds the strength of the base material.

**1.2.2 Specimens.** Representative components shall be brazed together into a test panel. The test panel shall accurately represent the materials, thicknesses, and plate pattern of the production configuration in an arrangement acceptable to the Authorized Inspector. A minimum of one plate-fin layer shall be assembled, complete with sealing bars and separation plates. The test panel need not exceed three plate-fin layers. All brazed joints in the test panel shall be the same size, shape, and overlap as those on the production vessel. Provisions for adequately filling and venting the test panel shall be provided.

**1.2.3 Test Procedure.** The test panel is pressurized to the point of failure in the presence of the Authorized Inspector.

**1.2.4 Acceptance Criteria.** The test is considered acceptable if the failure occurs in the base material.

## 1.3 WORKMANSHIP COUPONS

**1.3.1 Purpose.** Workmanship coupons are used to determine the soundness of the brazed joints.

**1.3.2 Specimens.** The dimensions and configuration of the workmanship coupon shall be sufficient to represent a cross section of the maximum width of each brazed joint used on the production vessel. Each plate-fin and sealing bar brazed joint design used in production under these rules shall be examined and evaluated independently.

**1.3.3 Test Procedure.** After completion of the strength test, the test panel shall be sectioned in two roughly parallel cuts across the width of the braze joints, and the outer sections discarded. Care should be taken to avoid making the cuts in the vicinity of any ruptured areas. Each cut edge face of the remaining center section shall be polished, and each brazed area examined with at least four-power magnification.

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**1.3.4 Acceptance Criteria**

The collective sum of the lengths of all indications of unbrazed areas for each individual edge shall not exceed 20% of the length of the joint overlap.

**2 BRAZING PROCEDURE QUALIFICATIONS**

**2.1 TENSION, WORKMANSHIP, AND STRENGTH TESTS**

The type and number of test specimens required to qualify a Brazing Procedure Specification, and the qualified thickness range of base materials, are shown in Table 1.

**2.2 RE-TESTS**

The failure of any test specimen to meet the required acceptance criteria shall require preparation and testing of a new test specimen.

**2.3 VARIABLES FOR BRAZING PROCEDURE QUALIFICATIONS**

The Essential and Nonessential variables applicable to this qualification process shall be those listed in QB-253 of Section IX except as follows:

**2.3.1** The thickness range qualified shall be as shown in Table 1 of this Case, in lieu of the requirements of QB-402.3.

**2.3.2** The requirements for overlap length for lap joints specified in QB-408.4 shall be applied.

**3 BRAZING PERFORMANCE QUALIFICATIONS**

**3.1 TYPE AND NUMBER OF TESTS REQUIRED**

Workmanship samples shall be brazed and examined as specified in 1.3 of this Case. Both edges of the test specimen shall meet the acceptance criteria specified.

**3.2 SIMULTANEOUS PROCEDURE AND PERFORMANCE QUALIFICATION**

Brazing operators who successfully prepare Procedure Qualification test coupons meeting the requirements of sections 1 and 3 of this Case are considered qualified with no further testing required.

**3.3 RANGE OF QUALIFICATION**

Brazing operators qualified for any Brazing Procedure Specification for furnace brazing under the provisions of this Case, shall also be qualified for all other Brazing Procedure Specifications qualified under the provisions of this Case.

**3.4 MAINTENANCE OF QUALIFICATIONS**

The maintenance of Brazing Operator Qualifications shall be in accordance with QB-320.

**4 DOCUMENTATION**

(a) All applicable procedure and performance qualification test documentation required by Section IX, Part QB shall also apply for tests performed using this Case.

(b) This Case number shall be shown on the Manufacturer's Data Report.

**Table 1  
Tension, Workmanship, and Strength Tests**

	Thickness Range of Materials Qualified		Type and Number of Test Specimens Required		
	Min.	Max.	Tension	Workmanship	Strength
	Specimen Thickness, <i>T</i> (as Brazed)	0.5 <i>T</i>	2 <i>T</i>	2	1

Approval Date: October 18, 2004

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2353-1**  
**Seamless 1.15Ni-0.65Cu-Mo-Cb Material**  
**Section I**

*Inquiry:* May high-strength low alloy steel seamless pipes and tubes having a chemical composition conforming to the requirements shown in Table 1, and heat treated to achieve the minimum mechanical properties shown in Table 2, that otherwise conform to the specifications listed in Table 3 be used for Section I construction?

*Reply:* It is the opinion of the Committee that high-strength low alloy seamless pipes and tubes having a chemical composition that conforms to the requirements shown in Table 1, and heat treated to achieve the minimum mechanical properties shown in Table 2, that otherwise conform to the specifications listed in Table 3 may be used for Section I construction, provided the following requirements are met:

(a) For Class 1 the material shall be normalized at 1,650°F (899°C) minimum and tempered at 1,100°F (593°C) minimum. For Class 2 the material may be normalized and tempered at the same conditions specified

for Class 1, or may be austenitized at 1,650°F (899°C) minimum, quenched, and then tempered at 1,100°F (593°C) minimum.

(b) The material shall not exceed a Brinell Hardness Number of 252 HB (HRC 25).

(c) The maximum allowable stress values for the material shall be those given in Table 4.

(d) Separate weld procedure and performance qualifications shall apply for both classes of this material. The post-weld heat treatment of the Class 1 and Class 2 materials shall be in accordance with the rules specified in Table 5.

(e) After either cold bending to strains in excess of 5% or any hot bending of this material, the full length of the component shall be heat treated in accordance with the requirements specified in (a). (See para. PG-19 of Section I for method for calculating strain.)

(f) Post-weld heat treatment is mandatory under all conditions.

(g) This Case number shall appear in the marking and certification for the material and on the Manufacturer's Data Report.

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**Table 1  
 Chemical Requirements**

Element	Composition Limits, %
Carbon	0.10-0.17
Manganese	0.80-1.20
Phosphorus, max.	0.030
Sulfur, max.	0.025
Silicon	0.25-0.50
Chromium, max.	0.30
Molybdenum	0.25-0.50
Nickel	1.00-1.30
Columbium	0.015-0.045
Nitrogen, max.	0.020
Aluminum, max.	0.050
Copper	0.50-0.80
Vanadium, max.	0.02

**Table 3  
 Specification**

SA-213	Tube
SA-335	Pipe

**Table 4  
 Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi	
	Class 1	Class 2
-20 to 100	25.7	27.3
200	25.7	27.3
300	25.1	26.6
400	25.1	26.6
500	25.1	26.6
600	25.1	26.6
700	25.1	26.6

**Table 2  
 Mechanical Properties Requirements**

	Class 1	Class 2
Tensile strength, min., ksi	90	95.5
Yield strength, min., ksi	64	66.5
Elongation in 2 in., min., % [Note (1)]	15	15

NOTE:

(1) For longitudinal strip tests, a deduction from the basic values of 1.00% for each  $\frac{1}{32}$  in. decrease in wall thickness below  $\frac{5}{16}$  in. shall be made. The following table gives the computed values.

Wall Thickness, in.	Elongation in 2 in., Min., %
$\frac{5}{16}$ (0.312)	15
$\frac{9}{32}$ (0.281)	14
$\frac{1}{4}$ (0.250)	13
$\frac{7}{32}$ (0.219)	12
$\frac{3}{16}$ (0.188)	11
$\frac{5}{32}$ (0.156)	10
$\frac{1}{8}$ (0.125)	9
$\frac{3}{32}$ (0.094)	8
$\frac{1}{16}$ (0.062)	7
0.062 to 0.035, excl.	6.6
0.035 to 0.022, excl.	5.9
0.022 to 0.015, incl.	5.6

GENERAL NOTE: The above table gives the computed minimum elongation values for each  $\frac{1}{32}$  in. decrease in wall thickness. Where the wall thickness lies between two values shown above, the minimum elongation shall be determined by the following equation:

$$E = 32t + 5.0$$

where

$E$  = elongation in 2 in., %

$F$  = actual thickness of specimen, in.

**Table 5**  
**Requirements for Post-Weld Heat Treatment**  
**(PWHT)**

Class	PWHT Temperature, °F	Holding Time
1	1,100–1,200	Up to 2 in. thickness, 1 hr/in., 15 min minimum. Over 2 in., add 15 min for each additional inch of thickness.
2	1,000–1,150	1 hr/in., $\frac{1}{2}$ hr min.

GENERAL NOTE: **CAUTION: Corrosion fatigue occurs by the combined actions of cyclic loading and a corrosive environment. In boilers, corrosion fatigue occurs frequently on the water side of economizer tubes and headers, waterwall tubes and headers, risers, downcorners and drums, with a preference toward regions with increased local stresses. While the mechanisms of crack initiation and growth are complex and not fully understood, there is consensus that the two major factors are strain and waterside environment. Strain excursions of sufficient magnitude to fracture the protective oxide layer play a major role. In terms of the waterside environment, high levels of dissolved oxygen and pH excursions are known to be detrimental. Historically, the steels applied in these water-touched components have had the minimum specified yield strengths in the range of 27 to 45 ksi (185 to 310 MPa) and minimum specified tensile strengths in the range of 47 to 80 ksi (325 to 550 MPa). As these materials are supplanted by higher strength steels, some have concern that the higher design stresses and thinner wall thicknesses will render components more vulnerable to failures by corrosion fatigue. Thus, when employing such higher strength steels for water circuits it is desirable to use "best practices" in design by minimizing localized strain concentrations, in control of water chemistry and during layup by limiting dissolved oxygen and pH excursions, and in operation by conservative startup, shutdown, and turndown practices.**

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Approval Date: December 30, 2006

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2357-2**  
**Ni-Fe-Cr Alloy N08801 for Water-Wetted Service**  
**Section I**

*Inquiry:* May nickel-iron-chromium alloy N08801, seamless condenser and heat exchanger tubes and seamless pipe and tubes conforming to SB-163 and SB-407 be used in water-wetted service construction in Section I?

*Reply:* It is the opinion of the Committee that nickel-iron-chromium alloy forms as described in the Inquiry may be used in construction under Section I for water-wetted service, provided the following requirements are met:

(a) The material will be given a 1,725°F (940°C) to 1,825°F (995°C) stabilizing heat treatment.

(b) The maximum allowable stress values for the material shall be those given in Table 1B of Section II, Part D.

(c) Welded fabrication shall conform to the applicable requirements of Section I.

(d) Welds that are exposed to the effects of corrosion should be made using a filler material having a corrosion resistance comparable to that of the base metal.

(e) Heat treatment after forming or fabrication is neither required nor prohibited, but if performed shall be in accordance with (a).

(f) The required thickness for external pressure shall be determined from the chart in Fig. NFN-9 of Section II, Part D.

(g) This Case number shall be shown on the Manufacturer's Data Report.

**CAUTION: Austenitic alloys are subject to stress corrosion cracking, intergranular attack, pitting, and crevice corrosion when used in boiler applications in aqueous environments. Factors that affect the susceptibility of these materials are applied or residual stress, water chemistry and deposition of solids, and material condition. Susceptibility to attack is enhanced when the material is used in a sensitized condition, or with residual cold work. Concentration of corrosive agents (e.g., chlorides, caustic, or reduced sulfur species) can occur under deposits formed on the surface of these materials, and can result in severe underdeposit wastage or cracking. For successful operation in water environments, careful attention must be paid to continuous control of water chemistry.**

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Approval Date: June 23, 2005

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2359-2**  
**Ni-25Cr-9.5Fe-2.1Al Alloy (UNS N06025)**  
**Section I; Section VIII, Division 1**

*Inquiry:* May solution annealed Ni-25Cr-9.5Fe-2.1Al Alloy (UNS N06025) wrought forgings, bar (up to 4 in. in diameter), plate, sheet, strip, welded pipe, seamless pipe and tube, and welded tube and fittings with chemical composition conforming to [Table 1](#), mechanical properties conforming to [Table 2](#), and otherwise conforming to the requirements of Specifications SB-163, SB-166, SB-167, SB-168, SB-366, SB-462, SB-516, SB-517, and SB-564 as applicable, be used in Section I for steam service and in Section VIII, Division 1 construction?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used for construction under the rules of Section I and Section VIII, Division 1, provided the following additional requirements are met:

(a) For Section I use, the  $y$  values [see Section I, para. PG-27.4, Note (6)] shall be as follows:

- (1) 1,050°F and below: 0.4
- (2) 1,100°F: 0.5

(3) 1,150°F and above: 0.7

(b) The rules of Section VIII, Division 1, Subsection C that shall apply are those given in Part UNF for nickel alloys.

(c) For external pressure design use Section II, Part D, Fig. NFN-13 for temperatures not exceeding 1,200°F. The external pressure charts do not account for reduction of buckling strength due to creep under long-term loads. The effect of creep on buckling shall be considered at temperatures for which allowable stresses are shown in italics in [Table 3](#).

(d) The maximum allowable stress values for the material shall be those given in [Table 3](#).

(e) For welded pipe and tube products, a joint efficiency factor of 0.85 shall be used.

(f) Separate weld procedure and performance qualifications conducted in accordance with Section IX, shall be required for this material.

(g) Heat treatment after welding or fabrication is neither required nor prohibited.

(h) This Case number shall be shown on the documentation and marking of the material and reproduced on the Manufacturer's Data Report.

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**Table 1**  
**Chemical Requirements**

Element	Composition, %
Nickel	Balance
Chromium	24.0–26.0
Iron	8.0–11.0
Aluminum	1.8–2.4
Carbon	0.15–0.25
Silicon, max.	0.50
Sulfur, max.	0.010
Phosphorus, max.	0.020
Yttrium	0.05–0.12

**Table 2**  
**Mechanical Property Requirements (Room Temperature)**

Tensile strength, min., ksi	98
Yield strength, 0.2% min., ksi	39
Elongation in 2 in., min., %	30

**Table 3**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi [Note (1)] and [Note (2)]	
100	26.0	26.0
200	25.5	26.0 [Note (3)]
300	24.7	26.0 [Note (3)]
400	23.7	26.0 [Note (3)]
500	22.7	26.0 [Note (3)]
600	21.7	26.0 [Note (3)]
650	21.2	26.0 [Note (3)]
700	20.8	26.0 [Note (3)]
750	20.5	26.0 [Note (3)]
800	20.2	26.0 [Note (3)]
850	20.0	26.0 [Note (3)]
900	19.8	26.0 [Note (3)]
950	19.6	21.3 [Note (3)]
1,000	16.3	16.3
1,050	12.3	12.3
1,100	9.2	9.2
1,150	6.9	6.9
1,200	4.1	4.1
1,250	2.8	2.8
1,300	2.0	2.0
1,350	1.5	1.5
1,400	1.2	1.2
1,450	0.97	0.97
1,500	0.80	0.80
1,550	0.68	0.68
1,600	0.58	0.58
1,650	0.51	0.51
1,700	0.44	0.44 [Note (4)]
1,750	0.37	0.37 [Note (4)]
1,800	0.32	0.32 [Note (4)]

## GENERAL NOTES:

- Time-dependent values are shown in italics.
- The criteria used to establish allowable stresses at design temperatures above 1,500°F included consideration of the  $F_{avg}$  factor as defined in Appendix 1 of Section II, Part D.
- Creep-fatigue, thermal ratcheting, and environmental effects are increasingly significant failure modes at temperatures in excess of 1,500°F and shall be considered in the design.

## NOTES:

- This alloy in the solution-annealed condition is subject to severe loss of rupture ductility in the approximate temperature range of 1,200°F to 1,400°F.
- The allowable stress values are based on the revised criterion for tensile strength of 3.5, where applicable.
- Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed  $66\frac{2}{3}\%$ , but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.
- For Section VIII, Division 1 use only.

Approval Date: January 27, 2003

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2377**  
**Radiographic Requirements for SA-612 Steel Plate**  
**Section VIII, Division 1**

*Inquiry:* Section VIII, Division 1, UCS-57 requires full radiographic examination of all butt welded joints in P-No. 10C Grade No. 1 materials with thickness greater than  $\frac{5}{8}$  in. Under what conditions may steel plate material conforming to specification SA-612 be used in welded construction without the full radiographic requirements of UCS-57?

*Reply:* It is the opinion of the Committee that steel plate materials conforming to specification SA-612 may be used in welded construction without the full radiographic requirements of UCS-57 provided the following requirements are met:

(a) The plate material shall be normalized and the nominal plate thickness shall not be thicker than 1 in.

(b) The maximum columbium (Cb) content is 0.02% by heat analysis or 0.03% by product analysis.

(c) All of the Category A butt weld joints with thickness greater than  $\frac{5}{8}$  in. in the vessel shall be examined 100% by radiography in accordance with UW-51.

(d) All of the Category B and C butt weld joints with thickness greater than  $\frac{5}{8}$  in. in the vessel shall be examined by spot radiography in accordance with UW-52.

(e) The completed vessel shall be hydrostatically tested per UG-99(b) or (c).

(f) Design temperature is no warmer than 650°F.

(g) The thermal or mechanical shock loadings are not a controlling design requirement. (See UG-22.)

(h) Cyclical loading is not a controlling design requirement. (See UG-22.)

(i) The vessel shall not be used for lethal service.

(j) This Case number shall be listed on the Manufacturer's Data Report.

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Approval Date: May 4, 2004

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2385-1**  
**37Ni-30Co-28Cr-2.75Si Alloy (UNS N12160)**  
**Section VIII, Division 1**

*Inquiry:* May annealed alloy UNS N12160 wrought sheet, strip, plate, rod, welded pipe and tube, wrought fittings, seamless pipe and tube, wrought fittings, seamless pipe and tube, and forgings, which meet the requirements of the specifications listed in [Table 1](#), be used in welded construction under Section VIII, Division 1 above 1,500°F?

*Reply:* It is the opinion of the Committee that annealed alloy UNS N12160 wrought sheet, strip, plate, rod, welded pipe and tube, wrought fittings, seamless pipe and tube, and forgings as described in the Inquiry, may be used in the construction of welded pressure vessels complying with the rules of Section VIII, Division 1 above 1,500°F, providing the following additional requirements are met:

(a) The rules in Section VIII, Division 1, Subsection C that shall apply are those given in Part UNF for nickel alloys.

(b) The maximum allowable stress values for the material shall be those given in [Table 2](#). For welded pipe and tube products, a joint efficiency factor of 0.85 shall be used.

(c) Welding shall be limited to GTAW and GMAW processes using filler metal with the same nominal composition as the base metal. The nominal thickness of the material at the weld shall not exceed 0.5 in.

NOTE: Thickness limitation is due to solidification cracking in sections greater than 0.5 in.

(d) Heat treatment after forming or welding is neither required nor prohibited. When heat treatment is to be employed, the requirements of UNF-56(b) shall apply.

(e) This Case number shall be referenced in the documentation and marking of the material and recorded on the Manufacturer's Data Report.

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**Table 1  
Product Specifications**

Sheet, plate, and strip	SB-435
Rod	SB-572
Wrought fittings	SB-366
Forgings	SB-564
Seamless pipe and tube	SB-622
Welded pipe	SB-619
Welded pipe	SB-626

**Table 2  
Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress, ksi [Note (1)] – [Note (4)]
1,550	1.8
1,600	1.5
1,650	1.3
1,700	1.0
1,750	0.85
1,800	0.73

NOTES:

- (1) Stresses are values obtained from time-dependent properties.
- (2) The criteria used to establish allowable stresses at design temperatures above 1,500°F included consideration of the  $F_{avg}$  factor as defined in Appendix 1 of Section II, Part D.
- (3) Creep-fatigue, thermal ratcheting, and environmental effects are increasingly significant failure modes at temperatures in excess of 1,500°F and shall be considered in the design.
- (4) Allowable stress values up to and including 1,500°F are in Section II-D, Table 1-B.

Approval Date: September 21, 2016

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2397-1**  
**Pressure Relief Valves That Exceed the Capability of**  
**Testing Laboratories**  
**Section I; Section VIII, Division 1**

*Inquiry:* If a valve design exceeds the size, capacity, or pressure capability of an ASME-accepted testing laboratory, what alternative requirements to Section I, PG-69 or Section VIII, Division 1, UG-131, Capacity Certification Testing, and Section I, PG-73 or Section VIII, Division 1, UG-136, Minimum Requirements, may be followed?

*Reply:* It is the opinion of the Committee that if a valve design exceeds the size, capacity, or pressure capability of an ASME-accepted testing laboratory the requirements of Section I, PG-67 through PG-73 and PG-110 or Section VIII, Division 1, UG-125 through UG-136 shall be met with the following exceptions:

(a) For Section I, PG-69; or Section VIII, Division 1, UG-131:

(1) If the design exceeds the laboratory pressure capability, Section I, PG-69.2.2 or PG-69.2.3; or Section VIII, Division 1, UG-131(d)(2) or UG-131(e) shall be followed with the exception that the valves will be tested with their disks fixed at the minimum design lift to establish the rated capacity.

(2) If the design exceeds the laboratory size or capacity capability, Section I, PG-69.2.3; or Section VIII, Division 1, UG-131(e) shall be followed with the exception that flow models of three different sizes, each tested at three different pressures, shall be used in place of valves required in Section I, PG-69.2.3(a); or Section VIII, Division 1, UG-131(e)(1). Such flow models shall be sized consistent with the capabilities of the accepted test laboratory, where the test will be conducted and shall accurately model those features that affect flow capacity, such as orifice size, valve lift, and internal flow configuration. The test models need not be functional pressure relief valves, but shall be geometrically similar to the final product.

(3) In either case of subpara. (1) or (2) above, the valve design (i.e., parameters such as spring properties, seat geometry, and mechanical valve lift) shall be evaluated to ensure that production valves will achieve design lift as modeled above.

(b) For Section I, PG-73.4.3; or Section VIII, Division 1, UG-136(c)(3), the requirements of either subpara. (1) or (2) below shall be met:

(1) In lieu of the test requirements of Section I, PG-73.4.3 or Section VIII, Division 1, UG-136(c)(3):

(-a) two production valves that are representative of the design shall be tested per PTC 25, Part III (edition adopted by the governing Code Section), to demonstrate to the satisfaction of the representative of the ASME designated organization that:

(-1) The measured set pressure is consistent with the stamped set pressure within the tolerances required by Section I, PG-72.2; or Section VIII, Division 1, UG-134(d).

(-2) The valve will achieve the minimum lift for its certified capacity.

(-3) The valve will operate without chatter or flutter. If only one valve of the design will be produced within the six-year period within which the permission is granted, only that valve need be tested as stated above.

(-b) The testing shall be performed at a facility that is mutually agreeable to the manufacturer, the representative of an ASME-designated organization, and the facility owner. The facility shall be capable of demonstrating the characteristics stated above.

(-c) In the event of failure of the tests, the manufacturer shall submit a written explanation to the ASME designated organization stating the cause and the corrective action taken to prevent recurrence followed by a repeat of the demonstration tests.

(2) The test requirements of Section I, PG-73.4.3; or Section VIII, Division 1, UG-136(c)(3) are followed using two functional models that are representative of the design in lieu of the production samples and the additional following tests are satisfactorily completed:

(-a) two production valves that are representative of the design shall be tested per PTC 25, Part III (edition adopted by the governing Code Section), to demonstrate to the satisfaction of the representative at the ASME designated organization that:

(-1) The measured set pressure is consistent with the stamped set pressure within the tolerances required by Section I, PG-72.2 ; or Section VIII, Division 1, UG-134(d);

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(-2) Seat tightness and a secondary pressure-zone leakage test are demonstrated in accordance with Section I, PG-73.5.3 or Section VIII, Division 1, UG-136 (d)(3) and UG-136(d)(5).

If only one valve of the design will be produced within the six-year period within which the permission is granted, only that valve need be tested as stated above.

(-b) The testing shall be performed at a facility that is mutually agreeable to the manufacturer, the representative of an ASME-designated organization, and the facility owner. The facility shall be capable of demonstrating the characteristics stated above.

(-c) In the event of failure of the tests, the manufacturer shall submit a written explanation to the ASME designated organization stating the cause and the corrective action taken to prevent recurrence followed by a repeat of the demonstration tests.

(-d) After initial permission is granted in accordance with Section I, PG-73.4.3, or Section VIII, Division 1, UG-136(c)(3), permission may be extended for six-year periods if the tests of production samples are successfully completed in accordance with subparas. (-a) through (-c) above.

(c) This Case number shall be included with the marking information required in Section I, PG-110; or Section VIII, Division 1, UG-129; and on Form P-8 or UV-1 for the valve, as applicable.

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Approval Date: February 14, 2003

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2400**  
**Alternative Rules for the Postweld Heat Treatment of**  
**Finned Tubes**  
**Section VIII, Division 1**

*Inquiry:* May electric resistance welded fins be exempt from the postweld heat treatment requirements of Table UHA-32 for P-No. 7 base materials?

*Reply:* It is the opinion of the Committee that it is not necessary that electric resistance welds used to attach extended heat absorbing surfaces to tubes be postweld heat treated provided the following requirements are met:

(a) The fin thickness is no greater than 0.125 in. (3.2 mm).

(b) The maximum carbon content of the base metal shall be restricted to 0.15%.

(c) The maximum outside pipe or tube diameter (excluding fins) shall be 4½ in.

(d) Postweld heat treatment is not a service requirement.

(e) Prior to using the welding procedure, the Manufacturer shall demonstrate that the heat affected zone does not encroach upon the minimum wall thickness.

(f) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: September 25, 2012

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2402-1**  
**SA-995, UNS J92205, (CD3MN), Austenitic/Ferritic**  
**Duplex Stainless Steel**  
**Section VIII, Division 1**

*Inquiry:* May SA-995 UNS J92205 (CD3MN) solution annealed casting material be used in the construction of vessels under the rules of Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used under the rules of Section VIII, Division 1, provided the following additional requirements are met:

(a) The maximum allowable design stress values in tension shall be those listed in [Table 1](#) and [Table 1M](#).

NOTE: This material may be expected to develop embrittlement after exposure at moderately elevated temperatures. See paras. A-340 and A-360 in Appendix A of Section II, Part D.

(b) Tensile,  $S_u$ , and yield strength,  $S_y$ , at temperature are shown in [Table 2](#), [2M](#), [3](#), and [3M](#), respectively.

(c) For Section VIII external pressure design, Figure and Table HA-5 of Section II, Part D shall be used.

(d) Separate welding procedure qualifications and performance qualifications shall be conducted as prescribed in Section IX.

(e) Heat treatment after welding is neither required nor prohibited. However, if heat treatment is applied, the solution annealing treatment shall consist of heating to a minimum temperature of 2050°F and then quenched in water or rapidly cooled by other means.

(f) The rules in Section VIII, Division 1 that shall apply are those given in Subsection C, Part UHA for austenitic-ferritic duplex stainless steels.

(g) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values In Tension**  
**For Metal Temperature of SA-995 Castings**

For Metal Temperatures Not Exceeding, °F	Maximum Allowable Stress Values, ksi
100	25.7
150	25.7
200	25.7
250	25.2
300	24.6
400	24.3
500	24.3

**Table 2M**  
**Tensile Strength Values**

For Metal Temperature Exceeding, °C	Tensile Strength, MPa
40	621
65	621
100	621
150	594
200	587
250	587
300	587

**Table 1M**  
**Maximum Allowable Stress Values In Tension**  
**For Metal Temperature of SA-995 Castings**

For Metal Temperatures Not Exceeding, °C	Maximum Allowable Stress Values, MPa
40	177
65	177
100	177
150	170
200	168
250	168
300	168 [Note (1)]

NOTE:  
(1) This value is provided for interpolation purposes only. The maximum temperature for this materials is 260 °C.

**Table 3**  
**Yield Strength Values**

For Metal Temperature Not Exceeding, °F	Yield Strength, ksi
100	60.0
200	53.9
300	47.9
400	44.5
500	42.3

**Table 3M**  
**Yield Strength Values**

For Metal Temperature Not Exceeding, °C	Yield Strength, MPa
40	414
65	395
100	366
150	330
200	308
250	294
300	284

**Table 2**  
**Tensile Strength Values**

For Metal Temperature Not Exceeding, °F	Tensile Strength, ksi
100	90.0
200	90.0
300	86.2
400	85.2
500	85.2

Approval Date: February 13, 2003

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2403**  
**Aluminum Alloy (Aluminum-6.3Magnesium) for Code Construction**  
**Section VIII, Division 1**

*Inquiry:* May aluminum alloy (Aluminum-6.3 Magnesium), plate, sheet, bar, rod, and wire that meet the chemical and mechanical property requirements in [Tables 1](#) and [2](#), respectively, and otherwise conforming to one of the specifications listed in [Table 3](#), be used in Section VIII, Division 1 welded construction?

*Reply:* It is the opinion of the Committee that aluminum alloy (Aluminum-6.3Magnesium) plate, sheet, bar, rod, and wire, as described in the Inquiry may be used in Section VIII, Division 1 welded construction provided the following additional requirements are met.

(a) The rules in Section VIII, Division 1, Subsection C that shall apply are those given in Part UNF for aluminum alloys.

(b) The maximum allowable stress values for the material shall be those given in [Table 4](#).

(c) Separate welding procedure and performance qualifications shall be conducted for the material in accordance with Section IX. The minimum tensile strength and elongation for weld procedure qualification shall be that given for the base metal product form.

(d) Heat treatment after welding is not permitted.

(e) This Case is not intended for material to be used for external pressure applications.

(f) This Case number shall be shown on the documentation and marking of the material and recorded in the Manufacturer's Data Report.

**CAUTION: Prolonged elevated temperature exposure above 150°F may make this material susceptible to exfoliation, intergranular attack, or stress-corrosion cracking.**

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1  
Chemical Requirements**

Element	Composition, %
Silicon, max.	0.4
Iron, max.	0.4
Copper, max.	0.10
Manganese	0.5–0.8
Magnesium	5.8–6.8
Zinc, max.	0.20
Titanium	0.02–0.10
Beryllium	0.0002–0.005
Other elements, each	0.05
Other elements, total	0.10
Aluminum	remainder

**Table 2  
Mechanical Property Requirements**

Property	Product Form		
	Sheet	Plate	Bar/Rod/ Wire
Tensile strength, min., ksi	43.5	39.5	45.0
Yield strength (0.2% offset), min., ksi	21.0	18.0	22.5
Elongation, min, %	15.0	6.0	15.0

**Table 3  
Product Specifications**

Product	Specification
Plate, sheet	SB-209
Bar, rod, wire	SB-211

**Table 4  
Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Product Form		
	Sheet	Plate	Bar/Rod/ Wire
100	12.4	11.3	12.9

GENERAL NOTE: The revised criterion of 3.5 on tensile strength was used in establishing these values.

Approval Date: February 13, 2003

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2407**  
**Pneumatic Test**  
**Section VIII, Division 1**

*Inquiry:* Is it permissible to use a pneumatic test in lieu of the hydrostatic test specified in ULT-99 for pressure testing of vessels constructed in accordance with the requirements of Section VIII, Division 1, Part ULT?

*Reply:* It is the opinion of the Committee that it is permissible to use a pneumatic test in lieu of the hydrostatic test specified in ULT-99 for pressure testing of vessels constructed in accordance with the requirements of Section VIII, Division 1, Part ULT, provided the following additional requirements are met:

(a) The vessel shall be pneumatically tested at ambient temperature for a minimum of 15 min.

(b) The pneumatic test shall be performed in accordance with UG-100, except that the ratio of stresses is not applied, and the test pressure shall be at least 1.2 times the internal design pressure at 100°F (38°C). In no case shall the pneumatic test pressure exceed 1.25 times the basis for calculated test pressure as defined in 3-2.

(c) The liquid penetrant examination required by ULT-57(b) shall be performed prior to the pneumatic test.

(d) This Case number shall be shown on the Manufacturer's Data Report.

**CAUTION: The vessel should be tested in such a manner as to ensure personnel safety from a release of the stored energy of the vessel.**

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: June 23, 2005

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2411**  
**Use of Polymer Material for Bolted Box Headers**  
**Section IV**

*Inquiry:* May the polymer composed of a polystyrene-modified polyphenylene ether reinforced with 30% glass fibers, be used as the material for a bolted box header in Section IV construction?

*Reply:* It is the opinion of the Committee that a polystyrene- modified polyphenylene ether reinforced with 30% glass fibers, by weight, may be used as the material for a bolted box header in Section IV "H" stamped construction, provided the following requirements are met:

## 1 GENERAL REQUIREMENTS

(a) The polymer material shall be in compliance with the ASTM material specification D4349-93 and shall be limited to the polymer with a classification designation of PPE210G30A40452G1125F11 in accordance with the ASTM D4349-93 specification. In addition, the polymer material shall be certified by the materials manufacturer, and a report of test results shall be furnished to the boiler manufacturer for each lot of material.

(b) The bolted box headers shall not be exposed to the products of combustion.

(c) The completed boiler shall be limited to hot water service.

(d) The maximum heat input to the completed boiler shall be limited to 400,000 Btu/hr (120 kW).

(e) The maximum allowable working pressure shall be limited to 30 psig (200 kPa).

(f) The maximum water temperature shall be limited to 115°F (45°C), which shall be noted in the ASME stamping and documented on the Manufacturer's Data Report.

(g) The maximum volume of the bolted box header shall be limited to 1.0 gal (3.7 L).

(h) The polymer box header shall not be repaired prior to the application of the ASME marking.

(i) The polymer box header shall have a permanently attached label stating, "No repairs are permitted to this polymer box header."

(j) The polymer box header shall be insulated from the tubesheet to which it is bolted.

(k) The polymer box header shall be permanently marked in a manner to provide traceability to the material manufacturer's report of test results and to the injection molding machine.

(l) The injection molding process shall be controlled by a written procedure in which all of the following process variables shall be considered essential:

- (1) melt temperature
  - (-a) nozzle
  - (-b) front
  - (-c) middle
  - (-d) rear
- (2) mold temperature
- (3) drying time (average)
- (4) drying time (maximum)
- (5) moisture content (% maximum)
- (6) back pressure
- (7) screw speed
- (8) shot size to cylinder size

A change in any of the essential variables shall require requalification of the written procedure per the test procedure specified below. The Authorized Inspector shall monitor compliance of the written procedure.

(m) Headers used for qualification testing shall not be used on Code stamped boilers.

(n) The use of regrind material is prohibited.

(o) This Code Case number shall be shown on the Manufacturer's Data Report.

## 2 DESIGN QUALIFICATION

The maximum allowable working pressure of the bolted box header shall be established by the following procedure:

(a) One or more full-scale prototype headers shall be subjected to a cyclic pressure test followed by a hydrostatic qualification test.

(b) The temperature of the test fluid for all tests shall be 115°F (45°C), minimum.

(c) The pressure shall be cycled from atmospheric to the design pressure and back 30,000 times.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

(d) Then the pressure in the same prototype header shall be applied at a uniform rate so that six times the MAWP is reached in not less than 1 min.

(e) Leaks are prohibited.

(f) The Authorized Inspector shall verify the cyclic pressure test and shall witness the hydrostatic pressure test.

(g) The prototype need not be tested to destruction.

(h) The prototype header shall be weighed to an accuracy of 0.1 oz (2.8 g). The weight shall be recorded on the Manufacturer's Data Report, Supplementary Sheet, H-6.

(i) The prototype header shall be visually examined for imperfections. Classification and acceptance level of imperfections shall be according to Table 1.

### 3 PRODUCTION HEADERS

(a) Each header shall be examined internally and externally for imperfections. Classification and acceptance level of imperfections shall be according to Table 1.

(b) Each production header shall be weighed within an accuracy of 0.1 oz (2.8 g), and the weight shall not be less than 98.75% of the weight of the prototype unit.

(c) The first ten headers in a production run shall be examined for conformance with dimensions and tolerances shown on the design drawings. Any dimension failing outside the specified limit shall be cause for rejection.

(d) Every tenth header after the first ten headers in a production run shall be examined for conformance with dimensions and tolerances shown on the design drawings. Any dimension failing outside the specified limits shall be cause for rejection of that header and the previous nine headers.

### 4 PRODUCTION QUALIFICATION

(a) At least one header per 1000 duplicate headers shall be subjected to a cyclic pressure and hydrostatic qualification pressure test per the requirements listed above.

(b) The header to be used for this test shall be selected at random by the Authorized Inspector.

**Table 1**  
**Visual Acceptance Criteria**

Defects	Definitions	Maximum
Black spots, brown streaks	Dark spots or streaks	None permitted
Blisters	Hollows on or in the part	Pressure side: none permitted; None Pressure side: $\frac{1}{8}$ in. (3 mm) max. diameter, max. density 1/sq. ft (1/0.1 sq. m), none less than 2 in. (50 mm) apart
Bubbles	Air entrapped in the part	$\frac{1}{8}$ in. (3 mm) max. diameter, max. density 4/sq. in. (4/650 sq. mm); $\frac{1}{16}$ in. (1.5 mm) max. diameter, max. density 10/sq. in. (10/650 mm)
Burn marks, dieseling	Charred or dark plastic caused by trapped gas	None permitted
Cracking, crazing	Any visible	None permitted
Delamination	Single surface layers flake off the part	None permitted
Discoloration	Similar to burn marks, but generally not as dark or severe	Acceptable
Flow, halo, blush marks	Marks seen on the part due to flow of molten plastic across the molding surface	Acceptable
Gels	Bubbles or blisters on or in the part due to poor melt quality	None permitted
Jetting	Undeveloped frontal flow	None permitted

Approval Date: February 13, 2003

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2416**  
**Use of 15Cr-5Ni-3Cu (UNS S15500)**  
**Section VIII, Division 2**

*Inquiry:* May martensitic precipitation hardened stainless steel 15Cr-5Ni-3Cu (UNS S15500) forgings complying with SA-705 Type XM-12 be used for pressure vessels constructed under Section VIII, Division 2?

*Reply:* It is the opinion of the Committee that martensitic precipitation hardened stainless steel forgings as described in the Inquiry may be used for pressure vessels constructed under Section VIII, Division 2 provided the following additional requirements are met:

- (a) The material shall be in the H1100 condition.
- (b) External pressure not permitted.
- (c) The design stress intensity and yield values shall be those listed in [Table 1](#).
- (d) No welding is permitted.
- (e) Exemption from impact testing is not permitted.
- (f) This Case number shall be shown on the material certification, marking on the material, and on the Manufacturer's Data report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Yield Strength and Design Stress Intensity Values**

For Metal		
Temperature Not Exceeding, °F	Yield Strength $S_y$ , ksi	Design Stress Intensity $S_m$ , ksi
100	115.0	46.7
200	107.1	46.7
300	103.2	46.2
400	100.5	44.7
500	98.1	43.5
600	95.4	42.4

GENERAL NOTE: Caution is advised when using this material above 550°F. After prolonged exposure above 550°F, the toughness of this material may be reduced See Appendix A, A-360 of Section II, Part D.

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Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2418-2**  
**SA-182, SA-240, SA-479, SA-789, SA-790, and SA-815**  
**21Cr-5Mn-1.5Ni-Cu-N (UNS S32101) Austenitic-Ferritic**  
**Duplex Stainless Steel**  
**Section VIII, Division 1**

*Inquiry:* May solution annealed UNS S32101 wrought material conforming to the requirements of specifications SA-182, SA-240, SA-479, SA-789, SA-790, and SA-815, or meeting the requirements of Table 1 and mechanical properties of Table 2 and otherwise meeting the requirements of SA-182 be used in the construction of vessels under the rules of Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used under the rules of Section VIII, Division 1, provided the following additional requirements are met:

(a) For SA-182, the material meets the chemical analysis and minimum mechanical properties shown in Table 1 and Table 2, respectively.

(b) The maximum allowable design stress values in tension shall be those listed in Table 3 and Table 3M. The maximum applicable use temperature shall be 600°F (316°C).

(c) For external pressure design, Figure HA-5 and Table HA-5 of Section II, Part D shall be used.

(d) This material is assigned P-No. 10H, Group 1.

(e) The solution annealing temperature shall be 1,870°F (1,020°C) minimum and then quenched in water or rapidly cooled by other means.

(f) Heat treatment after welding is neither required nor prohibited. However, if heat treatment is applied, the solution annealing treatment shall be as noted in (e).

(g) The rules that shall apply are those given in Subsection C, Part UHA for austenitic-ferritic duplex stainless steels.

(h) This Case number shall be included in the marking and documentation of the material and shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Chemical Requirements**

Element	Weight, %
Carbon	0.040
Manganese	4.0-6.0
Silicon, max.	1.00
Sulfur, max.	0.030
Phosphorus, max.	0.040
Chromium	21.0-22.0
Nickel	1.25-1.70
Molybdenum	0.10-0.80
Nitrogen	0.20-0.25
Copper	0.10-0.80

**Table 2**  
**Mechanical Properties**

Mechanical Properties	$t > 0.187$ in.	$t > 5.00$ mm	$t \leq 0.187$ in.	$t \leq 5.00$ mm
<b>Tensile Strength</b>				
Min. ksi	94	...	101	...
Min. MPa	...	650	...	700
<b>Yield Strength</b>				
Min. ksi	65	...	77	...
Min. MPa	...	450	...	530
Elongation in 2 in., %	30	30	30	30

**Table 3**  
**Maximum Allowable Stress Values, ksi**

For Metal Temperature Not Exceeding, °F	Seamless Products, $t > 0.187$ in.	Welded Products, $t > 0.187$ in.	Seamless Products,	Welded Products,
			$t \leq 0.187$ in. [Note (1)]	$t \leq 0.187$ in. [Note (1)]
100	26.9	22.9	28.9	24.6
200	26.9	22.9	28.9	24.6
300	25.6	21.8	27.5	23.4
400	24.7	21.0	26.5	22.5
500	24.7	21.0	26.5	22.5
550	24.7	21.0	26.5	22.5
600	24.7	21.0	26.5	22.5

**CAUTION:** This material may be expected to develop embrittlement after exposure at moderately elevated temperatures. See Section II, Part D, Nonmandatory Appendix A, A-207 and A-208.

NOTE:

(1) All SA-815 products shall only use allowable stresses listed for  $t > 0.187$  in.

**Table 3M**  
**Maximum Allowable Stress Values, MPa**

For Metal Temperature Not Exceeding, °C	Seamless Products, $t > 5.00$ mm	Welded Products, $t > 5.00$ mm	Seamless Products, $t \leq 5.00$ mm [Note (1)]	Welded Products, $t \leq 5.00$ mm [Note (1)]
40	186	158	200	170
65	186	158	200	170
90	186	158	200	170
150	177	150	190	161
200	171	145	184	156
250	170	145	183	156
300	170	145	183	156
325	170	145	183 [Note (2)]	156 [Note (2)]

**CAUTION:** This material may be expected to develop embrittlement after exposure at moderately elevated temperatures. See Section II, Part D, Nonmandatory Appendix A, A-207 and A-208.

NOTES:

- (1) All SA-815 products shall only use allowable stresses listed for  $t > 5.00$  mm.
- (2) This value is provided for interpolation purposes only. The maximum design temperature for this material is as stated in (b).

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Approval Date: May 21, 2003

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2419**  
**Use of SA-268 Ferritic Stainless Steel Welded Tubing,**  
**TP430 Ti, UNS S43036**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions is it permissible in construction conforming to the rules of Section VIII, Division 1, to use welded tubing of UNS S43036 ferritic stainless steel conforming to the requirements of SA-268 Grade TP430 Ti?

*Reply:* It is the opinion of the Committee that the welded tubular product materials described in the Inquiry may be used in Section VIII, Division 1, construction provided the following requirements are met:

- (a) The rules in Section VIII, Division 1, Subsection C, Part UHA, for ferritic stainless steel shall apply.
- (b) The design temperature shall not exceed 800°F.
- (c) The maximum allowable design stress values shall be those listed in Table 1.
- (d) For external pressure design, use Fig. CS-2 of Section II, Part D.
- (e) Welding procedure and performance qualifications shall be performed in accordance with Section IX.
- (f) This Case number shall be included on the Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Stress Values, ksi [Note (1)] and [Note (3)]
100	14.6 [Note (2)]
200	14.6 [Note (2)]
300	14.1 [Note (2)]
400	13.7 [Note (2)]
500	13.4 [Note (2)]
600	13.1 [Note (2)]
650	12.9 [Note (2)]
700	12.6 [Note (2)]
750	12.3 [Note (2)]
800	11.9 [Note (2)]

## NOTES:

- (1) The revised criterion of 3.5 on tensile strength was used in establishing these values.
- (2) These stress values include a joint efficiency factor of 0.85.
- (3) This material may be expected to develop embrittlement after service at moderately elevated temperatures.

Approval Date: May 21, 2003

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2421**  
**Single Fillet Lap Joint for Heat Exchanger Tube Welds**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions may a Type (6), single fillet lap joint, be used for Category B joints in heat exchanger tubes in Section VIII, Division 1 construction?

*Reply:* It is the opinion of the Committee that a Type (6) lap joint may be used for Category B joints in heat exchanger tubes provided the following requirements are met:

(a) The Type (6) joint is not allowed in heat exchangers where the tubes act as stays or for fixed-fixed tubesheets.

(b) The maximum design temperature shall not exceed 800°F (425°C).

(c) Neither cyclic loading nor tube vibration shall be a controlling design requirement. (See UG-22.)

(d) The vessel shall not be in lethal service.

(e) The joint efficiency to be used in the appropriate design equations shall be 0.45.

(f) The tube outside diameter shall not exceed 2 in. (50 mm).

(g) The nominal wall thickness of the tube shall not exceed  $\frac{1}{8}$  in. (3 mm).

(h) The lap at the joint and the weld size shall meet the requirements of [Figure 1](#).

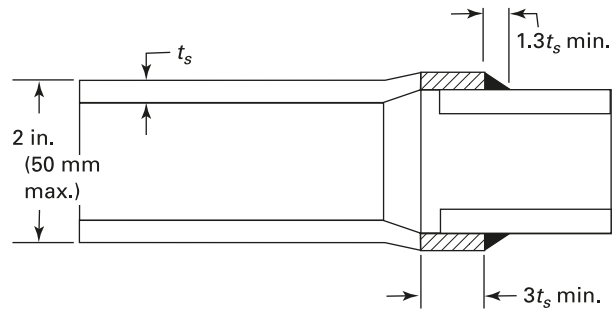
(i) The joint shall have a pressed fit before welding.

(j) No tube forming is permitted at the joint after welding.

(k) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

Figure 1



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Approval Date: January 27, 2003

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2426**  
**Titanium Nickel-Molybdenum Ruthenium Alloy,**  
**Ti-0.8Ni-0.3Mo-0.1Ru**  
**Section VIII, Division 1**

*Inquiry:* May a Ti-0.8Ni-0.3Mo-0.1Ru alloy identical to ASME Grade 12 (UNS R53400) with 0.1 ruthenium added for corrosion enhancement may be used in Section VIII, Division 1 construction?

*Reply:* It is the opinion of the Committee that a Ti-0.8Ni-0.3Mo-0.1Ru alloy identical to ASME Grade 12 (UNS R53400) with 0.1 ruthenium added for corrosion enhancement may be used in Section VIII, Division 1 construction provided the following requirements are met:

(a) The material shall meet the chemical analysis shown in [Table 1](#) and all other requirements of the corresponding specifications listed in [Table 2](#).

(b) The material shall meet the minimum mechanical properties of Grade 12 in the respective specifications shown in [Table 2](#).

(c) The maximum allowable stress values shall be as shown in [Table 3](#).

(d) External pressure chart NFT-1 shall be used for the material.

(e) Separate welding procedure qualifications and welding performance qualifications conducted in accordance with the requirements of Section IX shall be required for these materials.

(f) All other rules for Section VIII, Division 1 applicable to titanium-nickel-molybdenum alloy Grade 12 (including F12, WPT12, and WPT12W) shall be met.

(g) This Case number shall be referenced in the documentation and marking of the material and shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1  
Chemical Requirements**

Element	Composition, %
Oxygen	0.25 max.
Iron	0.30 max.
Hydrogen	0.015 max.
Carbon	0.08 max.
Nitrogen	0.03 max.
Nickel	0.6–0.9
Molybdenum	0.2–0.4
Ruthenium	0.08–0.14
Residuals, each	0.1
Residuals, total	0.4
Titanium	Remainder

**Table 2  
Product Specifications**

Product	Specification	Grade
Plate, sheet, strip	SB-265	12
Bar, billet	SB-348	12
Forgings	SB-381	F12
Seamless tube	SB-338	12
Welded tube	SB-338	12
Seamless pipe	SB-861	12
Welded pipe	SB-862	12
Seamless fittings	SB-363	WPT12
Welded fittings	SB-363	WPT12W

**Table 3  
Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Allowable Stress Values, ksi [Note (1)]	
	Wrought	Welded Pipe and Tube [Note (2)]
-20 to 100	20.0	17.0
150	20.0	17.0
200	18.7	15.9
250	17.4	14.8
300	16.2	13.8
350	15.2	12.9
400	14.3	12.1
450	13.6	11.5
500	13.1	11.1
550	12.7	10.8
600	12.3	10.5

NOTES:

- (1) Values are identical to the values for Grade 12 in ASME Section II, Part D, Table 1B.
- (2) A joint efficiency of 85% has been used in determining the joint efficiency in welded pipe, fittings, and tube.

Approval Date: May 21, 2003

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2427**  
**Chromium-Nickel-Molybdenum-Nitrogen-Tungsten**  
**Duplex Stainless Steel UNS S39274 Plate**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions may solution-annealed UNS S39274 plates be used in welded construction under the rules of Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used in the construction of welded pressure vessels conforming to the rules of Section VIII, Division 1, provided the following additional requirements are met:

(a) The material meets the chemical requirement given in Table 1 and the minimum mechanical property requirements given in Table 2, and otherwise conforms to the requirements of SA-240.

(b) For Section VIII, Division 1 construction, the rules for austenitic-ferritic stainless steels in Subsection C, Part UHA, shall apply.

(c) The plates shall be solution annealed in the temperature range of 1920°F–2100°F (1050°C–1150°C) and shall then be quenched in water or rapidly cooled by other means.

(d) The maximum allowable stress values shall be as given in Table 3. The maximum design temperature is 650°F (345°C).

(e) For external pressure design, Fig. HA-2, in Section II, Part D, shall be used.

(f) Welding procedure and performance qualifications shall be performed in accordance with Section IX.

(g) Heat treatment after forming or fabrication is neither required nor prohibited. When heat treatment is performed, it shall be performed as noted in (c).

(h) Welding shall be done using the GTAW or SMAW process.

(i) This Case number shall be included in the material documentation and marking and shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1  
Chemical Requirements**

Element	Composition, %
Carbon	0.030 max.
Manganese	1.00
Phosphorus	0.030 max.
Sulfur	0.020 max.
Silicon	0.80 max.
Nickel	6.0–8.0
Chromium	24.0–26.0
Molybdenum	2.5–3.5
Nitrogen	0.24–0.32
Copper	0.20–0.80
Tungsten	1.50–2.50

**Table 2  
Mechanical Property Requirements (Room Temperature)**

Tensile strength, min., ksi (MPa)	116	(800)
Yield strength, 0.2% offset, min., ksi (MPa)	80	(550)
Elongation in 2-in., (50 mm) gage length, min, %	15	
Hardness, max.	310 HB or 32 HRC	

**Table 3  
Maximum Allowable Stresses**

For Metal Temperature Not Exceeding, °F	Allowable Stress Values, ksi	For Metal Temperature Not Exceeding, °C	Allowable Stress Values, MPa
100	33.1	40	229
200	33.1	100	228
300	31.6	150	218
400	31.4	200	216
500	31.4	250	216
600	31.4	300	216
650	31.4	350	216 [Note (1)]

GENERAL NOTES:

(a) The revised criterion of 3.5 on tensile strength was used in establishing these values.

(b) The material embrittles after exposure at moderately elevated temperatures. See paras. A-340 and A-360 in Appendix A of Section II, Part D.

NOTE:

(1) This value is provided for interpolation purposes only. The maximum design temperature for this material is as stated in (d).

Approval Date: October 8, 2012

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2428-3**  
**Attachment of Tubes to Flat Tubesheets Using**  
**Complete Penetration Welds**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions is it permissible to attach tubes to a flat tubesheet by welding when the tubes have partial or no penetration into the tubesheet for Section VIII, Division 1 construction?

*Reply:* It is the opinion of the Committee that it is permissible to attach tubes to a flat tubesheet by welding when the tubes have partial or no penetration into the tubesheet for Section VIII, Division 1 construction, provided the following requirements are met:

(a) The tube and tubesheet materials shall be restricted to P-No. 1, P-No. 3, or P-No. 4 materials.

(b) The maximum design temperature at the weld joint shall not exceed 700°F (370°C).

(c) The weld joining the tube to the tubesheet shall be a full penetration weld made from the I.D. of the tube. (See Figure 1.) The throat of the weld shall be equal to or greater than the thickness of the tube. The root pass shall be made using the GTAW process.

(d) PWHT per UCS-56 is mandatory. The exemptions to PWHT noted in Table UCS-56 shall not apply.

(e) The welding procedure specifications, the welders, and the welding operators shall be qualified in accordance with Section IX.

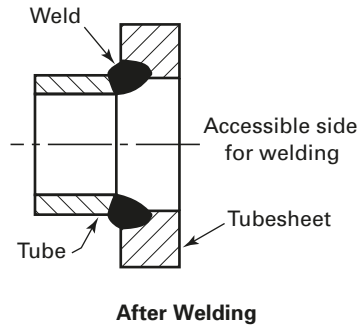
(f) In addition to meeting the performance qualification requirements of (e), before making a production weld each welder and welding operator shall demonstrate his or her ability to achieve complete weld penetration and minimum thickness by successfully welding six test pieces. The test pieces shall be welded in a mockup of the production weld. The mockup shall be of identical position, dimensions, and materials as that of the production weld. The test pieces shall be visually examined to verify complete penetration and sectioned to verify minimum required weld thickness. The results shall be recorded and maintained with the performance qualification record.

(g) Each weld surface on the tube I.D. shall receive either a magnetic particle or liquid penetrant examination in accordance with Section III Appendices, Mandatory Appendix 6 or Mandatory Appendix 8, as applicable. In addition, a visual examination of the weld surface on the tube O.D. shall be performed. The maximum practicable number of these welds, but in no case fewer than 50%, shall be visually examined. Visual examination shall show complete penetration of the joint root and freedom from cracks.

(h) This Case number shall be shown on the Manufacturer's Data Report.

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**Figure 1**  
**Full Penetration Weld**



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Approval Date: January 12, 2005

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2430**  
**Use of A213/A213M-04 UNS S31060 Austenitic Stainless Steel Seamless Tubing and A240/A240M-04a<sup>e1</sup> UNS S31060 Austenitic Stainless Steel Plate**  
**Section I; Section VIII, Division 1**

*Inquiry:* Under what conditions may A213/A213M-04a UNS S31060 austenitic stainless steel seamless tubes and A240/A240M-04a<sup>e1</sup> UNS S31060 austenitic stainless steel plates be used in steam service under the rules of Section I and in welded construction under the rules of Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used in steam service under the rules of Section I and in welded construction under the rules of Section VIII, Division 1, provided the following additional requirements are met:

(a) The grain size of UNS S31060 shall conform to an average grain size of ASTM No. 7 or coarser, as measured by Test Methods E112.

(b) For Section I construction, the rules of PG-19 for 304N shall apply for this material, except that solution treatment, when required, shall be in the range of 1,975°F to 2,160°F (1 080°C to 1 180°C); and the  $\gamma$  coefficient shall be that for austenitic materials in Note (6) of PG-27.4.

(c) For Section VIII, Division 1 construction, the rules for austenitic stainless steels in Subsection C, Part UHA shall apply. The rules of UHA-44 for 304N shall apply

for this material, except that solution treatment, when required, shall be in the range of 1,975°F to 2,160°F (1 080°C to 1 180°C).

(d) The maximum allowable stress values shall be as given in Tables 1 and 1M. The maximum design temperature is 1,740°F (950°C).

(e) For external pressure design, Figures 1 and 1M and Table 2 shall be used.

(f) Separate welding procedure and performance qualifications shall be performed in accordance with Section IX.

(g) For a design temperature above 1,500°F (815°C), filler metals shall be limited to those having a composition similar to that of the base material, except having an aim chemistry including 1% Mo, 0.04% (Ce + La), and 0.3% N.

(h) When welding is performed with filler metal of similar composition as the base metal [see (g)] welding processes shall be limited to the GTAW and SMAW welding processes.

(i) Post-weld heat treatment is neither required nor prohibited. When heat treatment is performed, the material shall be solution treated in the range of 1,975°F to 2,160°F (1 080°C to 1 180°C).

(j) This Case number shall be included in the material documentation and marking and shall be shown on the Manufacturer's Data Report.

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**Table 1  
Maximum Allowable Stresses**

For Metal		
Temperature Not Exceeding, °F	Allowable Stress Values, ksi	Allowable Stress Values, ksi
-20 to 100	24.9	24.9
200	24.2	24.2
300	22.9	22.9
400	22.0	22.3 [Note (1)]
500	21.3	22.0 [Note (1)]
600	20.7	21.8 [Note (1)]
650	20.5	21.7 [Note (1)]
700	20.2	21.6 [Note (1)]
750	20.0	21.4 [Note (1)]
800	19.8	21.2 [Note (1)]
850	19.6	20.9 [Note (1)]
900	19.5	20.5 [Note (1)]
950	19.3	20.1 [Note (1)]
1,000	19.2	19.5 [Note (1)]
1,050	18.8	18.8
1,100	15.3	15.3
1,150	12.2	12.2
1,200	9.4	9.4
1,250	7.1	7.1
1,300	5.4	5.4
1,350	4.0	4.0
1,400	3.1	3.1
1,450	2.4	2.4
1,500	1.9	1.9
1,550	1.5	1.5
1,600	1.3	1.3
1,650	1.0	1.0
1,700	0.87	0.87
1,750	0.74 [Note (2)]	0.74 [Note (2)]

GENERAL NOTE: The revised criterion of 3.5 on tensile strength was used in establishing these values.

NOTES:

- (1) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed 66<sup>2</sup>/<sub>3</sub>%, but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.
- (2) These values are provided for interpolation purposes only.

**Table 1M  
Maximum Allowable Stresses**

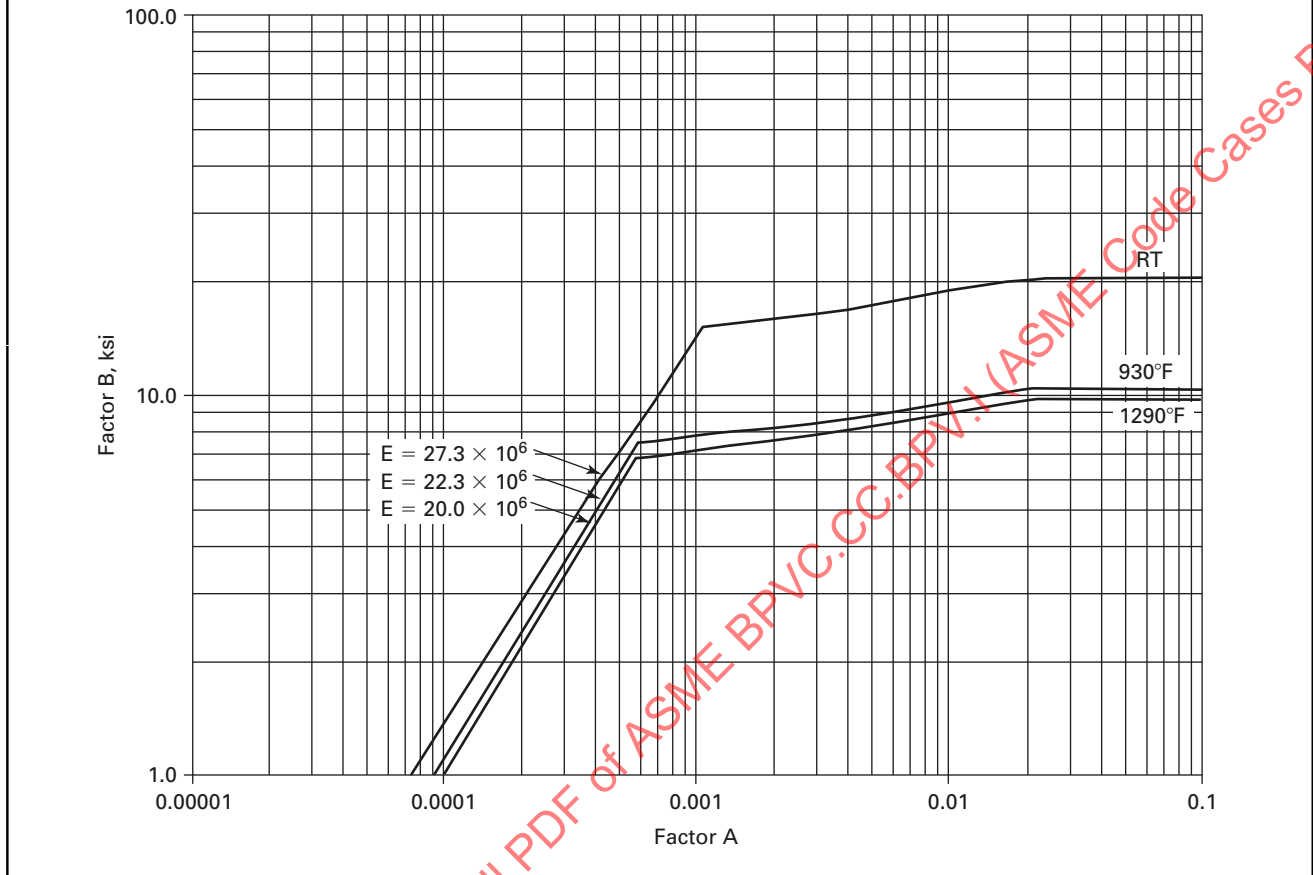
For Metal		
Temperature Not Exceeding, °C	Allowable Stress Values, MPa	Allowable Stress Values, MPa
-30 to 100	171	171
65	171	171
100	166	166
125	161	161
150	158	158
175	155	156 [Note (1)]
200	152	154 [Note (1)]
225	150	153 [Note (1)]
250	157	152 [Note (1)]
275	145	151 [Note (1)]
300	144	151 [Note (1)]
325	142	150 [Note (1)]
350	141	150 [Note (1)]
375	139	149 [Note (1)]
400	138	148 [Note (1)]
425	137	146 [Note (1)]
450	136	145 [Note (1)]
475	134	142 [Note (1)]
500	134	140 [Note (1)]
525	133	136 [Note (1)]
550	132	132
575	121	121
600	100	100
625	81.5	81.5
650	64.2	64.2
675	50.0	50.0
700	38.7	38.7
725	29.9	29.9
750	23.4	23.4
775	18.5	18.5
800	14.8	14.8
825	12.2	12.1
850	10.0	10.0
875	8.4	8.4
900	7.1	7.1
925	6.1	6.1
950	5.2	5.2

GENERAL NOTE: The revised criterion of 3.5 on tensile strength was used in establishing these values.

NOTE:

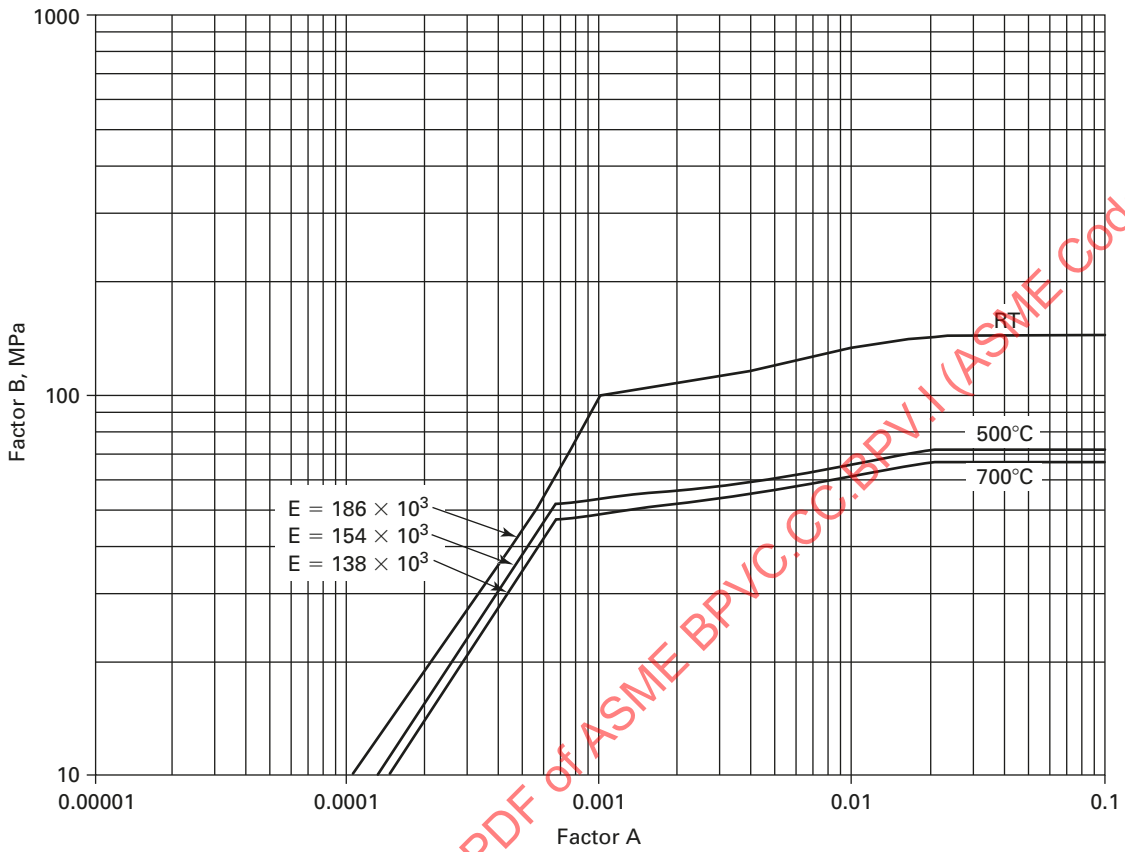
- (1) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed 66<sup>2</sup>/<sub>3</sub>%, but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.

**Figure 1**  
**Chart for Determining Shell Thickness of Components under External Pressure When Constructed of Alloy UNS S31060**



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**Figure 1M**  
**Chart for Determining Shell Thickness of Components under External Pressure When Constructed of Alloy UNS S31060**



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**Table 2**  
**Tabular Values for UNS S31060**

Temp., °F	Temp., °C	A	B, ksi	B, Mpa
RT	RT	7.33-05	1.0	6.9
		1.06-03	14.5	100.0
		3.00	16.0	110.3
		4.50	17.0	117.2
		6.85	18.0	124.1
		1.00-02	19.0	131.0
		1.75	20.0	137.9
		2.52	20.5	141.3
		1.00-01	20.5	141.3
		930	500	8.97-05
6.82-04	7.6			52.4
1.50-03	8.0			55.2
3.30	8.5			58.6
5.70	9.0			62.1
9.40	9.5			65.5
1.50-02	10.0			69.0
2.10	10.5			72.1
1.00-01	10.5			72.1
1,290	700			1.00-04
		6.80	6.8	46.9
		1.80-03	7.5	51.7
		6.20	8.5	58.6
		9.90	9.0	62.1
		2.05-02	9.75	67.2
		1.00-01	9.75	67.2

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Approval Date: June 20, 2008

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**Case 2432-1**  
**Use of 5052-H32, 6061-T6, and 6061-T651 Temper**  
**Aluminum Alloys in Part HF of Section IV, for**  
**Construction of Heating Boilers**  
**Section IV; Section II, Part B**

*Inquiry:* May aluminum alloys, 5052-H32, 5052-O, 6061-T6, and 6061-T651 be used in the construction of Section IV hot water heating boilers?

*Reply:* It is the opinion of the committee that 5052-H32, 5052-O, 6061-T6, and 6061-T651 aluminum alloys may be used for the construction of Section IV hot water heating boilers provided the following conditions are met:

(a) Materials shall conform to the specifications listed in [Table 1](#) for the various product forms.

(b) The minimum allowable thickness shall be the same as that shown in Table HF-301.2 for copper, admiralty, and red brass.

(c) Maximum metal temperature shall not exceed 300°F (150°C).

(d) Maximum allowable stress values shall be as shown in [Table 2](#), [Table 2M](#), [Table 3](#), and [Table 3M](#).

(e) All other requirements of Section IV shall apply.

(f) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Product Specifications**

Product Form	Specification Number	UNS Number
Sheet and plate	SB-209	A95052/A96061
Drawn seamless tube	SB-210	A95052/A96061
Bar, rod, and wire	SB-211	A96061
Extruded bar, rod, and shape	SB-221	A96061
Seamless pipe and seamless extruded tube	SB-241/SB-241M	A95052/A96061

**Table 2**  
**Maximum Allowable Stress Values for Welded 5052 Aluminum**

Specification Number	Temper	Specified Min. Tensile Strength, ksi	Specified Min. Yield Strength, ksi	Allowable Stress Values, ksi for Metal Temperature Not Exceeding, °F				
				-20 to 100	150	200	250	300
<b>Sheet and Plate</b>								
SB-209	H32 welded	25	9.5	5.0	5.0	5.0	4.7	4.5
<b>Drawn Seamless Tube</b>								
SB-210	H32 welded	25	10	5.0	5.0	5.0	4.7	4.5
<b>Seamless Pipe and Seamless Extruded Tube</b>								
SB-241/SB-241M	H32 welded	25	10	5.0	5.0	5.0	4.7	4.5
<b>Drawn Seamless Tube</b>								
SB-210	O brazed	25	10	5.0	5.0	5.0	4.7	4.5

**Table 2M**  
**Maximum Allowable Stress Values for Welded 5052 Aluminum**

Specification Number	Temper	Specified Min. Tensile Strength, MPa	Specified Min. Yield Strength, MPa	Allowable Stress Values, MPa for Metal Temperature Not Exceeding, °C				
				-30 to 40	65	100	125	150
<b>Sheet and Plate</b>								
SB-209	H32 welded	172	69	34.5	34.5	34.5	34.5	32.8
<b>Drawn Seamless Tube</b>								
SB-210	H32 welded	172	69	34.5	34.5	34.5	34.5	32.8
<b>Seamless Pipe and Seamless Extruded Tube</b>								
SB-241/SB-241M	H32 welded	172	69	34.5	34.5	34.5	34.5	32.8
<b>Drawn Seamless Tube</b>								
SB-210	O brazed	172	69	34.5	34.5	34.5	34.5	32.8

**Table 3**  
**Maximum Allowable Stress Values for Welded 6061-T6 And 6061-T651 Aluminum**

Specification Number	Temper	Specified Min. Tensile Strength, ksi	Specified Min. Yield Strength, ksi	Allowable Stress Values, ksi for Metal Temperature Not Exceeding, °F				
				-20 to 100	150	200	250	300
<b>Sheet and Plate</b>								
SB-209	T6 welded	24	8.0	4.8	4.8	4.8	4.7	4.4
	T651 welded	24	8.0	4.8	4.8	4.8	4.7	4.4
<b>Drawn Seamless Tube</b>								
SB-210	T6 welded	24	8.0	4.8	4.8	4.8	4.7	4.4
<b>Bar, Rod, Wire</b>								
SB-211	T6 welded	24	8.0	4.8	4.8	4.8	4.7	4.4
	T651 welded	24	8.0	4.8	4.8	4.8	4.7	4.4
<b>Extruded Bar, Rod, and Shapes</b>								
SB-221	T6 welded	24	8.0	4.8	4.8	4.8	4.7	4.4
<b>Seamless Pipe and Seamless Extruded Tube</b>								
SB-241/SB-241M	T6 welded	24	8.0	4.8	4.8	4.8	4.7	4.4

**Table 3M**  
**Maximum Allowable Stress Values for Welded 6061-T6 And 6061-T651 Aluminum**

Specification Number	Temper	Specified Min. Tensile Strength, MPa	Specified Min. Yield Strength, MPa	Allowable Stress Values, MPa for Metal Temperature Not Exceeding, °C				
				-30 to 40	65	100	125	150
<b>Sheet and Plate</b>								
SB-209	T6 welded	165	55	33.1	33.1	33.1	32.6	31.2
	T651 welded	165	55	33.1	33.1	33.1	32.6	31.2
<b>Drawn Seamless Tube</b>								
SB-210	T6 welded	165	55	33.1	33.1	33.1	32.6	31.2
<b>Bar, Rod, Wire</b>								
SB-211	T6 welded	165	55	33.1	33.1	33.1	32.6	31.2
	T651 welded	165	55	33.1	33.1	33.1	32.6	31.2
<b>Extruded Bar, Rod, and Shapes</b>								
SB-221	T6 welded	165	55	33.1	33.1	33.1	32.6	31.2
<b>Seamless Pipe and Seamless Extruded Tube</b>								
SB-241/SB-241M	T6 welded	165	55	33.1	33.1	33.1	32.6	31.2

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Approval Date: June 23, 2005

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2437-1**  
**Rules for Diffusion Bonded, Flat Plate, Microchannel**  
**Heat Exchanger**  
**Section VIII, Division 1**

*Inquiry:* In the absence of rules covering diffusion bonding of flat plate heat exchangers in Section VIII, Division 1, what alternative rules may be used to fabricate diffusion bonded flat plate, microchannel heat exchangers in compliance with Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that the following alternative rules for diffusion bonding may be used in fabricating flat plate, microchannel heat exchangers in compliance with Section VIII, Division 1.

## 1 SCOPE

The alternative rules in this Code Case cover minimum requirements for design, fabrication, and inspection of microchannel heat exchangers manufactured from flat plates of SA-240 Type 316L stainless steel.

(a) The microchannel flow passages may be formed in the flat plates to be bonded together by any of the following means prior to bonding:

- (1) photochemical machining
- (2) stamping
- (3) electrochemical machining

(b) Bonding processes covered in this Code Case include ram press and isostatic pressing.

## 2 SERVICE RESTRICTIONS

(a) Assemblies as defined in this Code Case shall not be used for the containment of substances defined as lethal by UW-2(a).

(b) Assemblies as defined in this Code Case shall not be used as unfired steam boilers or as vessels subject to direct firing.

(c) Heat exchangers covered in this Code Case are intended for service above room temperature. Impact testing of the diffusion bonding process is not required.

## 3 THICKNESS LIMITATIONS

The range of thickness of pressure containing parts that may be diffusion bonded under the provisions of this Case shall be limited to that qualified by the bonding procedure under the provisions of para. 5.

## 4 MAXIMUM ALLOWABLE WORKING PRESSURE

The MAWP or minimum thickness of the stacked heat exchanger plates shall be calculated by the following equations:

$$P = St^2/Cb^2 \quad (1)$$

$$t = b(CP/S)^{1/2} \quad (2)$$

$C$  = factor from Table 1 based on  $a/b$  ratio

$P$  = maximum design pressure (see UG-21), psi (kPa)

$S$  = maximum allowable stress value given in Section II, Part D, psi (kPa)

$a$  = maximum length of the microchannels, in. (mm)

$b$  = maximum width of the microchannels, in. (mm)

$t$  = minimum thickness of plate, in. (mm)

## 5 DIFFUSION BONDING CONTROL

In the absence of diffusion bonding requirements in Section IX, the following requirements shall be met:

(a) *Proof Testing for Procedures Qualification.* A pressure proof test shall be conducted on a finished vessel or representative panel. If a representative panel is used, it shall be constructed using rectangular plates with at least five channels in each direction. The aspect ratio (width/thickness/spacing) of the channels used in a representative panel shall be the same as to be used in the production bonding. The proof test shall be conducted in accordance with the requirements of UG-101 using the bursting test procedures of UG-101(m). In using the formulas for calculating the maximum allowable working pressure, a value of 0.80 shall be used for  $E$ , the weld joint efficiency factor.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

(b) *Workmanship Samples for Procedure and Performance Qualification.* One diffusion bonded test block specimen shall be made in accordance with Figure 1, using the same plate thickness and material of the same specification and grade as used in the proof test vessel. These bonds shall be representative of the manufacturing practice employed in the fabrication of the proof and of the practice to be used for the production vessel. The test block shall be cross-sectioned into at least three specimens. The welds shall be visually examined and shown to be free of cracks, incomplete penetration, and inclusions. At least one specimen from each test block shall be suitably polished on its edge and etched to show clearly the diffusion bond line. The etched macrosection shall reveal complete fusion along the bond line and complete freedom from cracks in the bond or base metal. At least two specimens from each test block shall be machined for reduced section tensile testing and subjected to tensile loading to failure and the tensile strength measured. The test specimen shall exhibit strength at least equal to the minimum ultimate tensile strength of the base metal.

(c) *Controls and Machine Settings.* For procedure and performance qualifications, all applicable parameters used in making proof test and workmanship samples shall be recorded. Parameters to be recorded are as follows:

- (1) thickness (maximum)
- (2) bonding pressure (minimum)

- (3) bonding temperature (minimum)
- (4) bonding hold time (minimum)
- (5) atmosphere
- (6) equipment (make and model)
- (7) filler metal (composition, form, size)
- (8) prebonding surface condition (surface finish, passivation, etching, cleaning, coating, flatness, lay, waviness)
- (9) maximum channel aspect ratio (width/depth/spacing)
- (10) postbonding cleaning method
- (11) pre or postbonding heat treatment
- (12) maximum time between prebond cleaning and bonding
- (13) width of the diffusion bonded zone, *d*

All of the above parameters are considered essential variables. Any changes to the essential variables outside values qualified required requalification. The settings recorded above shall be used in the fabrication of all vessels fabricated under the provisions of this Code Case.

**6 HYDROSTATIC TEST**

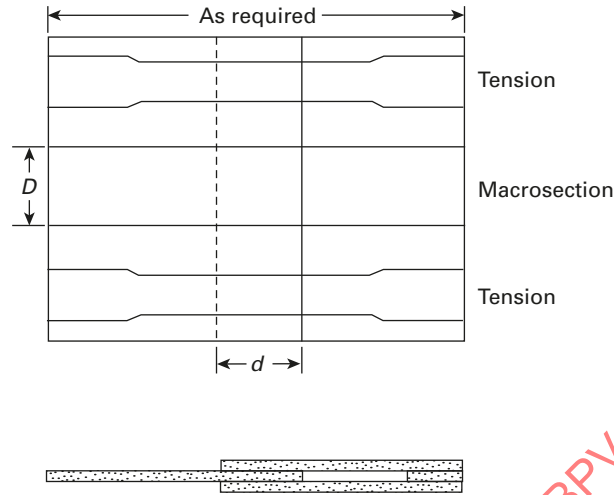
The completed heat exchanger shall be subjected to a hydrostatic test in accordance with UG-99.

This Code Case shall be recorded on the Manufacturer's Data Report.

**Table 1**  
**Values of C**

<i>a/b</i>	<i>c</i>
1.0	0.4182
1.2	0.4626
1.4	0.4860
1.6	0.4968
1.8	0.4971
2.0	0.4952
>2.0	0.5000

**Figure 1**  
**Bonding Specimen for Tension and Macrosection**



GENERAL NOTE: 1 in. (25 mm)  $< D \leq 1\frac{1}{4}$  in. (32 mm).

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Approval Date: February 14, 2003

*Code Cases will remain available for use until annulled by the applicable Standards Committee.***Case 2439**  
**Ni-Cr-Co-Mo Alloy (UNS N06617)**  
**Section I**

*Inquiry:* May solution annealed Ni-Cr-Co-Mo alloy (UNS N06617) wrought plate, rod, bar, forgings, and seamless tube that meet the requirements of the specifications listed in [Table 1](#) be used in water wetted service in welded construction under Section I?

*Reply:* It is the opinion of the Committee that solution annealed Ni-Cr-Co-Mo alloy (UNS N06617) as described in the Inquiry may be used in the construction of welded pressure vessels under Section I, provided the following additional requirements are met.

(a) Material shall be solution annealed at a temperature of 2100–2250°F and quenched in water or rapidly cooled by other means.

(b) The materials shall conform to the specifications listed in [Table 1](#).

(c) The maximum allowable stress values for the material shall be those given in [Table 2](#).

(d) For welding, P-No. 43 shall be applied for procedure qualifications and performance qualifications in accordance with Section IX.

(e) Heat treatment after forming or fabrication is neither required nor prohibited.

When heat treatment is performed, it shall be in accordance with (a) above. For parameter  $y$  [see PG-27.4, Note (6)], the  $y$  values shall be as follows:

1050°F and below	$y = 0.4$
1200°F	$y = 0.5$

This Case number shall be shown in the documentation and marking of the material.

**CAUTION:** Austenitic alloys are subject to stress corrosion cracking, intergranular attack, pitting, and crevice corrosion when used in boiler applications in aqueous environments. Factors that affect the susceptibility of these materials are applied or residual stress, water chemistry and deposition of solids, and material condition. Susceptibility to attack is enhanced when the material is used in a sensitized condition, or with residual cold work. Concentration of corrosive agents (e.g., chlorides, caustic, or reduced sulfur species) can occur under deposits formed on the surface of these materials, and can result in severe under deposit wastage or cracking. For successful operation in water environments, careful attention must be paid to continuous control of water chemistry.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1  
Product Specifications**

Product	Specifications
Forgings	SB-564
Plate and sheet	SB-168
Rod and bar	SB-166
Tube	SB-167

**Table 2  
Maximum Allowable Stress Values**

For Metal		
Temperature Not Exceeding, °F	Maximum Allowable Stress, ksi [Note (1)]	
100	23.3	...
200	20.5	23.3 [Note (2)]
300	19.1	23.3 [Note (2)]
400	18.1	23.3 [Note (2)]
500	17.3	23.3 [Note (2)]
600	16.7	22.5 [Note (2)]
700	16.2	21.9 [Note (2)]
800	15.9	21.5 [Note (2)]
900	15.7	21.1 [Note (2)]
1,000	15.5	20.9 [Note (2)]
1,100	15.4	20.7 [Note (2)]
1,150	15.4	20.7 [Note (2)]
1,200	15.3	16.9 [Note (2)]

NOTES:

- (1) The revised criterion of 3.5 on tensile strength was used in establishing these values.
- (2) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. The higher stress values exceed 66<sup>2</sup>/<sub>3</sub>% but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.

Approval Date: February 20, 2004

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2440**  
**Use of Mn- $\frac{1}{2}$ Mo- $\frac{1}{2}$ Ni (UNS K12039) Pipe**  
**Section I**

*Inquiry:* Under what conditions may UNS K12039 seamless pipe material, conforming to the chemical and mechanical properties of SA-302 C but meeting all the other requirements of SA-335, be used in the manufacture of Section I boilers?

*Reply:* It is the opinion of the Committee that UNS K12039, as described in the Inquiry, may be used for the manufacture of Section I boilers provided the following requirements are met:

(a) The material shall meet the chemical composition and mechanical property requirements of [Table 1](#) and [Table 2](#) of this Case and otherwise conform to applicable requirements in Specification SA-335.

(b) Material shall be supplied in the normalized condition.

(c) The design temperature shall not exceed 1000°F (540°C).

(d) The maximum allowable stress values shall be those listed in [Table 3](#) and [Table 3M](#).

(e) This material shall be treated as P-No. 3, Group 3.

(f) This Case number shall be shown on the material certification and marking of the material and on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Chemical Requirements**

Element	Composition, %
Carbon, max.	
Up to 1 in. (25 mm) incl. in thickness	0.20
Over 1 to 2 in. (50 mm), incl.	0.23
Over 2 in. (50 mm) in thickness	0.25
Manganese	
heat analysis	1.15-1.50
product analysis	1.07-1.62
Phosphorous, max. [Note (1)]	0.035
Sulfur, max. [Note (1)]	0.035
Silicon	
heat analysis	0.15-0.40
product analysis	0.13-0.45
Molybdenum	
heat analysis	0.45-0.60
product analysis	0.41-0.64
Nickel	
heat analysis	0.40-0.70
product analysis	0.37-0.73

NOTE:

(1) Value applies to both heat and product analyses.

**Table 2**  
**Mechanical Property Requirements**

Tensile strength, ksi (MPa)	80-100 (550-690)
Yield strength, min, ksi (MPa)	50 (345)
Elongation in 2 in., min., %	20

**Table 3**  
**Maximum Allowable Stress Values**  
**(Customary Units)**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress (ksi)
-20 to 100	22.9
200	22.9
300	22.9
400	22.9
500	22.9
600	22.9
700	22.9
800	22.9
850	20.0
900	13.7
950	8.2
1000	4.8

**Table 3M**  
**Maximum Allowable Stress Values (Metric Units)**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress (MPa)
-30 to 40	158
65	158
425	158
450	143
475	106
500	68.4
525	43.0
550	23.1

Approval Date: June 25, 2010

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2445-2**  
**23Cr-25Ni-5.5Mo-N, UNS S32053, Austenitic -Stainless Steel**  
**Section VIII, Division 1**

*Inquiry:* May 23Cr-25Ni-5.5Mo-N, UNS S32053, austenitic stainless steel sheet, strip, plate, pipe, tube, and bar, meeting the chemical composition and mechanical property requirements shown in [Tables 1](#) and [2](#), and otherwise conforming to one of the specifications given in [Table 3](#), be used in welded construction under the rules of Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used in Section VIII, Division 1 construction, provided the following additional requirements are met:

(a) The rules in Section VIII, Division 1, Subsection C that shall apply are those given in Part UHA for austenitic stainless steels.

(b) For external pressure design, use Fig. NFN-12 in Section II, Part D.

(c) The maximum allowable stress values for the material shall be those given in [Tables 4](#) and [4M](#). For welded pipe and tube products, a joint efficiency factor of 0.85 shall be used.

(d) Maximum design temperature of the material shall be 662°F (350°C).

(e) Separate welding procedure and performance qualifications shall be conducted for the material in accordance with Section IX.

(f) Heat treatment after forming or fabrication is neither required nor prohibited.

(g) The material shall be furnished in the solution annealed condition at a temperature range from 1967°F (1080°C) to 2156°F (1180°C) followed by rapid cooling in air or water.

(h) This Case number shall be shown on the documentation and marking of the material and on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1  
Chemical Requirements**

Element	Composition, %
Carbon, max.	0.030
Manganese, max.	1.00
Phosphorus, max.	0.030
Sulfur, max.	0.010
Silicon, max.	1.00
Chromium	22.00–24.00
Nickel	24.00–26.00
Molybdenum	5.00–6.00
Nitrogen	0.17–0.22
Iron	Balance

**Table 2  
Mechanical Property Requirements (Room Temperature)**

Tensile strength, min. (ksi)	93 [640 MPa]
Yield strength, 0.2% offset, min. (ksi)	43 [295 MPa]
Elongation in 2 in., or 4D, min. (%)	40

**Table 3  
Product Specifications**

Bars and shapes	SA-479
Bolting materials	SA-193
Flanges, fittings, and valves	SA-182
Nuts for bolts	SA-194
Piping fittings	SA-403
Seamless and welded pipes	SA-312
Sheet, strip, and plate	SA-240
Welded tubes	SA-249
Welded pipes	SA-358
Welded pipes	SA-409
Welded pipes	SA-813
Welded pipes	SA-814

**Table 4  
Maximum Allowable Stress Values**

For Metal			
Temperature Not Exceeding, °F	Allowable Stress Values, Max., ksi		
	100	26.5	26.5
200	24.2	26.5	[Note (1)]
300	21.9	25.1	[Note (1)]
400	20.8	23.9	[Note (1)]
500	19.3	23.0	[Note (1)]
600	18.5	22.3	[Note (1)]
650	18.2	22.0	[Note (1)]
700	17.9	21.8	[Note (1)], [Note (2)]

GENERAL NOTE: The revised criterion of 3.5 on tensile strength was used in establishing these values.

NOTES:

- (1) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed 66<sup>2</sup>/<sub>3</sub>%, but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.
- (2) These values are provided for interpolation purposes only. The maximum use temperature is 662°F.

**Table 4M**  
**Maximum Allowable Stress Values**

For Metal			
Temperature Not Exceeding, °C	Allowable Stress Values, Max., MPa		
	40	183	183
65	177	183	[Note (1)]
100	164	182	[Note (1)]
150	151	173	[Note (1)]
200	141	165	[Note (1)]
250	134	160	[Note (1)]
300	129	155	[Note (1)]
325	127	153	[Note (1)]
350	125	152	[Note (1)], [Note (2)]

GENERAL NOTE: The revised criterion of 3.5 on tensile strength was used in establishing these values.

NOTES:

- (1) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed  $66\frac{2}{3}\%$ , but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.
- (2) These values are provided for interpolation purposes only. The maximum use temperature is 350°C.

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Approval Date: November 29, 2004

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2446**  
**Pilot-Operated Pressure Relief Valves for PG-67.2.6**  
**Applications**  
**Section I**

*Inquiry:* Under what conditions may a pilot-operated pressure relief valve be used to satisfy the requirements of PG-67.2.6?

*Reply:* It is the opinion of the Committee that a pilot-operated pressure relief valve may be used to satisfy the requirements of PG-67.2.6, provided all of the following conditions are met:

(a) all requirements of PG-67 through PG-73 inclusive, as applicable for economizer overpressure protection.

(b) the pilot-operated pressure relief valve must be self-actuated and the main valve will open automatically at not over the set pressure and will discharge its full rated capacity if some essential part of the pilot should fail.

(c) the pilot-operated pressure relief valve shall be capacity certified for steam service per PG-69.

(d) the pilot-operated pressure relief valve shall be capacity certified for water service to the test requirements of PG-69 with the following exceptions:

(1) set pressure and blowdown adjustment tests shall be performed using steam in accordance with PG-69.1.1 but the flow capacity certification tests shall be conducted on water at a temperature between 40°F and 125°F (4°C and 52°C);

(2) if the slope method of PG-69.2.2 is used, the instantaneous slope of each test point shall be calculated and averaged, where slope is defined as the measured capacity divided by the square root of the difference between the flow rating pressure and the valve discharge pressure. If any of the experimentally determined slopes fall outside of a range of ±5% of the average slope, the unacceptable valves shall be replaced by two valves of the same size and set pressure. Following the test of these valves, a new average slope shall be determined, excluding the replaced valve test results. If any individual slope is now outside of the ±5% range, then the tests shall be considered unsatisfactory and shall be cause for the ASME designated organization to refuse certification of the particular valve design. The certified capacity shall be 90% of

the average slope multiplied by the square root of the difference between the flow rating pressure and the valve discharge pressure;

(3) if the coefficient of discharge method of PG-69.2.3 is used, the theoretical flow rate for water shall be calculated as:

(-a) for 45 deg seat

(U.S. Customary Units)

$$W_T = 2,407\pi DL(0.707)\sqrt{(P - P_d)w}$$

(SI Units)

$$W_T = 5.092\pi DL(0.707)\sqrt{(P - P_d)w}$$

(-b) for flat seat

(U.S. Customary Units)

$$W_T = 2,407A\sqrt{(P - P_d)w}$$

(SI Units)

$$W_T = 5.092A\sqrt{(P - P_d)w}$$

where

$A$  = nozzle throat area, in.<sup>2</sup> (mm<sup>2</sup>)

$D$  = seat diameter, in. (mm)

$L$  = lift at pressure,  $P$ , in. (mm)

$P$  = (1.03 × set pressure + 14.7), psia or

= (set pressure + 2 + 14.7), psia, whichever is greater

$P$  = (1.03 × set pressure + 0.101), MPa, or

= (set pressure + 0.015 + 0.101), MPa, whichever is greater

$P_d$  = pressure at discharge of the valve, psia (MPa)

$w$  = specific weight of water at inlet conditions, lb/ft<sup>3</sup> (kg/m<sup>3</sup>)

$W_T$  = theoretical flow, lb/hr (kg/hr)

To convert lb/hr of water to gal/min of water multiply the capacity in lb/hr by  $\frac{1}{500}$ . To convert kg/hr of water to liter/min of water multiply the capacity in liter/min by  $\frac{1}{60}$ .

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

(e) for overpressure conditions where the fluid is water, the discharge capacity of the pilot valve(s) shall be sufficient to prevent the pressure from rising more than the requirements of PG-67.2;

(f) the nameplate shall be marked in accordance with PG-110. The set pressure shall be based on steam tests. In addition to the steam capacity in lb/hr (kg/hr), the nameplate shall be marked with water capacity in gal/min (L/min) at 70°F (20°C);

(g) the pilot sensing line shall be adequately protected from freezing;

(h) this Case number shall be on a plate permanently attached to the valve.

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Approval Date: May 4, 2004

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2450**  
**Use of UNS S38815 Stainless Steel to 800°F (427°C)**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions is it permissible in welded construction conforming to the rules of Section VIII, Division 1, to use UNS S38815 wrought austenitic stainless steel conforming to the composition requirements of [Table 1](#) and the mechanical property requirements of [Table 2](#), and otherwise conforming to the requirements of SA-213, SA-240, SA-249, SA-312, SA-403, and SA-479 as applicable?

*Reply:* It is the opinion of the Committee that S38815 materials described may be used in Section VIII, Division 1 construction, provided the following requirements are met:

(a) The rules in Section VIII, Division 1, Part UHA, for austenitic stainless steel shall apply, except the exemptions of UHA-51(d) do not apply.

(b) The design temperature shall not exceed 800°F (427°C).

(c) The maximum allowable design stress values shall be those listed in [Tables 3](#) and [3M](#). For welded pipe and tube joints, a joint efficiency factor of 0.85 shall be used.

(d) For external pressure design, use Fig. HA-2 of Section II, Part D.

(e) Separate welding procedure and performance qualifications shall be performed in accordance with Section IX.

(f) This Case number shall be included in the material identification and on the Manufacturer's Data Report.

## NONMANDATORY APPENDIX

The use of filler metal that will deposit metal within the composition limits of the base metal is recommended when maximum corrosion resistance is needed.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Chemical Requirements**

Element	Composition, %
Carbon, max.	0.04
Manganese, max.	2.00
Phosphorus, max.	0.040
Sulfur, max.	0.020
Silicon	5.5–6.5
Chromium	13.0–15.0
Nickel	15.0–17.0
Molybdenum	0.75–1.50
Copper	0.75–1.50
Aluminum, max.	0.30

**Table 2**  
**Mechanical Property Requirements**

Tensile strength, min.	78.0 ksi (540 MPa)
Yield strength, 0.2% offset, min.	37.0 ksi (255 MPa)
Elongation in 2-in. gage, min., %	30

**Table 3**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Allowable Stress Values, Max., ksi [Note (1)]	
100	22.3	22.3
200	20.7	22.3 [Note (2)]
300	18.5	22.2 [Note (2)]
400	17.0	21.5 [Note (2)]
500	16.2	21.0 [Note (2)]
600	16.0	20.7 [Note (2)]
650	16.0	20.6 [Note (2)]
700	16.0	20.6 [Note (2)]
750	16.0	20.6 [Note (2)]
800	16.0	20.6 [Note (2)]

## NOTES:

- (1) The revised criteria of 3.5 on tensile strength was used in establishing these values.
- (2) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed 66<sup>2</sup>/<sub>3</sub>%, but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.

**Table 3M**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Allowable Stress Values, Max., MPa [Note (1)]	
40	154	154
65	153	154 [Note (2)]
100	141	154 [Note (2)]
150	127	153 [Note (2)]
200	118	148 [Note (2)]
250	113	145 [Note (2)]
300	110	143 [Note (2)]
325	110	143 [Note (2)]
350	110	142 [Note (2)]
375	110	142 [Note (2)]
400	110	142 [Note (2)]
425	110	142 [Note (2)]
450 [Note (3)]	110	142 [Note (2)]

## NOTES:

- (1) The revised criteria of 3.5 on tensile strength was used in establishing these values.
- (2) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed 66<sup>2</sup>/<sub>3</sub>%, but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.
- (3) The value at 450°C is for interpolation only. The maximum use temperature is 427°C (800°F).

Approval Date: August 4, 2006

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2451-1**  
**Steel Plates Produced by Thermomechanical Control**  
**Process (TMCP)**  
**Section VIII, Division 3**

*Inquiry:* Is it permissible to use steel plates produced by the thermomechanical control process (TMCP) with chemical analysis shown in Table 1, the mechanical properties shown in Table 2, and otherwise conforming to SA-841, in construction of welded pressure vessels conforming to the rules of Section VIII, Division 3?

*Reply:* It is the opinion of the Committee that steel plates produced by TMCP with chemical analysis shown in Table 1, the mechanical properties shown in Table 2, and otherwise conforming to SA-841, may be used in the construction of welded pressure vessels conforming to the rules of Section VIII, Division 3, provided the following additional requirements are met:

(a) The thickness of the material designated as Class 6 shall not exceed 1.25 in. (32 mm). The thickness of the material designated as Class 7 shall not exceed 1 in. (25 mm).

(b) The yield strength values,  $S_y$ , shall be those shown in Table 3.

(c) For external pressure design, the requirements of Section VIII, Division 3, KD-222 shall apply.

(d) Transverse Charpy V-notch impact tests are required and shall meet the requirements of Table KM-234.2(a).

(e) Except for cutting and welding, heating of the material above 1200°F (650°C) during fabrication is not permitted.

(f) For the purpose of postweld heat treatment and radiography, the material shall be considered as P-No. 1. If postweld heat treatment is performed, the maximum postweld heat treatment temperature shall not exceed 1200°F (650°C).

(g) Separate welding procedures and performance qualifications shall be conducted in accordance with Section IX.

(h) Welding by electroslag or electrogas process is not permitted.

(i) Materials certification shall be in accordance with KM-101 of Section VIII, Division 3.

(j) This Case number shall be marked on the material, shown and documented on the material test report, and shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1  
Chemical Composition**

Element	Composition, Classes 6 and 7
Carbon, max.	0.10 [Note (1)]
Manganese	1.10–1.70 [Note (1)]
Phosphorus, max.	0.020
Sulfur, max.	0.008
Silicon	0.10–0.45
Copper, max.	0.40
Nickel	0.85 max.
Chromium, max.	0.30
Molybdenum, max.	0.50
Columbium, max.	0.10 [Note (2)]
Vanadium, max.	0.09 [Note (2)]
Titanium	[Note (2)],[Note (3)]
Boron	0.0007 max.
Aluminum, min.	0.020 total or 0.015 acid soluble [Note (3)]

NOTES:

- (1) For each reduction of 0.01 percentage point below the specified maximum for carbon, an increase of 0.06 percentage points above the specified maximum for manganese is permitted, up to a maximum of 1.85%.
- (2) The sum of columbium, vanadium, and titanium contents shall not exceed 0.15% by heat analysis.
- (3) By agreement, the steel may be produced with titanium, in which case the minimum aluminum content shall not apply. When this option is exercised, the titanium content, by heat analysis, shall be 0.006% to 0.03%, and the actual titanium content shall be reported on the test report.

**Table 2  
Tensile Requirements**

	Class 6	Class 7
Yield strength, min., ksi (MPa)	70 (485)	75 (515)
Tensile strength, ksi (MPa)	82–102 (565–705)	86–106 (590–730)
Elongation in 2 in. (50 mm), min., % [Note (1)]	20	19
Elongation in 8 in. (200 mm), min., % [Note (1)]	16	15

NOTE:

- (1) See Specification SA-20/SA-20M for elongation requirement adjustment.

**Table 3  
Values of Yield Strength**

Specification, Grade, Class, Thickness	Yield Strength, ksi (MPa), for Metal Temperature Not Exceeding, °F (°C)	
	100 °F (38°C)	150°F (65°C)
<b>Class 6</b>		
$t \leq 1\frac{1}{4}$ in. (32 mm)	70 (483)	65 (448)
<b>Class 7</b>		
$t \leq 1$ in. (25 mm)	75 (517)	70 (483)

Approval Date: January 22, 2007

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2458-3**  
**Austenitic Fe-27Ni-22Cr-7Mo-Mn-Cu-N Alloy (UNS S31277)**  
**Section I; Section VIII, Division 1**

*Inquiry:* May annealed austenitic Fe-27Ni-22Cr-7Mo-Mn-Cu-N Alloy (UNS S31277) wrought sheet, strip, plate, rod and bar, flanges and fittings, and seamless and welded pipe and tubing with chemical analysis shown in [Table 1](#) and minimum mechanical properties shown in [Table 2](#) and otherwise conforming to one of the specifications shown in [Table 3](#), be used in welded construction under the rules of Section I for water wetted and steam service?

*Reply:* It is the opinion of the Committee that material described in the inquiry may be used in Section I construction at a design temperature of 800°F (427°C) or less, provided the following additional requirements are met:

(a) The maximum allowable stress values for material shall be those given in [Tables 4](#) and [4M](#). The maximum design temperature shall be 800°F (427°C). For welded pipe and tube products, a joint efficiency factor of 0.85 shall be used.

(b) The material shall be considered as P-No. 45.

(c) Heat treatment during or after fabrication is neither required nor prohibited.

(d) For external pressure design, use [Figures 1](#) and [1M](#) and [Tables 5](#) and [5M](#).

(e) This Case number shall be shown on the documentation and marking of the material and recorded in the Manufacturer's Data Report.

**CAUTION:** Austenitic alloys are subject to stress corrosion cracking, intergranular attack, pitting, and crevice corrosion when used in boiler applications in aqueous environments. Factors that affect the susceptibility of these materials are applied or residual stress, water chemistry and deposition of solids, and material condition. Susceptibility to attack is enhanced when the material is used in a sensitized condition, or with residual cold work. Concentration of corrosive agents (e.g., chlorides, caustic, or reduced sulfur species) can occur under deposits formed on the surface of these materials, and can result in severe underdeposit wastage or cracking. For successful operation in water environments, careful attention must be paid to continuous control of water chemistry.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Chemical Composition**

Element	Composition, %
Carbon, max.	0.020
Manganese, max.	3.00
Phosphorus, max.	0.030
Sulfur, max.	0.010
Silicon, max.	0.50
Nickel	26.0–28.0
Chromium	20.5–23.0
Molybdenum	6.5–8.0
Copper	0.50–1.50
Nitrogen	0.30–0.40
Iron [Note (1)]	Balance

NOTE:

(1) This element shall be determined arithmetically by difference.

**Table 2**  
**Mechanical Property Requirements (All Product Forms)**

Tensile strength, min.	112 ksi (770 MPa)
Yield strength, 0.2% offset, min.	52 ksi (360 MPa)
Elongation in 2 in. or 4D, min.	40%

**Table 3**  
**Product Specifications**

Flanges and fittings	SA-182
Plate, sheet, and strip	SA-240
Rod and bar	SA-479
Seamless and welded pipe	SA-312
Seamless tubing	SA-213
Welded tubing	SA-249

**Table 4**  
**Maximum Allowable Stress Values**

For Metal			
Temperature Not Exceeding, °F	Allowable Stress Values, Max., ksi		
	100	32.0	32.0
150	32.0	32.0	...
200	32.0	32.0	...
250	30.4	31.5	[Note (1)]
300	28.8	30.7	[Note (1)]
350	27.5	30.0	[Note (1)]
400	26.5	29.4	[Note (1)]
450	25.9	28.4	[Note (1)]
500	25.5	28.4	[Note (1)]
550	25.4	27.9	[Note (1)]
600	25.4	27.5	[Note (1)]
650	25.4	27.1	[Note (1)]
700	25.3	26.8	[Note (1)]
750	25.1	26.5	[Note (1)]
800	24.9	26.3	[Note (1)]

GENERAL NOTE: The revised criteria of 3.5 on tensile strength was used in establishing these values.

NOTE:

(1) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed 66<sup>2</sup>/<sub>3</sub>%, but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.

**Table 4M**  
**Maximum Allowable Stress Values**

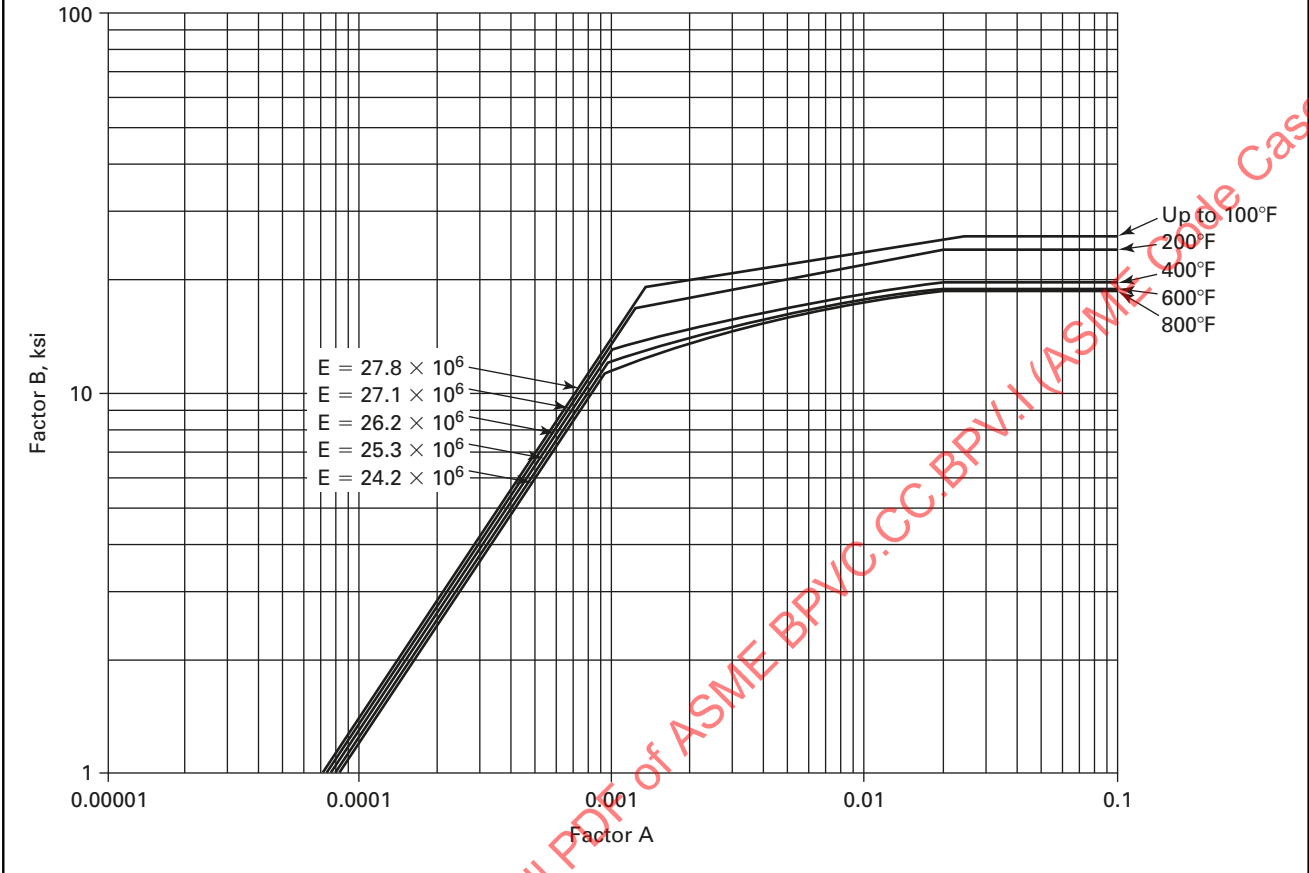
For Metal			
Temperature Not Exceeding, °C	Allowable Stress Values, Max., MPa		
	40	220	220
65	220	220	...
100	218	220	[Note (1)]
150	198	212	[Note (1)]
200	184	203	[Note (1)]
250	177	197	[Note (1)]
300	175	191	[Note (1)]
325	175	189	[Note (1)]
350	175	186	[Note (1)]
375	175	185	[Note (1)]
400	173	183	[Note (1)]
425	172	181	[Note (1)]
450	172	182	[Note (1)], [Note (2)]

GENERAL NOTE: The revised criteria of 3.5 on tensile strength was used in establishing these values.

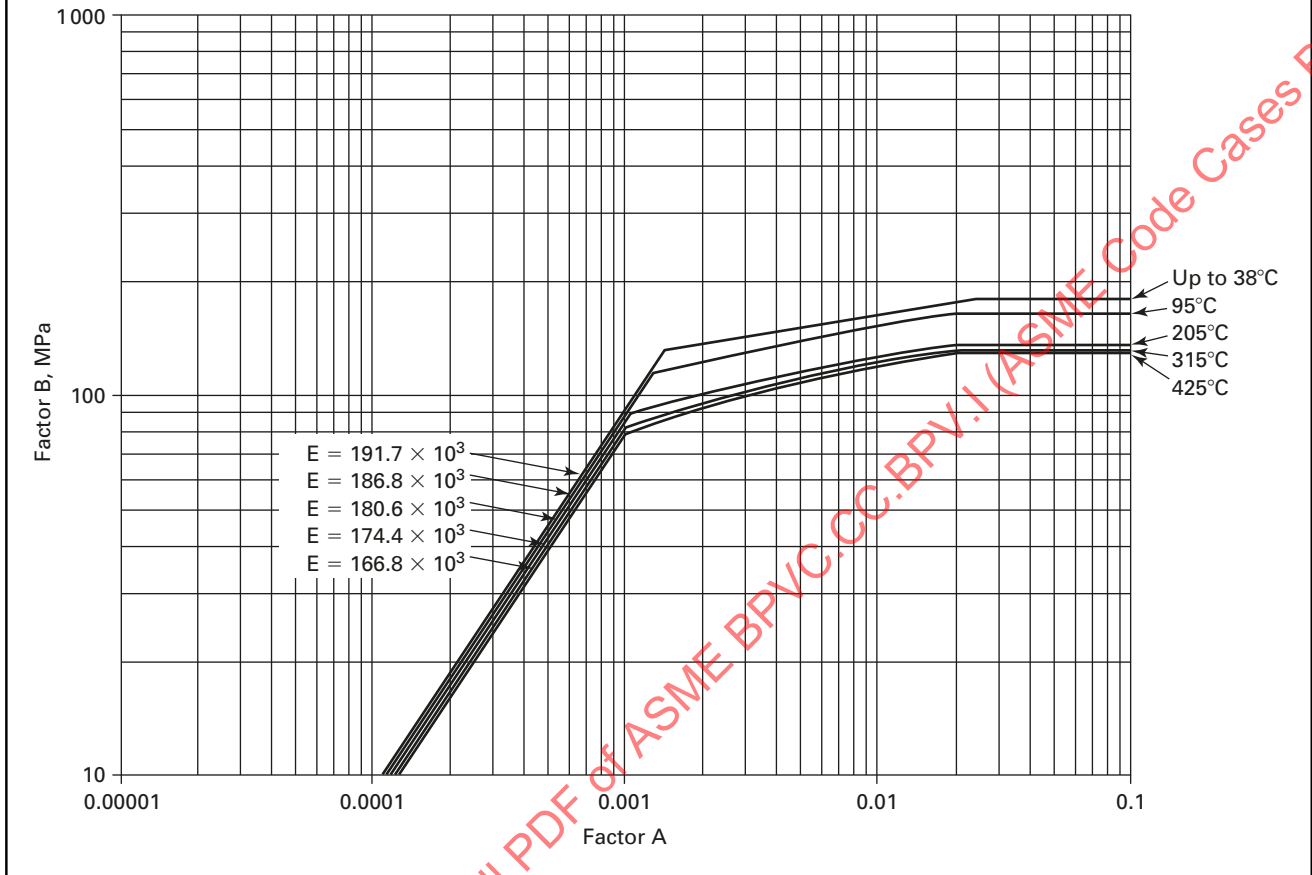
NOTES:

- (1) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed  $66\frac{2}{3}\%$ , but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.
- (2) The maximum use temperature is 427°C, the value listed at 450°C is provided for interpolation purposes only.

**Figure 1**  
**Chart for Determining Shell Thickness of Components under External Pressure When Constructed of Alloy UNS S31277**



**Figure 1M**  
**Chart for Determining Shell Thickness of Components under External Pressure When Constructed of Alloy UNS S31277**



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**Table 5  
Tabular Values for UNS S31277**

Temp., °F	A	B, ksi	Temp., °F	A	B, ksi	
Up to 100	1.00 -05	0.139	400	8.90 -03	18.0	
	7.21	1.0		2.10 -02	19.8	
	1.37 -03	19.0	1.00 -01	19.8		
	2.00	20.0	600	1.00 -05	0.126	
	5.00	22.0		7.92	1.0	
	1.10 -02	24.0		9.50 -04	12.0	
	2.40	26.0		2.00 -03	14.0	
	1.00 -01	26.0	4.50	16.0		
	200	1.00 -05	0.136	800	1.20 -02	18.0
		7.38	1.0		2.10	19.0
1.22 -03		16.6	1.00 -01	19.0		
2.10		18.0	1.00 -05	0.121		
4.70		20.0	8.27	1.0		
2.10 -02		24.1	9.27 -04	11.3		
1.00 -01		24.1	1.70 -03	13.0		
400		1.00 -05	0.131	3.50	15.0	
		7.63	1.0	8.50	17.0	
		9.92 -04	13.0	2.00 -02	18.7	
	2.20 -03	15.0	1.00 -01	18.7		
	5.50	17.0				

**Table 5M  
Tabular Values for UNS S31277**

Temp., °C	A	B, MPa	Temp., °C	A	B, MPa	
Up to 38	1.00 -05	0.958	205	8.90 -03	124.1	
	1.04 -04	10.0		2.10 -02	136.5	
	1.37 -03	131.0	1.00 -01	136.5		
	2.00	137.9	315	1.00 -05	0.869	
	5.00	151.7		1.15 -04	10.0	
	1.10 -02	165.5		9.50	82.7	
	2.40	179.3		2.00 -03	96.5	
	1.00 -01	179.3	4.50	110.3		
	95	1.00 -05	0.938	425	1.20 -02	124.1
		1.07 -04	10.0		2.10	131.0
1.22 -03		114.5	1.00 -01	131.0		
2.10		124.1	1.00 -05	0.834		
4.70		137.9	1.20 -04	10.0		
2.10 -02		166.2	9.27	77.6		
1.00 -01		166.2	1.70 -03	89.6		
205		1.00 -05	0.903	3.50	103.4	
		1.11 -04	10.0	8.50	117.2	
		9.92	89.6	2.00 -02	128.9	
	2.20 -03	103.4	1.00 -01	128.9		
	5.50	117.2				

Approval Date: September 12, 2017

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2461-2**  
**Use of Chromium-Silicon Alloy Steel Wire for Pressure**  
**Vessel Winding**  
**Section VIII, Division 3**

*Inquiry:* May a flat hardened and tempered chromium-silicon alloy steel wire be used for winding of Section VIII, Division 3 pressure vessels constructed to the requirements of KD-9 and KF-9?

*Reply:* It is the opinion of the Committee that flat hardened and tempered chromium-silicon alloy steel wire may be used for winding of Section VIII, Division 3 pressure vessels, provided the wire conforms to SA-905 with the following exceptions:

*(a) Materials and Manufacture*

(1) The steel may be made by any commercially accepted steel making process. The steel shall be continuously cast.

(2) The finished wire shall be free from detrimental pipe and undue segregation.

*(b) Chemical Analysis*

(1) The steel shall conform to the requirements for chemical composition specified in [Table 1](#).

(2) *Heat Analysis.* Each heat of steel shall be analyzed by the manufacturer to determine the percentage of elements prescribed in [Table 1](#). This analysis shall be made from a test specimen preferably taken during the pouring of the heat. When requested, this shall be reported to the purchaser and shall conform to the requirements of [Table 1](#).

(3) *Product Analysis.* An analysis may be made by the purchaser from finished wire representing each heat of steel. The average of all the separate determinations made shall be within the limits specified in the analysis column. Individual determinations may vary to the extent shown in the product analysis tolerance column, except that several determinations of a single element in any one heat shall not vary both above and below the specified range.

(4) For reference purposes, A751, Test Methods, Practices, and Terminology, shall be used.

*(c) Metallurgical Requirements*

*(1) Decarburization*

*(-a)* Transverse sections of the wire properly mounted, polished, and etched shall show no completely decarburized (carbon-free) areas when examined using 100× magnification. Partial decarburization shall not exceed a depth of 0.001 in. (0.025 mm).

*(-b) Number of Tests.* One test specimen shall be taken for each of five coils, or fraction thereof, in a lot.

*(-c) Location of Tests.* Test specimens may be taken from either end of the coil.

*(2) Inclusion Content*

*(-a)* The inclusion content of the wire rod in the worst case shall not exceed the limits shown in [Table 2](#) as described in Test Method E45, Plate I-r, Method D, except that alternate methodologies are acceptable upon agreement between the purchaser and supplier, provided minimum requirements are not lower than those of Test Method E45, Method D.

*(-b)* If any coil exceeds the limits in [Table 2](#), all coils in the lot will be inspected. Each coil that fails to meet the requirements will be rejected.

*(-c) Number of Tests.* One test specimen shall be taken for each group of 10 coils, or fraction thereof, in the lot.

*(-d) Location of Tests.* Test specimens may be taken from either end of the coil.

*(-e) Test Method.* Examination shall be made in accordance with Test Method E45.

*(d)* Final heat treatment shall consist of austenitizing, quenching, and tempering to achieve the required mechanical properties.

*(e)* Mechanical properties shall meet the properties given in [Table 3](#).

*(f)* The nondestructive examination according to Supplementary Requirement S1 of SA-905 is mandatory.

*(g)* Yield strength values provided in [Tables 4](#) and [4M](#) shall be used for design.

*(h)* The design temperature shall not exceed 300°F (150°C). The designer is cautioned that stress relaxation might occur at design conditions permitted by this Code Case.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

(i) This Case number shall be shown on the marking and certification of the material and on the Manufacturer's Data Report.

**Table 1**  
**Chemical Requirements**

Element	Heat Analysis, %	Product Analysis
		Tolerance, %
Carbon	0.51-0.59	±0.02
Manganese	0.50-0.80	±0.03
Phosphorus	0.025 max.	±0.005
Sulfur	0.025 max.	±0.005
Silicon	1.20-1.60	±0.05
Chromium	0.60-0.80	±0.03

**Table 2**  
**Maximum Inclusion Content**

Zone	Inclusion Type							
	A		B		C		D	
	Thin	Heavy	Thin	Heavy	Thin	Heavy	Thin	Heavy
Surface	1	1	1	1/2	1	1	1	1/2
Core	2	1 1/2	2	1	2	1 1/2	2	1

NOTE:

(1) The *surface zone* is from the wire surface to  $\frac{1}{3}$  radius deep. The *core* is the balance.

**Table 3**  
**Tensile Requirements**

Thickness, in. (mm)	Tensile Strength min., ksi (MPa)	Yield Strength min., ksi (MPa)	Elongation min., %
0.04-0.06 (1.0-1.5)	297 (2 050)	261 (1 800)	4.0

**Table 4**  
**Design Data for Yield Strength**

Thickness, in.	Yield Strength, ksi for Metal Temperature Not Exceeding		
	100°F	200°F	300°F
0.04-0.06	261	254	230

**Table 4M**  
**Design Data for Yield Strength**

Thickness, mm	Yield Strength, MPa for Metal Temperature Not Exceeding				
	40°C	65°C	100°C	125°C	150°C
1.0-1.5	1 800	1 800	1 740	1 670	1 580

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Approval Date: September 8, 2010

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**Case 2463-1**  
**Welding of Tubes to Tubesheets by Deformation**  
**Resistance Welding (DRW) Process**  
**Section VIII, Division 1**

*Inquiry:* Deformation Resistance Welding (DRW) is a resistance welding process in which coalescence of mating components is accomplished by heating them together in a resistance weld machine and facilitating their relative movement at the weld interface, while deforming them. The resulting joint is primarily a solid-state weld while some melting and solidification of the mating parts may also occur. May the DRW process be used to weld tubes to tubesheets for Section VIII, Division 1 construction if impact testing of the tube-to-tubesheet joint is not required?

*Reply:*

(a) It is the opinion of the Committee that it is permissible to use the DRW process to weld tubes to tubesheets for Section VIII, Division 1 construction, if impact testing of the tube-to-tubesheet joint is not required, provided the following requirements are met.

(b) This Case number shall be shown on the Manufacturer's Data Report.

**1 TEST AND EXAMINATIONS****1.1 WELD SAMPLE**

A demonstration qualification mockup assembly, consisting of ten mockup welds, shall be prepared and examined in accordance with Section IX, QW-193.1.

**1.2 WELDING**

Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs) shall address the requirements specified in 2.1. The requirements of Section IX, QW-288, as well as the additional requirements specified in 2.1 shall apply. The original Welder/Welding Operator Performance Qualifications shall be performed in accordance with QW-303.5, with the renewal being performed per 2.2.

**1.3 SHEAR LOAD TEST**

The tensile strength of the weld shall be at least equal to the tube strength as verified by shear load testing tensile test specimens in accordance with para. A-3, Shear Load Test, of Section VIII, Division 1, Appendix A.

**2 WELD SAMPLE****2.1 ESSENTIAL VARIABLES**

In addition to the applicable requirements in Section IX, QW-288, the following essential variables shall apply for the WPS and PQR:

(a) a change in the method of preparing the base metal prior to welding (e.g., changing from mechanical cleaning to chemical or to abrasive cleaning or vice versa)

(b) a change in the specified tube fold diameter by more than  $0.25t$  from the nominal value, when tubes are pre-folded prior to welding (see Figure 1)

(c) a change of more than 15% in the extension of the tube above the surface of the tubesheet when tubes are not pre-folded prior to welding (see Figure 1)

(d) a change in the tubesheet counterbore diameter by more than 3% (see Figure 1)

(e) a change in the tubesheet counterbore depth by more than 5% (see Figure 1)

(f) an increase in tubesheet thickness by more than 20%

(g) change from one RWMA (Resistance Welding Manufacturer's Association) class electrode material to another

(h) a change of more than 5% in the electrode pressure, weld current, or the weld time from those qualified

(i) a change of more than 5% in the pulse width from that qualified

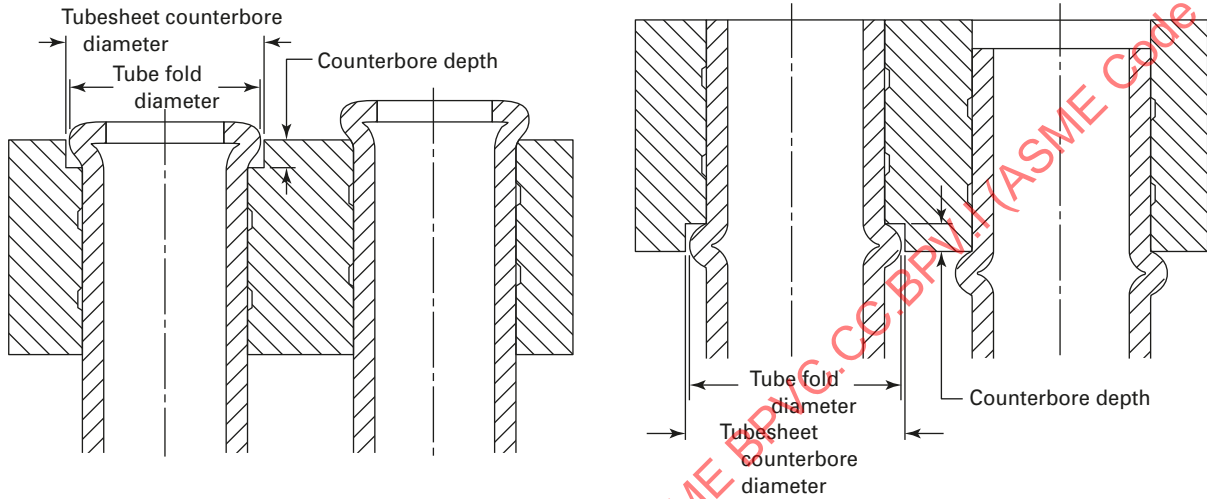
(j) any change in the number of weld pulses from that qualified

(k) a change in cool time between pulses by more than 5%

(l) addition or deletion of upslope or downslope current control or a change of more than 10% in the slope current time or amplitude

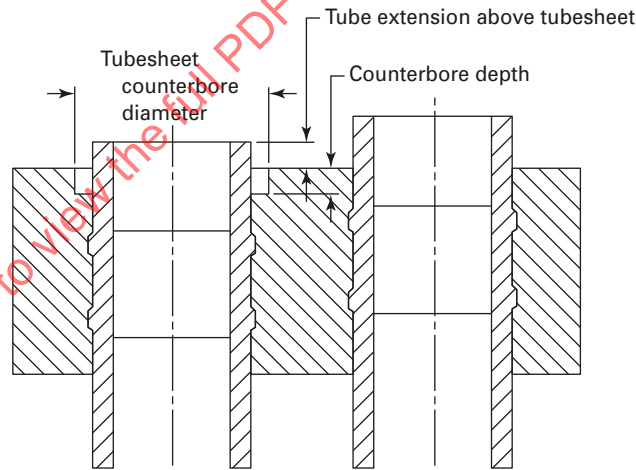
The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Figure 1**  
**Typical Tube-to-Tubesheet Configurations Prior to Welding**



**(a) DRW Welding on Front Side of Tubesheet**  
**With or Without Tubesheet Counterbore**

**(b) DRW Welding on Rear Side of Tubesheet**  
**With or Without Counterbore**



**(c) DRW Welding on Front Side of Tubesheet**  
**With or Without Tubesheet Counterbore**

GENERAL NOTE: These figures show the configuration prior to welding.

## 2.2 RENEWAL OF WELDING OPERATOR PERFORMANCE QUALIFICATIONS

Only the mockup weld per the tests in para. 1 is required to renew a welding operator's performance qualification per the requirements of Section IX, QW-322.1.

## 3 PRODUCTION TEST MONITORING

### 3.1 GENERAL

Production test monitoring is required to ensure the quality and repeatability of the DRW process. If there is a change in the WPS, welding machine, or operator, a new production test shall be performed.

(a) Either one push-out test or one metallographic test shall be performed at the beginning and end of each shift.

(b) Production welds made during a shift shall be considered acceptable if the tests at the beginning and end of the shift pass.

### 3.2 PUSH-OUT TEST

The push-out tests shall be performed as follows on test coupons containing at least one tube:

(a) Cut the tube flush with the surface of the coupon opposite the weld.

(b) Apply a uniform load to the cut surface of the tube using suitable equipment and any required jigs and fixtures to hold the test coupon. The load shall be at least 1.5 times the strength of the tube (specified minimum tensile strength divided by the nominal cross-sectional area of the tube).

(c) The test is acceptable provided the tube is not expelled from the test assembly.

### 3.3 METALLOGRAPHIC TEST

The metallographic tests shall be performed as follows on test coupons containing at least one tube:

(a) Make a cut on the tube-to-tubesheet coupon along the length of the tube at its centerline.

(b) Grind or polish one of the two sections to reveal two weld interfaces approximately 180 deg apart.

(c) Etch the weld section with a suitable etchant to reveal the bond length.

(d) Visually examine the test coupon at a minimum of 10 × magnification to verify there is complete bonding for a distance at least equal to the minimum required bond length.

### 3.4 REJECTION CRITERIA AND CORRECTIVE ACTION

(a) If the production test fails at the beginning of a shift, a new production test shall be performed. Production welding shall not commence until a successful production test is achieved.

(b) If the production test fails at the end of a shift, all the welds made during the shift shall be rejected. All rejected tube welds shall be repaired using an arc welding procedure qualified in accordance with Section IX.

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Approval Date: September 30, 2018

(19)

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**Case 2468-2**  
**Use of Nickel-Chromium-Molybdenum-Columbium**  
**Alloy UNS N06625 for Class 2**  
**Section VIII, Division 2**

*Inquiry:* Under what conditions may UNS N06625 SB-443, Grade 1 (annealed) plate, sheet, and strip, SB-444 Grade 1 (annealed) pipe and tube, SB-446 Grade 1 (annealed) rod and bar, and SB-564 be used in Section VIII, Division 2, Class 2?

*Reply:* It is the opinion of the Committee that UNS N06625 SB-443 Grade 1 (annealed) plate, sheet, and strip, SB-444 Grade 1 (annealed) pipe and tube, SB-446 Grade 1 (annealed) rod and bar, and SB-564 may be used for welded construction in Section VIII, Division 2, Class 2, provided the following additional requirements are met:

(a) The allowable stress values,  $S$ , shall be those listed in **Tables 1** and **1M**. The maximum use temperature is 800°F (427°C).

(b) For external pressure design, the requirements of Fig. NFN-17 of Section II, Part D shall apply.

(c) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Allowable Stress Values, S**

For Metal Temperatures Not Exceeding °F	Allowable Stress Values for SB-443 Gr. 1 Annealed Material, ksi	Allowable Stress Values for SB-444 Gr. 1 Annealed Material, ksi	Allowable Stress Values for SB-446 Gr. 1 Annealed and SB-564 Material Up to 4 in. incl., ksi	Allowable Stress Values for SB-446 Gr. 1 Annealed and SB-564 Material Over 4 in. to 10 in. incl., ksi
100	36.7	40.0	40.0	33.3
200	35.3	38.5	38.5	32.1
300	34.3	37.4	37.4	31.2
400	33.3	36.3	36.3	30.3
500	32.4	35.3	35.3	29.4
600	31.5	34.4	34.4	28.6
650	31.1	33.9	33.9	28.3
700	30.7	33.5	33.5	27.9
750	30.4	33.2	33.2	27.6
800	30.1	32.9	32.9	27.4

**Table 1M**  
**Allowable Stress Values, S**

For Metal Temperatures Not Exceeding °C	Allowable Stress Values for SB-443 Gr. 1 Annealed Material, MPa	Allowable Stress Values for SB-444 Gr. 1 Annealed Material, MPa	Allowable Stress Values for SB-446 Gr. 1 Annealed and SB-564 Material Up to 100 mm incl., MPa	Allowable Stress Values for SB-446 Gr. 1 Annealed and SB-564 Material Over 100mm to 250mm incl., MPa
40	253	276	276	230
65	247	270	270	225
100	243	265	265	221
125	239	261	261	218
150	236	258	258	215
175	233	254	254	212
200	230	251	251	209
225	227	248	248	206
250	224	245	245	204
275	221	242	242	201
300	219	239	239	199
325	216	236	236	197
350	214	233	233	194
375	212	231	231	192
400	210	229	229	191
425	208	227	227	189
450 [Note 1]	206	225	225	187

NOTE:

(1) This value is for interpolation purposes only. The maximum design temperature is 427°C.

Approval Date: October 21, 2009

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2469-1**  
**Pneumatic Testing**  
**Section IV**

*Inquiry:* Under what conditions may heating boilers manufactured and stamped in accordance with Section IV be tested pneumatically in lieu of the hydrostatic test required in HG-510(c)?

*Reply:* It is the opinion of the Committee that pneumatic testing may be substituted for the hydrostatic test required in HG-510(c), provided the following requirements are met:

(a) The water volume of the boiler shall be less than 70 gals (265 L).

(b) Maximum material thickness of any component part shall not exceed  $\frac{1}{2}$  in. (12.7 mm). No components of the pressure vessel that will be subject to pneumatic testing may be constructed of cast iron.

(c) The MAWP shall not be greater than 160 psi (1 100 kPa).

(d) The boiler shall be externally cleaned to prevent air bubble adherence while being tested to prevent leaks from being masked.

(e) The pneumatic test shall be conducted with the boiler submerged in water. Minimum water temperature shall be 60°F (16°C). The upper most portion of the boiler, as oriented in the test tank, shall be a minimum of 6 in. (150 mm) below the surface of the water.

(f) The required test pressure shall be greater of 38 psi (262 kPa) or  $1\frac{1}{4}$  times the MAWP.

(g) The pressure in the boiler shall be gradually increased to not more than one-half of the required test pressure. Thereafter, the pressure shall be increased in steps of approximately one-tenth of the required test pressure until the required test pressure has been reached.

(h) A hold time of 5 min shall be maintained on the boiler at the required test pressure. Thorough visual inspection is not required during this stage. The pressure shall then be reduced to its maximum MAWP and maintained at this pressure while a thorough visual inspection for leakage is made with the boiler submerged under water.

(i) The boiler shall meet all other requirements of Section IV.

(j) This Code Case number shall be shown on the Manufacturer's Data Report.

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Approval Date: December 18, 2018

(19)

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**Case 2473-2**  
**F-Number Grouping for Cr-Fe-Ni-Mo-Cu, Classification**  
**UNS R20033 Filler Metal**  
**Section I; Section VIII, Division 1; Section VIII, Division 2;**  
**Section VIII, Division 3; Section IX**

*Inquiry:* What alternate rules may be applied to grouping UNS R20033 Cr-Fe-Ni-Mo-Cu welding filler metal meeting the chemical requirements of [Table 1](#), but otherwise conforming to AWS A5.9 to reduce the number of welding procedures and performance qualifications?

*Reply:* It is the opinion of the Committee that UNS R20033 Cr-Fe-Ni-Mo-Cu welding filler metal meeting the requirements of [Table 1](#), but otherwise conforming to AWS A5.9 may be considered as F-No. 45 for both procedure and performance qualification purposes. Further, this material shall be identified as UNS R20033 in the Welding Procedure Specification, Procedure Qualification Record, and Performance Qualification Records.

This Case number shall be shown in the Manufacturer's Data Report.

**Table 1**  
**Chemical Requirements (UNS R20033)**

Element	Composition, %
Carbon, max.	0.015
Chromium	31.0-35.0
Nickel	30.0-33.0
Molybdenum	0.050-2.0
Manganese, max.	2.0
Silicon, max.	0.50
Phosphorus, max.	0.02
Sulfur, max.	0.01
Nitrogen	0.35-0.60
Copper	0.30-1.2
Iron	Balance
Other Elements	0.5 max.

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Approval Date: November 29, 2004

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2475**  
**18Cr-9Ni-2.5W-V-Cb Austenitic Seamless Tube Steel**  
**Section I**

*Inquiry:* May solution-treated 18Cr-9Ni-2.5W-V-Cb austenitic stainless seamless tube steel with chemical analysis shown in [Table 1](#), the mechanical properties shown in [Table 2](#), and that otherwise conform to applicable requirements in specification SA-213 be used for steam service in Section I construction?

*Reply:* It is the opinion of the Committee that the material listed in the Inquiry may be used for steam service in Section I construction, provided the following requirements are met:

(a) The material shall meet the chemical analysis and minimum tensile requirements described in the Inquiry and shall otherwise meet the requirements of SA-213 as applicable, except as shown in paras. (b) and (c).

(b) The minimum solution treating temperature for this material shall be 2000°F (1100°C).

(c) This material shall have a hardness not exceeding 219 HB/230 HV (95 HRB).

(d) The rules of PG-19 for TP347H shall apply for this material, except that solution treatment, when required, shall be at the minimum temperature of 2000°F (1100°C).

(e) The maximum allowable stress values for the material shall be as given in [Tables 3](#) and [3M](#). The maximum design temperature is 1427°F (775°C).

(f) Separate welding procedures and performance qualification shall be conducted for the material in accordance with Section IX.

(g) Welding processes shall be limited to GTAW and SMAW.

(h) This Case number shall be referenced in the documentation and marking of the material and recorded on the Manufacturer's Data Report.

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**Table 1  
Chemical Requirements**

Element	Composition, %
Carbon, max.	0.05
Manganese, max.	2.00
Phosphorus, max.	0.040
Sulfur, max.	0.030
Silicon, max.	1.00
Nickel	8.00–11.0
Chromium	17.0–20.0
Columbium	0.25–0.50
Nitrogen	0.10–0.25
Tungsten	1.50–2.60
Vanadium	0.20–0.50

**Table 2  
Mechanical Property Requirements**

Tensile strength, min. ksi (MPa)	90 (620)
Yield strength, min. ksi (MPa)	38 (260)
Elongation in 2 in. or 50 mm, min. %	30

**Table 3  
Maximum Allowable Stresses**

For Metal		
Temperature Not Exceeding, °F	Allowable Stress Values, ksi	Allowable Stress Values, ksi
-20 to 100	25.3	25.3
200	20.0	24.9 [Note (1)]
300	17.9	23.5 [Note (1)]
400	16.6	22.4 [Note (1)]
500	15.7	21.1 [Note (1)]
600	15.0	20.2 [Note (1)]
650	14.7	19.8 [Note (1)]
700	14.4	19.4 [Note (1)]
750	14.1	19.1 [Note (1)]
800	13.9	18.7 [Note (1)]
850	13.7	18.5 [Note (1)]
900	13.5	18.2 [Note (1)]
950	13.3	18.0 [Note (1)]
1000	13.2	17.9 [Note (1)]
1050	13.2	17.8 [Note (1)]
1100	13.2	17.8 [Note (1)]
1150	13.2	15.6 [Note (1)]
1200	11.9	11.9
1250	9.1	9.1
1300	6.9	6.9
1350	5.3	5.3
1400	4.0	4.0
1450	3.1 [Note (2)]	3.1 [Note (2)]

GENERAL NOTE: The revised criterion of 3.5 on tensile strength was used in establishing these values.

NOTES:

- (1) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed  $66\frac{2}{3}\%$ , but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.
- (2) These values are provided for interpolation purposes only.

**Table 3M**  
**Maximum Allowable Stresses**

For Metal		
Temperature Not Exceeding, °C	Allowable Stress Values, MPa	Allowable Stress Values, MPa
-30 to 40	175	175
65	149	175 [Note (1)]
100	136	170 [Note (1)]
125	129	165 [Note (1)]
150	123	162 [Note (1)]
175	118	159 [Note (1)]
200	115	155 [Note (1)]
225	112	151 [Note (1)]
250	109	147 [Note (1)]
275	107	144 [Note (1)]
300	104	141 [Note (1)]
325	103	138 [Note (1)]
350	101	136 [Note (1)]
375	98.9	134 [Note (1)]
400	97.3	131 [Note (1)]
425	95.8	129 [Note (1)]
450	94.5	128 [Note (1)]
475	93.3	126 [Note (1)]
500	92.3	125 [Note (1)]
525	91.6	124 [Note (1)]
550	91.1	123 [Note (1)]
575	90.9	123 [Note (1)]
600	90.8	123 [Note (1)]
625	90.8	103 [Note (1)]
650	80.8	80.8
675	63.3	63.3
700	49.7	49.7
725	38.9	38.9
750	30.5	30.5
775	23.9	23.9

GENERAL NOTE: The revised criterion of 3.5 on tensile strength was used in establishing these values.

NOTE:

- (1) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed  $66\frac{2}{3}\%$ , but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.

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**Case 2476  
Radiography Using Phosphor Imaging Plate  
Section V**

**ANNULLED**

Annulment Date: December 30, 2018

Reason: No longer needed.

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Approval Date: November 17, 2016

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2481-1**  
**Ni-29Cr-3.5Fe-3.3Al-1.5Nb Alloy (UNS N06693)**  
**Section VIII, Division 1**

*Inquiry:* May annealed austenitic Ni-29Cr-3.5Fe-3.3Al-1.5Nb Alloy (UNS N06693) wrought sheet, strip, plate, rod and bar, and seamless pipe and tubing with chemical analysis shown in [Table 1](#) and minimum mechanical properties shown in [Table 2](#) and otherwise conforming to one of the specifications shown in [Table 3](#) be used in welded construction under the rules of Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that material described in the Inquiry may be used in Section VIII, Division 1 construction at a design temperature of 1,200°F (649°C) or less, provided the following additional requirements are met:

(a) The maximum allowable stress values for material shall be those given in [Tables 4](#) and [4M](#). The maximum design temperature shall be 1,200°F (649°C). For welded pipe and tube products, a joint efficiency factor of 0.85 shall be used.

(b) Separate welding procedure and performance qualifications shall be conducted in accordance with Section IX.

(c) Heat treatment during or after fabrication is neither required nor prohibited. For Section VIII applications, all other requirements in Part UNF for nickel alloys shall be required.

(d) This Case number shall be shown on the documentation and marking of the material and recorded in the Manufacturer's Data Report.

**Table 1**  
**Chemical Composition**

Element	Composition, %
Carbon, max.	0.15
Manganese, max.	1.0
Sulfur, max.	0.01
Silicon, max.	0.5
Nickel [ <a href="#">Note (1)</a> ]	Balance
Chromium	27.0–31.0
Copper, max.	0.5
Iron	2.5–6.0
Aluminum	2.5–4.0
Titanium, max.	1.0
Niobium	0.5–2.5

## NOTE:

(1) This element shall be determined arithmetically by difference.

**Table 2**  
**Mechanical Property Requirements (All Product Forms)**

Tensile strength, min., ksi (MPa)	85 (586)
Yield Strength, min., ksi (MPa)	40 (276)
Elongation in 2 in., or 4D min., %	30.0

**Table 3**  
**Product Specifications**

Fittings	SB-462, SB-366
Forgings	SB-564
Plate, sheet, and strip	SB-168
Rod, bar and wire	SB-166
Seamless pipe and tube	SB-167
Welded pipe	SB-517
Welded tube	SB-516

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**Table 4**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi	Maximum Allowable Stress Values, ksi
75	24.3	24.3
100	24.3	24.3
150	24.3	24.3
200	24.3	24.3
250	24.3	24.3
300	24.3	24.3
350	24.3	24.3
400	24.3	24.3
450	24.3	24.3
500	24.2	24.3 [Note (1)]
550	24.0	24.2 [Note (1)]
600	23.8	23.9 [Note (1)]
650	23.5	23.7 [Note (1)]
700	23.4	23.4
750	23.2	23.2
800	23.0	23.0
850	23.0	23.0
900	23.0	23.0
950	23.0	23.0
1,000	23.0	23.0
1,050	17.5	17.5 [Note (2)]
1,100	12.3	12.3 [Note (2)]
1,150	8.3	8.3 [Note (2)]
1,200	5.6	5.6 [Note (2)]

## GENERAL NOTES:

- (a) The revised criterion of 3.5 on tensile strength was used in establishing these values.
- (b) The alloy in the solution-annealed condition is subject to severe loss of rupture ductility in the approximate temperature range of 1,112°F to 1,200°F.

## NOTES:

- (1) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These high stress values exceed 66<sup>2</sup>/<sub>3</sub>% but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.
- (2) These are time-dependent values.

**Table 4M**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Values, MPa	Maximum Allowable Stress Values, MPa
21	167.4	167.4
40	167.4	167.4
65	167.4	167.4
100	167.4	167.4
125	167.4	167.4
150	167.4	167.4
175	167.4	167.4
200	167.4	167.4
225	167.4	167.4
250	167.2	167.4 [Note (1)]
275	166.0	167.4 [Note (1)]
300	164.6	166.3 [Note (1)]
325	163.3	164.4 [Note (1)]
350	162.0	162.6 [Note (1)]
375	160.9	161.0 [Note (1)]
400	159.7	159.7
425	158.8	158.8
450	158.3	158.3
475	158.2	158.2
500	158.4	158.4
525	158.7	158.7
550	143.9	143.9
575	107.5	107.5
600	77.0	77.0 [Note (2)]
625	53.8	53.8 [Note (2)]
650	37.8	37.8 [Note (2)], [Note (3)]

## GENERAL NOTES:

- (a) The revised criterion of 3.5 on tensile strength was used in establishing these values.
- (b) The alloy in the solution-annealed condition is subject to severe loss of rupture ductility in the approximate temperature range of 600°C to 650°C.

## NOTES:

- (1) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These high stress values exceed 66<sup>2</sup>/<sub>3</sub>% but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.
- (2) These are time-dependent values.
- (3) The maximum use temperature is 649°C, the value listed at 650°C is provided for interpolation purposes, only.

Approval Date: September 18, 2006

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2483**  
**Use of Aluminum Alloy EN AC- $\text{AlSi7Mg}$  Sand Castings in F Temper Condition Meeting All Requirements of BS EN1706 1998**  
**Section IV**

*Inquiry:* May aluminum alloy EN AC- $\text{AlSi7Mg}$  sand castings in the F temper condition meeting the requirements of BS EN1706 1998, be used in Section IV, Part HF, construction of heating boilers?

*Reply:* It is the opinion of the Committee that aluminum alloy EN AC- $\text{AlSi7Mg}$  sand castings in the F temper condition meeting the requirements of BS EN1706 1998, may be used in Section IV, Part HF, construction of heating boilers, under the following conditions:

(a) Maximum Allowable Working Pressure shall not exceed 60 psi (413 kPa).

(b) The maximum water temperature shall be 250°F (120°C).

(c) The Castings may not be repaired.

(d) All applicable requirements of BS EN1706 1998 shall apply.

(e) The specified minimum tensile strength at room temperature shall be 20.3 ksi (140 MPa), and the maximum allowable stresses are those given in Tables 1 and 1M.

(f) The design  $P$ , psi (kPa) shall be computed by the following formula:

$$P = \frac{B}{5} \times \frac{S}{S_a \text{ or } S_m} \times \frac{S_2}{S_1}$$

where

$B$  = bursting test pressure, psi (kPa)

$S$  = specified minimum tensile strength, psi (kPa)

$S_a$  = average actual tensile strength of test specimens, psi (kPa)

$S_m$  = maximum tensile strength of range of specimens, psi (kPa)

$S_1$  = maximum allowable stress at room temperature, psi (kPa)

$S_2$  = maximum allowable stress at design temperature, psi (kPa)

(g) The foundry shall provide material certifications that are traceable to the parts delivered in accordance with HF-203.2.

(h) All other applicable parts of Section IV shall apply.

(i) This Case number shall be shown on the Manufacturer's Data Report.

**Table 1**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Max. Allowable Stress Values, ksi
-20 to 100	3.2
150	3.2
200	3.1
250	3.1
300	3.0

**Table 1M**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Max. Allowable Stress Values, MPa
-28 to 40	24.0
65	23.3
100	22.9
125	22.7
150	22.2

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Approval Date: February 22, 2005

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2489**  
**Use of SA-508 Class 1, Grades 2 and 3 Forgings**  
**Section I**

*Inquiry:* Under what conditions may SA-508 Class 1, Grades 2 and 3 forgings be used in the manufacture of Section I boilers?

*Reply:* It is the opinion of the Committee that SA-508 Class 1, Grades 2 and 3 forgings may be used in the manufacture of Section I boilers, provided the following requirements are met:

(a) The design temperature shall not exceed 800°F (427°C).

(b) The maximum allowable stress value shall be 22.9 ksi (158 MPa) at all temperatures from -20°F to 800°F (-29°C to 427°C).<sup>1</sup>

(c) For external pressure design, use Fig. CS-5 of Section II, Part D to a maximum temperature of 650°F (343°C). For temperatures higher than 650°F (343°C), use Fig. CS-2 of Section II, Part D.

(d) This Case number shall be shown on the material certification and marking of the material and on the Manufacturer's Data Report.

<sup>1</sup> The revised criterion of 3.5 on tensile strength was used in establishing the maximum allowable stress value.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: September 12, 2017

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**Case 2493-1**  
**Parallel Plate Explosion Welding for Butt Joints**  
**Between Dissimilar Metals**  
**Section VIII, Division 1; Section VIII, Division 2; Section IX**

*Inquiry:* May the Parallel Plate Explosion Welding Process (with or without interlayers) be used to weld dissimilar metal plate and sheet to produce butt joint transitions for cryogenic systems, which can then be welded by conventional processes to adjacent similar metals, be qualified under the rules of Section IX?

*Reply:* It is the opinion of the Committee that butt joints between dissimilar metal plate and sheet produced by Parallel Plate Explosion Welding (with or without interlayers) used to produce butt joint transitions for cryogenic systems may be qualified under the rules of Section IX, provided the joints meet the applicable requirements of Section IX, the specific ASME or other Design Code where they will be utilized, and the following requirements:

## 1 GENERAL REQUIREMENTS

(a) The welds shall be produced between parallel flat plates in the horizontal position in normal air atmosphere.

(b) The prime, interlayer, if used, and backer component materials shall meet the requirements of appropriate ASME SA- or SB- specifications. The backer component may consist of previous explosion welded plates for multilayer requirements.

(c) Where multilayer welded plates are produced, mechanical test specimens shall be taken from the finished multilayer welded plate with a single test representing all welds.

(d) Weld repairs to the explosion weld are prohibited. Weld repair of surface blemishes or defects that do not extend to nor affect the explosion weld is permissible. Procedures and welders shall be qualified in accordance with Section IX.

(e) Fabricators shall satisfy themselves through appropriate testing that subsequent heat treatment applied to completed weldments that include explosion welded transitions does not adversely affect the explosion weld properties.

(f) Finished transition components shall meet all other applicable requirements of the ASME Process Piping or Pressure Vessel Code for which they will be used.

## 2 WELDING PROCEDURE QUALIFICATION

(a) The prime, interlayer, and backer materials shall be the same type and grade as the material to be welded in production (type and grade are materials of the same nominal chemical analysis and mechanical property range, even though of different product form).

(b) The arrangement of components, explosive, and other essential welding parameters listed in 5 shall be the same as will be used in production.

(c) The welding procedure shall be qualified in the same facility as the production welding.

(d) The welded plate shall be 100% ultrasonic inspected in accordance with 6.

(e) A minimum of one longitudinal bend sample in accordance with para. 7(a) shall be taken from each corner of the qualification test plate (4 tests total).

(f) A minimum of one tensile test in accordance para. 7(b) shall be taken from each corner of the qualification test plate (4 tests total).

(g) When impact testing is required by other Code sections or other standards, a minimum of three Charpy V-notch tests for each weld and each test temperature shall be taken from representative material from the qualification plate and tested in accordance with para. 7(c) (3 tests for each weld at each test temperature).

(h) Remaining material from a successful procedure qualification plate welded by a qualified operator may be used for production requirements.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

### 3 WELDING OPERATOR PERFORMANCE QUALIFICATION

(a) The prime, interlayer(s), and backer materials shall be the same type and grade as the material to be welded in production.

(b) The arrangement of components, explosive, and other essential welding parameters listed in 5 shall be the same as will be used in production.

(c) The welding operator shall be qualified in the same facility as the production welding.

(d) The welded plate shall be 100% ultrasonic inspected in accordance with 6.

(e) A minimum of two longitudinal bend tests in accordance with 7(a) shall be taken from material from at least two corners of the qualification test plate (4 tests total).

(f) A minimum of two tensile tests in accordance 7(b) shall be taken from material from at least two corners of the qualification test plate (4 tests total).

(g) Remaining material from a successful performance qualification plate using a qualified procedure may be used for production requirements.

### 4 PRODUCTION WELDING

(a) The welded plate shall be 100% ultrasonic inspected in accordance with 6.

(b) A minimum of two tensile tests taken from material from at least two corners of each production plate shall be required (4 tests total).

(c) A minimum of two bend tests taken from material from at least two corners of each production plate shall be required (4 tests total).

(d) When impact testing is required by the customer, other Code sections, or other standards, a minimum of three Charpy V-notch tests for each weld and each test temperature shall be taken from representative material from each production plate and tested in accordance with 7(c) (3 tests for each weld and test temperature).

### 5 WELDING VARIABLES

Qualified welding procedures may be applied to production within the limits of the welding variables defined as follows:

(a) The following shall be considered essential variables:

(1) a change in the number of layers or sequence of assembly of multiple layer plates

(2) a change in the type or grade of the prime, interlayer (if used), or backer material

(3) a change in the heat treat condition of the prime, interlayer (if used), or backer material

(4) a change from a backer consisting of one material to a multilayer backer

(5) an increase in the length or the width of the plates to be welded of more than 10%

(6) a change in thickness of the prime or interlayer (if used) of more than 25%

(7) a reduction in the total thickness of the backer of more than 50%

(8) addition or deletion of an interlayer welded simultaneously in the same shot as the prime and backer

(9) a change in the stand-off between the prime and the backer (or interlayer and interlayer to backer, when used) of more than +100% or -50%

(10) QW-406.1

(11) QW-407.1

(12) a change in roughness of the prepared weld surface greater than 50% of the roughness (in microinches RMS) of the qualified surface

(13) a change in the material used for stand-off spacers that will be inside the area of usable material

(14) addition, deletion, or a change of an anvil

(15) a change in the location of the initiation point from the perimeter of the plate to the interior of the plate

(16) an increase in the run of explosive of more than 10%

(17) a change in explosive composition of more than 10%

(18) a change in the explosive loading of more than 10%

(b) The following shall be considered nonessential variables:

(1) QW-410.31

(2) a change in the arrangement or spacing of stand-off spacers of more than 25%

(3) addition, deletion, or a change in buffer

(4) a change in the material used for stand-off spacers that will be outside the area of usable material

(5) a change in booster type or booster protection

(6) addition, deletion, or change in extension bar

(7) addition, deletion, or change in score

### 6 EXAMINATION

Explosion welded plate material shall be 100% nondestructively tested using contact ultrasonic inspection in accordance with Section V, Article 4. The acceptance standard shall be based on a calibration block with 5 mm diameter flat bottomed holes drilled to each weld interface.

### 7 MECHANICAL TEST REQUIREMENTS

(a) Tensile properties shall be demonstrated by testing in accordance with Section IX, QW-150.

(1) Standard round tensile specimens as defined in Section IX, Figure QW-462.1(d) taken in the Z-direction from the welded plate shall be used. Tests of plates welded with one or more interlayers may be taken from the finished multilayer welded plate with a single test representing all welds.

(2) Acceptance criteria for tensile tests shall be as defined in QW-153.1 considering interlayer materials as base metals when plates with interlayers are tested.

(b) Weld ductility shall be demonstrated by testing in accordance with Section IX, QW-160 using Longitudinal Bend tests in accordance with QW-161.5, except specimens shall be cut from the thickness of the plate with the weld oriented along the length of the specimen. No distinction between face and root side is required.

(1) Specimen dimensions shall be in accordance with Figure QW-462.3(b) and shall be at least  $\frac{3}{8}$  in. thick and  $1\frac{1}{2}$  in. wide or wider if necessary to capture all of the welds in a multilayer material, with a minimum of the lesser of  $\frac{1}{2}$  in. or the thickness of each face material included in the overall width.

(2) Bend testing shall be in accordance with Section IX, QW-162. Bend testing shall be performed on a jig using same criteria described in Section IX, QW-466.1 for the component material with the largest ram diameter "A" allowable for the materials in the weld, including any interlayer materials.

(3) Acceptance criteria for longitudinal bend tests shall be as defined in Section IX, QW-163.

(c) Weld toughness shall be demonstrated by testing in accordance QW-171. Charpy V-notch specimens shall be made with the notch located at the weld interface or at each weld interface for multilayer joints.

(1) Acceptance criteria for impact tests shall be as defined in Section IX, QW-171.

## 8 DEFINITIONS

*anvil*: a heavy plate material, usually steel, used to support backer components of insufficient thickness to withstand the explosive force without excessive deformation.

*backer component (backer)*: material to which the prime (and interlayer, if used) is welded, usually of greater thickness than the prime and usually providing a structural function in the clad plate.

*booster*: a high explosive used to create sufficient energy to initiate the detonation of the base explosive charge.

*booster protection*: material placed between the booster and the prime to protect the prime metal surface.

*buffer*: a substance used to inhibit chemical reaction between the explosive and the prime, usually applied as a paint-like coating.

*explosion weld*: a weld produced between two materials using the energy released during a controlled detonation of an explosive material. A clean surface is achieved by expulsion of a jet of surface oxides and impurities ahead of the collision point of the two materials. Atomic closeness is achieved by the force of the explosion.

*explosion welding (EXW)*: a welding process that uses explosive energy to generate a jet of surface oxides and impurities that is expelled ahead of the collision point of the two materials to achieve a clean surface and to supply force to achieve atomic closeness.

*explosion welding operator*: the member of the team that assembles the plate for welding is responsible to check the assembly and to verify the explosive composition, loading, and detonation, and is therefore responsible for the overall weld joint.

*explosive composition*: the chemical composition, the physical characteristics, and other factors that affect the detonation velocity and energy released by the explosive.

*explosive loading*: the amount (mass) of explosive used per unit area of material to be welded.

*extension bar*: a steel bar surrounding the perimeter of the prime used to maintain a steady state of explosive energy beyond the edge of the plate. Can be compared to run-off tabs in conventional welding.

*frame*: a steel frame surrounding the explosive that is set at an approximate height based on the density of the explosive. Frame height is a secondary calculation. The required explosive loading is maintained.

*initiation point*: the point on the predetonation assembly of material where the detonation is initiated. Usually this is at the perimeter of the plate, e.g., at a corner or center of the long side, but may be in the interior.

*interlayer component (interlayer)*: a material placed between the prime and the backer to improve metallurgical compatibility in the overall weld. Interlayers may be welded to the backer separately (in which case they are the prime for the specific welding procedure) or in the same explosion welding operation used to weld the prime and backer.

*multilayer backer*: a backer component that consists of two or more previously explosion welded plates.

*parallel plate explosion welding*: the arrangement of flat plates in a parallel configuration with a controlled stand-off in preparation for explosion welding.

*prime component (prime)*: the material closest to the explosive that is to be welded to the backer component. The prime usually provides special surface characteristics like corrosion resistance or metallurgical compatibility to the backer or intermediates. The prime is usually (but not always) of lesser thickness than the backer.

*run of explosive*: the distance from the initiation point to the extreme limit of the plate.

*score*: a groove cut into the prime along the periphery of the plate that controls the location of edge shearing during explosion welding.

*stand-off*: the spacing between the prime and the backer materials (or the prime and the interlayer, and interlayer and backer where interlayers are used) that are being joined by the EXW process.

**CAUTION:** Dissimilar metal joints are known to be susceptible to galvanic and other corrosion effects. Users shall satisfy themselves, at minimum, by appropriate corrosion tests at conditions comparable to the service conditions to which the weld joint will be exposed, including start-up and upset conditions, that the weld and adjacent material will not suffer adverse metallurgical, corrosion, or mechanical degradation.

## 9 DOCUMENTATION

Use of this Case shall be documented on the applicable PQR, WPS, WOPQ, and Data Report Forms.

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Approval Date: March 28, 2017

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**Case 2494-2**  
**Corrosion-Resistant Cu-Sb Carbon Steel Tube and**  
**Seamless Pipe**  
**Section I**

*Inquiry:* May seamless and electric resistance welded Cu-Sb carbon steel tube and seamless pipe with chemical analysis shown in [Table 1](#), the mechanical properties shown in [Table 2](#), and otherwise conforming to the requirements in SA-423/SA-423M for tube and SA-106/SA-106M for pipe be used in Section I construction?

*Reply:* It is the opinion of the Committee that the material listed in the Inquiry may be used in Section I construction, provided the following requirements are met:

(a) The material shall meet the chemical analysis and minimum tensile requirements given in [Tables 1](#) and [2](#), and shall otherwise meet the requirements of SA-423/SA-423M for tube and SA-106/SA-106M for pipe.

(b) The maximum allowable stress values for the material are given in [Tables 3](#) and [3M](#). The maximum design temperature is 797°F (425°C).

(c) Separate welding procedure and performance qualifications shall be conducted for the material in accordance with Section IX. For the purpose of postweld heat treatment, this material shall be considered P-No. 1 Gr. No. 1.

(d) This Case number shall be referenced in the documentation and marking of the material and recorded on the Manufacturer's Data Report.

**Table 1**  
**Chemical Requirements**

Element	Composition, %
Carbon, max.	0.06
Manganese	0.70-1.40
Phosphorus, max.	0.020
Sulfur, max.	0.020
Silicon, max.	0.55
Copper	0.25-0.45
Nickel, max.	0.50
Molybdenum, max.	0.20
Antimony	0.05-0.15

**Table 2**  
**Tensile Requirements**

Tensile strength, min. ksi (MPa)	55 (380)
Yield strength, min. ksi (MPa)	33 (230)
Elongation in 2 in. (50 mm), min. %	35
For tube having a specified wall thickness of less than $\frac{5}{16}$ in. (8 mm), if tested using longitudinal strip test specimen	<a href="#">[Note (1)]</a>
NOTE:	
(1) The minimum elongation shall be determined by the following equation, with the calculated value rounded to the nearest percent:	
$E = 56t + 16.5$	
where	
$E$	= minimum elongation in 2 in. (50 mm), %
$t$	= specified wall thickness, in.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 3  
Maximum Allowable Stresses**

For Metal Temperature Note Exceeding, °F	Allowable Stress Values, ksi	
	Seamless	Welded [Note (1)]
-20 to 100	15.7	13.4
200	15.7	13.4
300	15.7	13.4
400	15.7	13.4
500	15.7	13.4
600	15.2	12.9
650	14.4	12.2
700	13.8	11.7
750	13.5	11.5
800	13.5 [Note (2)]	11.5 [Note (2)]

GENERAL NOTE: The revised criterion of 3.5 on tensile strength was used in establishing these values.

NOTES:

(1) These *S* values include a 0.85 weld efficiency factor. Values for seamless tubing may be used provided the following additional restrictions requirements are met:

- (a) The tubing shall be used for boiler, waterwall, superheater, and economizer tubes that are enclosed within the setting.
- (b) The maximum outside diameter shall be 3½ in. (89 mm).
- (c) The weld seam of each tube shall be subjected to an angle beam ultrasonic inspection per SA-450.
- (d) A complete volumetric inspection of the entire length of each tube shall be performed in accordance with SA-450.
- (e) Material test reports shall be supplied.

(2) This value is provided for interpolation purposes only.

**Table 3M  
Maximum Allowable Stresses**

For Metal Temperature Note Exceeding, °C	Allowable Stress Values, MPa	
	Seamless	Welded [Note (1)]
-30 to 40	109	92.7
65	109	92.7
125	109	92.7
150	109	92.7
175	109	92.7
200	109	92.7
225	109	92.7
250	109	92.7
275	109	92.7
300	109	92.7
325	103	87.6
350	97.9	83.2
375	94.8	80.6
400	93.3	79.3
425	92.9	79.0

GENERAL NOTE: The revised criterion of 3.5 on tensile strength was used in establishing these values.

NOTE:

(1) These *S* values include a 0.85 weld efficiency factor. Values for seamless tubing may be used provided the following additional restrictions requirements are met:

- (a) The tubing shall be used for boiler, waterwall, superheater, and economizer tubes that are enclosed within the setting.
- (b) The maximum outside diameter shall be 3½ in. (89 mm).
- (c) The weld seam of each tube shall be subjected to an angle beam ultrasonic inspection per SA-450.
- (d) A complete volumetric inspection of the entire length of each tube shall be performed in accordance with SA-450.
- (e) Material test reports shall be supplied.

Approval Date: September 30, 2018

(19)

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**Case 2496-4**  
**27Cr-7.6Ni-1Mo-2.3W-N UNS S32808, Solution**  
**Annealed Austenitic-Ferritic Duplex Stainless Steel**  
**Plate, Seamless Tubing, Seamless Pipe, Forgings, and**  
**Bar for Class 2**  
**Section VIII, Division 1; Section VIII, Division 2**

*Inquiry:* May solution annealed 27Cr-7.6Ni-1Mo-2.3W-N, UNS S32808, seamless tubing, seamless pipe, plate, forgings, and bar conforming to the specifications listed in [Table 1](#) be used in welded construction under the rules of Section VIII, Division 1 and Division 2, Class 2?

*Reply:* It is the opinion of the Committee that solution-annealed 27Cr-7.6Ni-1Mo-2.3W-N, UNS S32808 material, as described in the Inquiry, may be used in welded construction under the rules of Section VIII, Division 1 and Division 2, Class 2, provided that the following additional requirements are met:

(a) For Section VIII, Division 1 application, the rules of Subsection C, Part UHA for austenitic-ferritic duplex stainless steels shall apply. For Section VIII, Division 2, application, the rules for austenitic-ferritic duplex stainless steels shall apply.

(b) The yield strength and tensile strength values shall be as given in [Tables 2](#) and [2M](#).

(c) The maximum allowable stress values for the material shall be as given in [Tables 3](#) and [3M](#). The maximum design temperature is 662°F (350°C).

(d) For external pressure design, Fig. HA-5 in Section II, Part D shall be used.

(e) Physical properties for UNS S32808 shall be as follows:

(1) modulus of elasticity, as given in Table TM-1 of Section II, Part D, Subpart 2, for Material Group B

(2) coefficients of mean linear thermal expansion, as given in [Table 4](#)

(3) thermal conductivity and diffusivity, as given in Table TCD of Section II, Part D, Subpart 2 for Material Group J

(4) density, 0.284 lb/in.<sup>3</sup> (7 860 kg/m<sup>3</sup>)

(f) Separate welding procedure and performance qualifications shall be performed in accordance with Section IX.

(g) Heat treatment after welding or fabrication is neither required nor prohibited. When heat treatment is performed, the tube, pipe, or plate material shall be heat treated at a temperature of 1,925°F to 2,100°F (1 050°C to 1 150°C) followed by rapid cooling in air or water.

(h) Product analysis tolerances for SA-789/SA-789M tubing, ASTM A790/A790M pipe, and SA-240/SA-240M plate shall be as specified in Table 1 of SA-484/SA-484M.

(i) This Case number shall be included in the documentation and marking of SA-789/SA-789M tubing, ASTM A790/A790M pipe, and SA-240/SA-240M plate, and in the Manufacturer's Data Report for all product forms.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1  
Specifications**

Specification	Product Form
SA-789/SA-789M [Note (1)]	Seamless and Welded Ferritic/Austenitic Stainless Steel Tubing for General Service
SA-240/SA-240M	Chromium and Chromium-Nickel Stainless Steel Plate for Pressure Vessels and General Service
ASTM A182/A182M-14a	Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A479/A479M-13	Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels
ASTM A790/A790M-14	Seamless and Welded Ferritic/Austenitic Stainless Steel Pipe

NOTE:

(1) Only the editions listed in Section II, Part A, Mandatory Appendix II, Table II-200-1 (2013 edition) under SA-789/SA-789M without the application of item (f) may be used for this Case.

**Table 2  
Yield Strength,  $S_y$ , and Tensile Strength,  $S_u$ , Values**

For Metal Temperature Not Exceeding, °F	Yield Strength Values, ksi [Note (1)]		Tensile Strength Values, ksi [Note (2)]	
	SA-789/SA-789M and ASTM A790/A790M for $t < 0.40$ in.	SA-789/SA-789M and ASTM A790/A790M for $t \geq 0.40$ in.; and SA-240/SA-240M, ASTM A182/A182M, and ASTM A479/A479M	SA-789/SA-789M and ASTM A790/A790M for $t < 0.40$ in.	SA-789/SA-789M and ASTM A790/A790M for $t \geq 0.40$ in.; and SA-240/SA-240M, ASTM A182/A182M, and ASTM A479/A479M
100	80.0	72.0	116.0	102.0
200	65.5	61.2	113.7	101.5
300	60.7	55.9	109.1	95.8
400	57.6	53.5	106.5	93.6
500	56.0	52.9	106.0	93.6
600	56.0	52.5	106.0	93.6
650	56.0	51.9	106.0	93.6
700 [Note (3)]	56.0	51.1	106.0	93.2

NOTES:

(1) See Section II, Part D, Subpart 1, Table Y-1, General Note (b).

(2) See Section II, Part D, Subpart 1, Table U, General Note (b)

(3) These values are provided for interpolation purposes only. The maximum design temperature of this material is 662°F.

**Table 2M**  
Yield Strength,  $S_y$ , and Tensile Strength,  $S_u$ , Values

For Metal Temperature Not Exceeding, °C	Yield Strength Values, MPa [Note (1)]		Tensile Strength Values, MPa [Note (2)]	
	SA-789/SA-789M and ASTM A790/A790M for $t < 10$ mm	SA-789/SA-789M and ASTM A790/A790M for $t \geq 10$ mm; and SA-240/SA-240M, ASTM A182/A182M, and ASTM A479/A479M	SA-789/SA-789M and ASTM A790/A790M for $t < 10$ mm	SA-789/SA-789M and ASTM A790/A790M for $t \geq 10$ mm; and SA-240/SA-240M, ASTM A182/A182M, and ASTM A479/A479M
40	550	500	800	700
65	478	452	800	700
100	445	420	779	691
125	429	401	764	671
150	417	388	752	657
175	406	378	743	648
200	397	372	735	643
225	390	369	731	642
250	386	368	731	642
275	384	367	731	642
300	384	366	731	642
325	384	363	731	642
350	384	359	731	642

## NOTES:

- (1) See Section II, Part D, Subpart 1, Table Y-1, General Note (b).  
 (2) See Section II, Part D, Subpart 1, Table U, General Note (b).

**Table 3**  
Maximum Allowable Stress Values

For Metal Temperature Not Exceeding, °F [Note (1)]	Division 1 Values, ksi		Division 2 Values, ksi	
	SA-789 Tube; Pipe, $t < 0.40$ in.	SA-789/SA-789M and ASTM A790/A790M for $t \geq 0.40$ in.; and SA-240/SA-240M, ASTM A182/A182M, and ASTM A479/A479M	SA-789/SA-789M and ASTM A790/A790M for $t < 0.40$ in.	SA-789/SA-789M and ASTM A790/A790M for $t \geq 0.40$ in.; and SA-240/SA-240M, ASTM A182/A182M, and ASTM A479/A479M
100	33.1	29.1	48.3	42.5
200	32.5	29.0	43.7	40.8
300	31.2	27.4	40.4	38.2
400	30.4	26.8	38.4	35.7
500	30.3	26.8	37.3	35.2
600	30.3	26.8	37.2	35.0
650	30.3	26.8	37.2	34.6
700 [Note (2)]	30.3	26.6	37.2	34.1

## NOTES:

- (1) This material may embrittle by exposure to moderately elevated temperatures. See Section II, Part D, Non-mandatory Appendix A, A-207 and A-208.  
 (2) These values are provided for interpolation purposes only. The maximum design temperature of this material is 662°F.

**Table 3M  
Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C [Note (1)]	Division 1 Values, MPa		Division 2 Values, MPa	
	SA-789M Tube; Pipe, SA-789/SA-789M and ASTM A790/A790M for $t < 10$ mm	SA-789/SA-789M and ASTM A790/A790M for $t \geq 10$ mm; and SA-240/SA-240M, ASTM A182/A182M, and ASTM A479/A479M	SA-789/SA-789M and ASTM A790/A790M for $t < 10$ mm	SA-789/SA-789M and ASTM A790/A790M for $t \geq 10$ mm; and SA-240/SA-240M, ASTM A182/A182M, and ASTM A479/A479M
40	229	200	333	292
65	229	200	318	292
100	223	197	297	280
125	218	192	286	268
150	215	188	278	258
175	212	185	271	252
200	210	184	265	248
225	209	183	260	246
250	209	183	257	245
275	209	183	256	244
300	209	183	256	244
325	209	183	256	242
350	209	183	256	240

NOTE:

(1) This material may embrittle by exposure to moderately elevated temperatures. See Section II, Part D, Non-mandatory Appendix A, A-207 and A-208.

**Table 4**  
**Mean Coefficients of Thermal Expansion**

Temperature Range, °C	Coefficient, (/°C) × 10 <sup>6</sup>	Temperature Range, °F	Coefficient, (/°F) × 10 <sup>6</sup>
RT-100	13.7	RT-212	7.6
RT-150	13.9	RT-302	7.7
RT-200	14.0	RT-392	7.8
RT-250	14.2	RT-482	7.9
RT-300	14.4	RT-572	7.9
RT-350	14.5	RT-662	8.0
RT-400	14.7	RT-752	8.1

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Approval Date: June 20, 2008

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2498**  
**Use of SA/EN 10028-2, Grades P235GH and P265GH**  
**Steel**  
**Section VIII, Division 1**

*Inquiry:* Is it permissible to use steel plate, manufactured in accordance with SA/EN 10028-2, Grades P235GH and P265GH to a maximum thickness of  $2\frac{1}{4}$  in. (60 mm) in the construction of pressure vessels under the rules of Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that steel plate manufactured in accordance with SA/EN 10028-2, Grades P235GH and P265GH to a maximum thickness of  $2\frac{1}{4}$  in. (60 mm) may be used, in Section VIII, Division 1 construction, provided the following additional requirements are met:

(a) The design temperature shall not exceed 700°F (371°C).

(b) The maximum allowable stress values for the materials shall be those given in Tables 1 and 1M.

(c) The material shall be considered as P No. 1, Group No. 1.

(d) For external pressure design, use Fig. CS-2 of Section II, Part D.

(e) In UCS-66 the material shall be assigned to Curve B in the as-rolled condition and Curve D in the normalized condition.

(f) This Case number shall be on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Grade P235GH Maximum Allowable Stress Values, ksi	Grade P265GH Maximum Allowable Stress Values, ksi
100	14.9	17.0
150	14.9	17.0
200	14.9	17.0
250	14.9	17.0
300	14.9	17.0
400	14.9	17.0
500	14.9	17.0
600	14.9	17.0
650	14.9	17.0
700	12.5	15.6

**Table 1M**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Grade P235GH Maximum Allowable Stress Values, MPa	Grade P265GH Maximum Allowable Stress Values, MPa
40	103	117
65	103	117
100	103	117
125	103	117
150	103	117
200	103	117
250	103	117
300	103	117
325	103	117
350	96.8	117
375 [Note (1)]	85.0	108

NOTE:

(1) These values are provided for interpolation purposes only.  
The maximum use temperature is 371°C.

Approval Date: November 2, 2004

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2500**  
**Use of ASTM A576 Hot-Wrought Carbon Steel Bars for Forming Fittings for HLW Construction**  
**Section IV**

*Inquiry:* May internally threaded fittings formed from ASTM A576, Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, by the cold heading process be used in the construction of water heaters and storage tanks to the rules of Part HLW?

*Reply:* It is the opinion of the Committee that the material specified in the Inquiry may be used in the forming of fittings for water heaters and storage tanks under the rules of Section IV, Part HLW, with the following additional requirements:

- (a) The grades shall be limited to 1008 through 1015.
- (b) Supplementary requirement, S1, Cold-Working Quality, of ASTM A576 shall apply.

(c) A certificate shall be provided that identifies the material, with its material specification, grade, and Rockwell B hardness number. This number shall be between 55 and 78.

(d) The fitting size shall not exceed NPS 1 (DN 25).

(e) The fitting manufacturer shall provide the purchaser with a Certificate of Compliance that states compliance with this Case and identifies by part number all of the purchaser's fittings that comply with requirements of this Case.

(f) Identification of the fittings shall conform to the requirements of HLW-203(b).

(g) Welding procedure and performance qualification shall be performed in accordance with Section IX and the additional requirements of Part HLW.

(h) The maximum allowable working pressure for a vessel incorporating these fittings shall be established by a proof test per HLW-500.

(i) All other requirements of Part HLW shall be met.

(j) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: November 20, 2007

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2503-1**  
**Use of UNS S32003 Stainless Steel**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions is it permissible in welded construction conforming to the rules of Section VIII, Division 1, to use UNS S32003 wrought ferritic/austenitic stainless steel as seamless and welded pipe and tube, and plate, conforming to the composition requirements of [Table 1](#), and the mechanical property requirements of [Table 2](#), and otherwise conforming to the requirements of SA-240, SA-789, and SA-790, as applicable?

*Reply:* It is the opinion of the Committee that the materials described in the Inquiry may be used in Section VIII, Division 1, construction, provided the following requirements are met:

(a) The material shall be furnished in the heat treated condition. The heat treatment shall be performed in the range of 1850°F–2010°F (1010°C–1100°C) with subsequent rapid cooling.

(b) The rules for austenitic-ferritic stainless steels in Section VIII, Division 1, Subsection C, Part UHA shall apply.

(c) The design temperature shall not exceed 650°F (343°C).

(d) The maximum allowable design stress values shall be those listed in [Tables 3](#) or [3M](#). For welded pipe and tube, a joint efficiency factor of 0.85 shall be used.

(e) For external pressure design, use Fig. HA-5 of Section II, Part D.

(f) Separate welding procedure qualifications shall be performed in accordance with Section IX. For welding performance qualifications, the material shall be considered P-No. 10H, Group 1.

(g) Heat treatment after welding is neither required nor prohibited. However, if heat treatment is applied, the solution annealing treatment shall be as noted in [\(a\)](#).

(h) This Case number shall be included in the material documentation and marking and shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Chemical Requirements**

Element	Weight %
Carbon, max.	0.030
Manganese, max.	2.00
Phosphorus, max.	0.030
Sulfur, max.	0.020
Silicon, max.	1.00
Chromium	19.5–22.5
Nickel	3.0–4.0
Molybdenum	1.50–2.00
Nitrogen	0.14–0.20
Iron	Balance

**Table 2**  
**Mechanical Property Requirements**

	Sheet/Strip $\leq \frac{3}{16}$ in. ( $\leq 4.8$ mm)	Plate $> \frac{3}{16}$ in. ( $> 4.8$ mm)	Tube	Pipe
Tensile Strength, min., ksi (MPa)	100 (690)	95 (655)	100 (690)	90 (620)
Yield Strength, min. (0.2% Offset), ksi (MPa)	70 (485)	65 (450)	70 (485)	65 (450)
Elongation, min. (in 2 in.)	25%	25%	25%	25%

**Table 3**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Stress Values, ksi [Note (1)]			
	Sheet	Plate	Tube	Pipe
100	28.6	27.1	28.6	25.7
200	27.7	26.3	27.7	24.9
300	26.1	24.8	26.1	23.5
400	25.8	24.5	25.8	23.2
500	25.8	24.5	25.8	23.2
600	25.8	24.5	25.8	23.2
650	25.8	24.5	25.8	23.2

NOTE:

(1) The revised criterion of 3.5 on tensile strength was used in establishing the values.

**Table 3M**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Stress Values, MPa [Note (1)]			
	Sheet	Plate	Tube	Pipe
40	197	187	197	177
65	197	187	197	177
100	189	180	189	170
150	180	171	180	162
200	178	169	178	160
250	178	169	178	160
300	178	169	178	160
325	178	169	178	160
350 [Note (2)]	178	169	178	160

GENERAL NOTE: **CAUTION: This material may be expected to develop embrittlement after exposure at moderately elevated temperatures. See paragraphs A-340 and A-360 in Appendix A of Section, II Part D.**

NOTES:

- (1) The revised criterion of 3.5 on tensile strength was used in establishing the values.
- (2) The value at 350°C is for interpolation only. The maximum use temperature is 343°C.

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Approval Date: August 3, 2005

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2511**  
**Requirements for Use of an Alternative Test Method**  
**Under PG-73.4.2.2**  
**Section I**

*Inquiry:* Under what conditions may the requirements of PG-73.4.2.2(b), requiring owner and boiler manufacturer acceptance to use an alternative test method, be waived?

*Reply:* It is the opinion of the Committee that the requirements of PG-73.4.2.2(b), requiring owner and boiler manufacturer acceptance to use an alternative test method, may be waived, provided that the safety valve manufacturer and either the boiler manufacturer or boiler owner agree to invoke this Code Case.

This Case number is to be included with the safety valve stamping information required by PG-110.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: October 27, 2005

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2512**  
**18Cr-10Ni-3Cu-Ti-Cb Seamless Austenitic Stainless**  
**Steel Tube**  
**Section I**

*Inquiry:* May solution-treated 18Cr-10Ni-3Cu-Ti-Cb seamless austenitic stainless steel tube with chemical analysis shown in [Table 1](#), the mechanical properties shown in [Table 2](#), and otherwise conforms to applicable requirements in SA-213 be used for steam service in Section I construction?

*Reply:* It is the opinion of the Committee that the material listed in the Inquiry may be used for steam service in Section I construction, provided that the following requirements are met:

(a) The material shall meet the chemical analysis and minimum tensile requirements described in the Inquiry, and shall otherwise meet the requirements of SA-213 as applicable, except as shown in paras. (b) and (c).

(b) The minimum solution-treating temperature for this material shall be 2120°F (1160°C).

(c) This material shall have a hardness not exceeding 192 HB/200 HV (90 HRB).

(d) The rules of PG-19 for TP321H shall apply for this material, except that solution treatment, when required, shall be at the minimum temperature of 2120°F (1160°C) and the recommended maximum temperature of 2270°F (1245°C).

(e) The maximum allowable stress values for the material shall be as given in [Tables 3](#) and [3M](#). The maximum design temperature is 1382°F (750°C).

(f) Separate welding procedure and performance qualification shall be conducted for the material in accordance with Section IX.

(g) This Case number shall be referenced in the documentation and marking of the material and recorded on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Chemical Requirements**

<b>Element</b>	<b>Composition, %</b>
Carbon	0.07–0.14
Manganese, max.	2.00
Phosphorus, max.	0.040
Sulfur, max.	0.010
Silicon, max.	1.00
Nickel	9.00–12.00
Chromium	17.50–19.50
Titanium	0.10–0.25
Columbium plus Tantalum	0.10–0.40
(Ti+Cb/2)/C	2.0–4.0
Copper	2.50–3.50
Boron	0.0010–0.0040

**Table 2**  
**Mechanical Property Requirements**

Tensile strength, min. ksi (MPa)	73 (500)
Yield strength, min. ksi (MPa)	30 (205)
Elongation in 2 in. or 50 mm, min., %	35

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**Table 3**  
**Maximum Allowable Stresses**

For Metal Temperature Not Exceeding, °F		
Exceeding, °F	Allowable Stress Values, ksi	Allowable Stress Values, ksi
-40 to 100	20.0	20.0
200	17.6	20.0 [Note (1)]
300	17.0	20.0 [Note (1)]
400	16.8	20.0 [Note (1)]
500	16.7	20.0 [Note (1)]
600	16.5	20.0 [Note (1)]
650	16.2	20.0 [Note (1)]
700	15.9	20.0 [Note (1)]
750	15.6	20.0 [Note (1)]
800	15.2	20.0 [Note (1)]
850	14.8	19.8 [Note (1)]
900	14.3	19.4 [Note (1)]
950	13.9	18.8 [Note (1)]
1000	13.5	18.3 [Note (1)]
1050	13.2	17.8 [Note (1)]
1100	12.9	17.4 [Note (1)]
1150	12.6	15.3 [Note (1)]
1200	11.8	11.8
1250	9.0	9.0
1300	7.1	7.1
1350	5.7	5.7
1400	4.8 [Note (2)]	4.8 [Note (2)]

GENERAL NOTE: The revised criterion of 3.5 on tensile strength was used in establishing these values.

NOTES:

- (1) Due to the relatively low yield strength of this material, these high stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed 66<sup>2</sup>/<sub>3</sub>%, but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.
- (2) These values are provided for interpolation purposes only.

**Table 3M  
Maximum Allowable Stresses**

For Metal Temperature Not Exceeding, °C		
Exceeding, °C	Allowable Stress Values MPa	Allowable Stress Values MPa
-30 to 40	138	138
65	126	138 [Note (1)]
100	121	138 [Note (1)]
125	118	138 [Note (1)]
150	117	138 [Note (1)]
175	116	138 [Note (1)]
200	116	138 [Note (1)]
225	116	138 [Note (1)]
250	116	138 [Note (1)]
275	115	138 [Note (1)]
300	114	138 [Note (1)]
325	113	138 [Note (1)]
350	111	138 [Note (1)]
375	109	138 [Note (1)]
400	107	138 [Note (1)]
425	105	138 [Note (1)]
450	102	137 [Note (1)]
475	99.7	135 [Note (1)]
500	97.1	131 [Note (1)]
525	94.5	128 [Note (1)]
550	92.2	124 [Note (1)]
575	90.0	122 [Note (1)]
600	88.2	119 [Note (1)]
625	86.6	102 [Note (1)]
650	80.7	80.7
675	63.3	63.3
700	50.5	50.5
725	41.5	41.5
750	35.2	35.2

GENERAL NOTE: The revised criterion of 3.5 on tensile strength was used in establishing these values.

NOTE:

- (1) Due to the relatively low yield strength of this material, these high stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed 66<sup>2</sup>/<sub>3</sub>%, but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.

Approval Date: July 7, 2006

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2514-1**  
**Use of SA-182 F22V, SA-336 F22V, SA-541 22V, SA-542**  
**Type D, Class 4a, and SA-832 22V to 850°F (454°C)**  
**Section VIII, Division 3**

*Inquiry:* May SA-182 F22V, SA-336 F22V, SA-541 22V, SA-542 Type D, Class 4a, and SA-832 22V be used at a temperature of less than or equal to 850°F (454°C) for Section VIII, Division 3 construction?

*Reply:* It is the opinion of the Committee that SA-182 F22V, SA-336 F22V, SA-541 22V, SA-542 Type D, Class 4a, and SA-832 22V may be used for Section VIII, Division 3 construction at a temperature of less than or equal to 850°F (454°C), provided the following conditions are met:

(a) The maximum continuous time and temperature shall be included in user's design specification.

(b) Design temperature is equal to or less than 850°F (454°C).

(c) The yield strength value,  $S_y$ , shall be those shown in Tables 1 or 1M.

(d) The diameter ratio ( $Y = D_o/D_t$ ) shall be equal to or less than 1.2.

(e) The design pressure for a cylindrical shell shall not exceed the limit set by eq. (1).

$$P_D = \left(\frac{2}{3}\right) \times k_c \times S_y \times I_n(Y) \quad (1)$$

where

$D_i$  = inside diameter

$D_o$  = outside diameter

$k_c$  = membrane adjustment factor from Table 2. Interpolation may be used for intermediate values of design temperature.

$P_D$  = design pressure

$S_y$  = yield strength value at design temperature

$Y$  = diameter ratio  $D_o/D_i$

(f) The design pressure for a spherical shell shall not exceed the limit set by eq. (2).

$$P_D = \left(\frac{4}{3}\right) \times k_c \times S_y \times I_n(Y) \quad (2)$$

(g) For all components except standard pressure parts and bolted flanges specified in (m), the elastic analysis shall be performed. The local primary membrane,  $P_l$ , local primary membrane plus bending ( $P_l + P_b$ ), and primary plus secondary stresses intensity ( $P_l + P_b + Q$ ) shall not exceed the following limits:

$$P_m \leq k_c \times S_y / 1.5 \quad (3)$$

$$P_l \leq k_b \times S_y \quad (4)$$

$$P_l + P_b \leq \alpha \times k_b \times S_y / 1.5 \quad (5)$$

$$P_l + P_b + Q \leq 2 \times k_b \times S_y \quad (6)$$

$\alpha$  = shape factor [see KD-210(o)]

$k_b$  = local, bending and secondary adjust factor from Table 4. Interpolation may be used for intermediate values of the design temperature.

(h) The inelastic analysis for the shakedown and total accumulated inelastic strain including the effect of creep shall be performed for pressure parts except standard pressure parts and bolted flanges specified in (m). The elastic perfectly plastic stress strain curve using  $S_y$  and creep rate specified in the following equation shall be used for the analysis.

The following creep rate shall be used in the creep analysis:

(U.S. Customary Units)

$$\log \sigma_{\text{ksi}} = -0.0263 \times (P/1000)^2 + 0.8159 \times (P/1000) - 4.6063$$

(SI Units)

$$\log \sigma_{\text{MPa}} = -0.0263 \times (P/1000)^2 + 0.8159 \times (P/1000) - 3.7677$$

where

$\sigma$  = stress, ksi (MPa)

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$P$  = Larson-Miller parameter  
 $= (T_C + 273.16) \times (20 - \log \epsilon_{min})$   
 $= (T_F/1.8 + 255.38) \times (20 - \log \epsilon_{min})$

$T_C$  = temperature, °C

$T_F$  = temperature, °F

$\epsilon_{min}$  = upper bound minimum creep rate, %/hr

The total accumulated inelastic strain shall not exceed the following:

	For weld and heat affected zone	Other Parts
Membrane	0.5%	1.0%
Bending	1.25%	2.5%
Local	2.5%	5.0%

A shakedown analysis shall be conducted by using maximum expected operating loads and maximum continuous time at operating temperature for at least 2 cycles. The analysis shall demonstrate that the unloading and subsequent reloading portions of the cycle are elastic at any point. The hold time at the maximum load that is used in the analysis shall be at least one year to consider the effects of creep on shakedown.

(i) ( $k_c \times S_y$ ) instead of  $S_y$  shall be used in the pure shear stress evaluation in KD-232 and bearing stress evaluation in KD-233.

(j) When the design cycles are calculated in accordance with KD-3, the design fatigue curve for 2<sup>1</sup>/<sub>4</sub>Cr-1Mo-<sup>1</sup>/<sub>4</sub>V steel shown in Figures 1 and 1M and Table 3 shall be used. Interpolation may be used for the intermediate temperature between 800°F (427°C) and 850°F (454°C). A mean stress correction is not necessary. The design cycles shall be less than or equal to 1,000 cycles.

(k) When the design cycles are calculated in accordance with KD-4, the fatigue crack growth rate factors for high strength low alloy steels shown in Tables KD-430 or KD-430M shall be used. The creep crack growth during hold time shall be considered.

(l) The design using autofrettage per KD-5, layered vessel constructions per KD-8 and wire-wound vessel construction per KD-9 shall not be used.

(m) Standard pressure parts that comply with an ASME product standard listed in Table KG-141 and flange joints in accordance with Appendix 2 of Section VIII, Division 1 may be used as closure components at the pressure

temperature rating listed in the ASME standard or calculated per Appendix 2 of Section VIII, Division 1. These parts shall be made of materials listed in Section VIII, Division 3. When calculations are performed for supplementary loads, the following stress limits are applied. The average primary stress intensity in bolts shall be based on the thread root diameter and shall not exceed the maximum allowable stress values of  $S$  in Table 3 of Section II, Part D. Primary plus secondary membrane stress intensity in bolts shall not exceed  $2S$ . Primary plus secondary membrane plus bending stress intensity in bolts shall not exceed  $3S$  due to the combination of both the design loads and preloads. Stress intensification due to the threads shall not be considered in the above analysis. The primary plus bending stress for the bolted flange shall not exceed  $1.5S$  and primary plus secondary stress for the bolted flange shall not exceed  $3S$ .

(n) Two sets of tension specimens and one set of Charpy V-notch impact specimens shall be tested. One set each of tension specimens shall be exposed to heat treatment Condition A. The second set of tension specimens and the set of Charpy impact specimens shall be exposed to heat treatment Condition B.

(1) Condition A: maximum anticipated cycles of heat treatment during fabrication and field repair (if required) of vessel portion

(2) Condition B: minimum anticipated cycle(s) of heat treatment during fabrication of vessel portion

(o) Welding procedure qualifications using a production weld consumable shall be made for material welded to itself or to other materials. The qualifications shall conform to requirements of Section IX, and the maximum tensile strength at room temperature shall be 110 ksi (758 MPa) for heat treatment Conditions A and B.

(p) Deposited weld metal from each heat or lot of electrodes, filler rod and filler wire-flux combination shall be tested for each welding process to be used. The maximum tensile strength specified in (o) and the minimum tensile strength for the base metal shall be met in PWHT Conditions A and B. The minimum CVN impact properties specified in (s) shall be met in PWHT Condition B. Testing shall be in general conformance with SFA-5.5 for covered electrodes, SFA-5.23 for filler wire-flux combinations, and SFA-5.28 for gas shielded welding.

**Table 1**  
**Values of Yield Strength**

Spec. No. Grade, Class	Yield Strength, ksi, for Metal Temperature Not Exceeding, °F										
	100	200	300	400	500	600	650	700	750	800	850
SA-182 F22V, SA-336 F22V, SA-541 22V, SA-542 Type D, Class 4a, SA-832 22V	60	59.5	58.6	57.4	56.0	54.2	53.3	52.3	51.2	50.1	49.0

**Table 1M**  
**Values of Yield Strength**

Spec. No. Grade, Class	Yield Strength, MPa, for Metal Temperature Not Exceeding, °C											
	40	100	150	200	250	300	350	375	400	425	450	475
SA-182 F22V, SA-336 F22V, SA-541 22V, SA-542 Type D, Class 4a, SA-832 22V	414	410	404	396	388	377	366	360	353	346	339	332

GENERAL NOTE: The maximum design temperature for these materials is 454°C. Values above 454°C are provided only for the purpose of interpolation.

(q) The requirements for postweld heat treatment for this material (P-No. 5C) shall be as specified for P-No. 5A material in Table KF-402.1 in Section VIII, Division 3.

(r) The welding process shall be SAW, SMAW, GTAW, or GMAW. The deposited weld metal shall meet the compositional requirements listed in Table 4.

(s) Average transverse Charpy V-notch impact values for base metal, weld metal, and heat affected zone at the lower temperature of -20°F (-29°C) or the minimum design metal temperature shall not be less than 40 ft-lb (54 J) with no single value below 35 ft-lb (48 J) after exposure to the vessel minimum postweld heat treatment cycle. The minimum postweld heat treatment temperature and hold time shall be as specified in Table KF-402.1.

In addition each heat of base metal, welding materials, and production weld tests for deposited weld metal and heat affected zone shall be tested for temper embrittlement susceptibility to determine the respective transition temperature shifts following step cooling heat treatment and shall meet the transition temperature shift relationship provided in (t). When the purchaser agrees, in lieu of step cooling tests, chemical composition limits for the J-factor and X-bar factor specified in API 934, December 2000 Edition, may be used, with the additional requirement that the X-bar chemical composition limits for welding consumables shall also be applied to the base metals and shall be less than or equal to 15. The step cooling heat treatment cycle shall be as follows:

- (1) heat to 600°F (316°C), heating rate not critical
- (2) heat at 100°F (56°C)/hr maximum to 1100°F (593°C)
- (3) hold at 1100°F (593°C) for 1 hr

**Table 2**  
**Values of  $K_c$  And  $K_b$**

Design Temperature	$k_c$	$k_b$
Less than or equal to 750°F (399°C)	1.0	0.76
800°F (427°C)	0.98	0.75
825°F (441°C)	0.90	0.75
850°F (454°C)	0.87	0.75

(4) cool at 10°F (6°C)/hr maximum to 1000°F (538°C)

(5) hold at 1000°F (538°C) for 15 hr

(6) cool at 10°F (6°C)/hr maximum to 975°F (524°C)

(7) hold at 975°F (524°C) for 24 hr

(8) cool at 10°F (6°C)/hr maximum to 925°F (496°C)

(9) hold at 925°F (496°C) for 60 hr

(10) cool at 5°F (3°C)/hr maximum to 875°F (468°C)

(11) hold at 875°F (468°C) for 100 hr

(12) cool at 50°F (28°C)/hr maximum to 600°F (316°C)

(13) cool to ambient temperature in still air

(t) The transition temperature shift relationship is as follows:

$$vTr40 + 2.5\Delta vTr40 \leq 50^\circ\text{F} (10^\circ\text{C})$$

where

$vTr40$  = 40 ft-lb (54 J) minimum transition temperature before step cooling at minimum PWHT

$\Delta vTr40$  = shift in the 40 ft-lb (54 J) minimum transition temperature due to step cooling at minimum PWHT ( $vTr40_{sc} - vTr40$ )

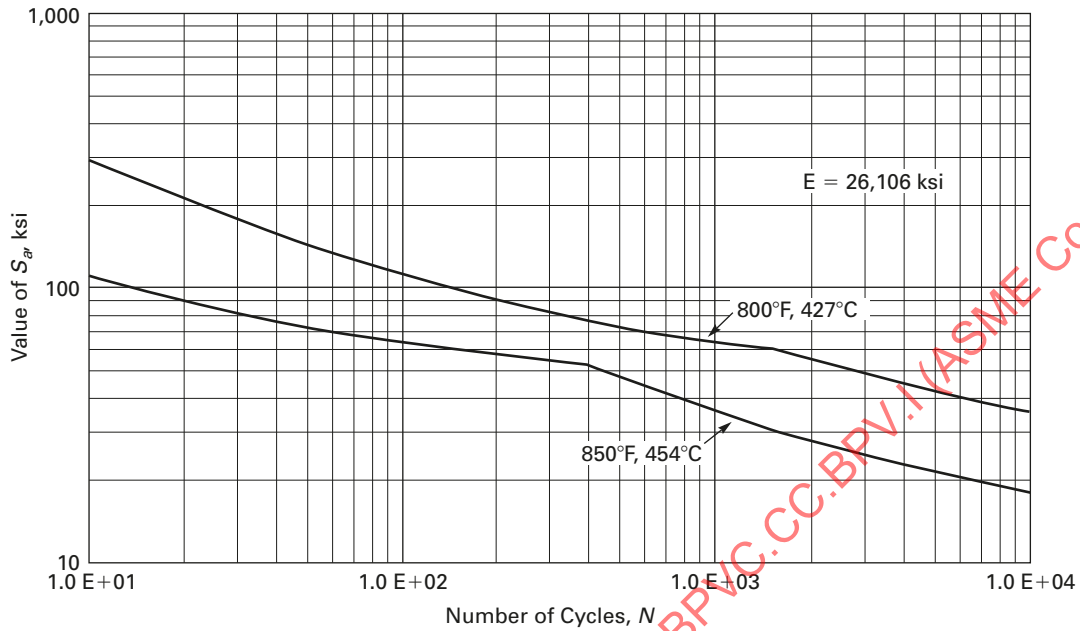
$vTr40_{sc}$  = 40 ft-lb (54 J) minimum transition temperature after step cooling at minimum PWHT

(u) Caution is advised when using this material above 700°F (375°C). After exposure to temperature above 700°F (375°C), this material may exhibit temper embrittlement and stress relaxation effects. The designer shall consider these effects and their influence on the vessel.

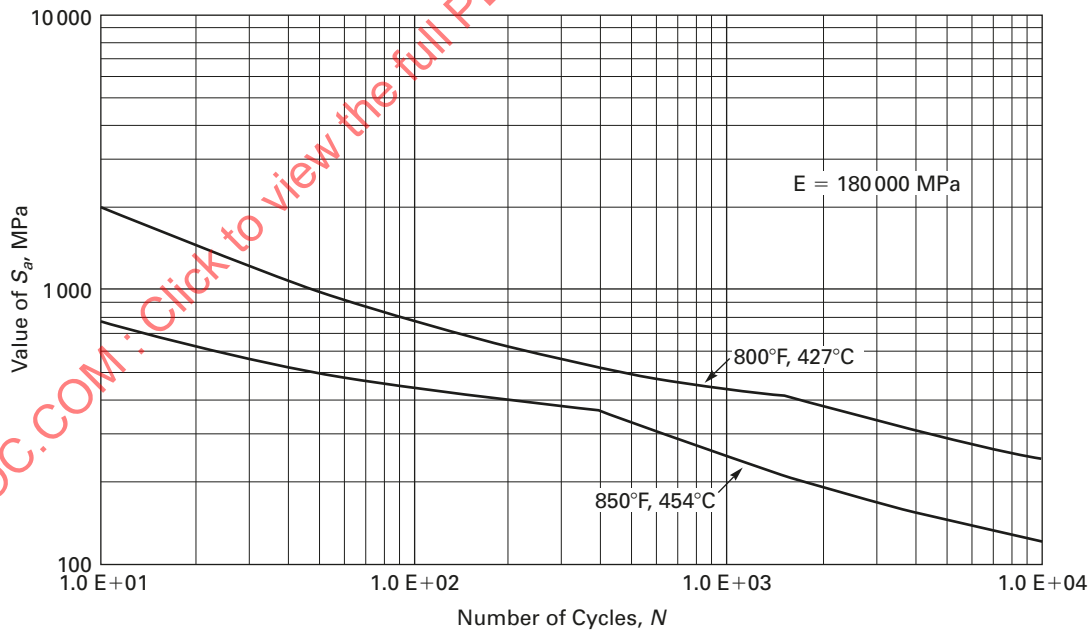
(v) All other requirements of Section VIII, Division 3 shall be satisfied.

(w) This Case number shall be marked on the material, shown and documented on the material test report, and shown on the Manufacturer's Data Report.

**Figure 1**  
Design Fatigue Curve for 2 $\frac{1}{4}$ Cr-1Mo-V Steel for Temperatures Not Exceeding 800°F (427°C) and 850°F (454°C)



**Figure 1M**  
Design Fatigue Curve for 2 $\frac{1}{4}$ Cr-1Mo-V Steel for Temperatures Not Exceeding 800°F (427°C) and 850°F (454°C)



**Table 3**  
**Tabulated Values of  $S_a$ , From Figure 1**

N	ksi	MPa
<b>For Temperature Not Exceeding 800°F (427°C)</b>		
1.E+00	294	2026
2.E+01	210	1450
5.E+01	142	978
1.E+02	110.0	759
2.E+02	88.9	613
5.E+02	71.2	491
1.E+03	62.8	433
1.72E+03	58.0	400
2.E+03	55.0	379
5.E+03	41.9	289
1.E+04	35.7	246
<b>For Temperature Not Exceeding 850°F (454°C)</b>		
1.E+00	110	759
2.E+01	89	613
5.E+01	71	491
1.E+02	62.8	433
2.E+02	56.8	392
3.97E+02	53.4	368
5.E+02	47.4	327
1.E+03	35.4	244
2E+03	27.5	190
5.E+03	20.9	144
1.E+04	17.8	123

**Table 4**  
**Composition Requirements for 2 $\frac{1}{4}$ Cr-1Mo- $\frac{1}{4}$ V Weld Metal**

Welding Process	C	Mn	Si	Cr	Mo	P	S	V	Cb
SAW	0.05-0.15	0.50-1.30	0.05-0.35	2.00-2.60	0.90-1.20	0.015 max.	0.015 max.	0.20-0.40	0.010-0.040
SMAW	0.05-0.15	0.50-1.30	0.20-0.50	2.00-2.60	0.90-1.20	0.015 max.	0.015 max.	0.20-0.40	0.010-0.040
GTAW	0.05-0.15	0.30-1.10	0.05-0.35	2.00-2.60	0.90-1.20	0.015 max.	0.015 max.	0.20-0.40	0.010-0.040
GMAW	0.05-0.15	0.30-1.10	0.20-0.50	2.00-2.60	0.90-1.20	0.015 max.	0.015 max.	0.20-0.40	0.010-0.040

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Approval Date: August 3, 2005

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2515**  
**Use of ASTM A514-00a Plate Material, All Grades**  
**Section VIII, Division 3**

*Inquiry:* May steel plate manufactured in accordance with ASTM A514-00a, all grades be used in Section VIII, Division 3 construction?

*Reply:* It is the opinion of the Committee that steel plate manufactured in accordance with ASTM A514-00a, all grades may be used in Section VIII, Division 3 construction, provided the following additional requirements are met:

(a) The design temperature shall not exceed 100°F (40°C).

(b) The yield strength values,  $S_y$ , shall be obtained from Table 1.

(c) No welding is permitted on this material.

(d) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Yield Strength Values**

For Metal Temperature Not Exceeding, °F (°C)		
Exceeding, °F (°C)	Thickness, in. (mm)	Yield Strength, ksi (MPa)
100 (40)	To $\frac{3}{4}$ (20), incl.	100 (690)
100 (40)	Over $\frac{3}{4}$ to $2\frac{1}{2}$ (20 to 65), incl.	100 (690)
100 (40)	Over $2\frac{1}{2}$ to 6 (65 to 150), incl.	90 (620)

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Approval Date: August 3, 2005

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2516**  
**Use of Chromium-Silicon Alloy Steel Wire ASTM A401/  
A401M UNS G92540**  
**Section VIII, Division 3**

*Inquiry:* Under what conditions may ASTM A401/A401M UNS G92540 be used for manufacture of special closure parts designed in accordance with KD-6 of Section VIII, Division 3?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used in the construction of closure parts conforming to the rules of KD-6 of Section VIII, Division 3, providing the following additional requirements are met:

(a) The maximum design temperature shall be 100°F (40°C).

(b) Tensile strength values to be used in design shall be as shown in [Tables 1](#) and [1M](#). Tensile strength values for intermediate diameters may be linearly interpolated. The

tensile strength used for design shall be determined using the diameter found in (c) for material that is not of a round cross-section.

(c) The mechanical testing of the material shall be performed once it is in the final cross-sectional shape and heat treated in accordance with the specification prior to coiling into a helical spring. The material shall be certified to the mechanical properties for a diameter of wire that has a diameter equivalent to the smallest cross-sectional dimension of the wire in the final shape.

(d) Welding is prohibited.

(e) The materials shall not be used for fabrication of other pressure retaining components, such as bolting, wire wound vessels, or wire wound frames.

(f) This Case number shall be shown on the material certification, marking on the material, and on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Tensile Strength Values,  $S_u$**

Diameter, in.	$S_u$ , min., ksi
0.032	300
0.041	298
0.054	292
0.062	290
0.080	285
0.092	280
0.120	275
0.135	270
0.162	265
0.177	260
0.192	260
0.219	255
0.250	250

**Table 1M**  
**Tensile Strength Values,  $S_u$**

Diameter, mm	$S_u$ min., MPa
0.8	2 080
0.9	2 070
1.0	2 060
1.1	2 040
1.2	2 020
1.4	2 000
1.6	1 980
1.8	1 960
2.0	1 940
2.2	1 920
2.5	1 900
2.8	1 880
3.0	1 860
3.5	1 840
4.0	1 820
4.5	1 800
5.0	1 780
5.5	1 760
6.0	1 740

Approval Date: December 8, 2014

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2518-2**  
**SB-407 UNS N06811, 42Ni-29Cr-28Fe-Mo-N, Seamless**  
**Pipes and Tubes**  
**Section I; Section VIII, Division 1**

*Inquiry:* Under what conditions may SB-407 UNS N06811, 42Ni-29Cr-28Fe-Mo-N, seamless pipes and tubes be used in welded construction under the rules of Section I and Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used in welded construction under the rules of Section I and Section VIII, Division 1, provided the following requirements are met:

- (a) The  $y$  value for use in PG-27 shall be 0.4.
- (b) For Section VIII, Division 1, the rules in Subsection C that shall apply are those in Part UNF for nickel, cobalt, and high nickel alloys.
- (c) The yield and tensile strength values shall be as given in Table 1 and Table 1M.
- (d) The maximum allowable stress values shall be as given in Tables 2 and 2M.
- (e) The maximum design temperature is 1,000°F (538°C) when the high set of allowable stresses is used and 1,050°F (565°C) when the low set of allowable stresses is used.

(f) For external pressure values, see Figure NFN-13 of Section II, Part D.

(g) Separate welding procedure and performance qualifications shall be performed in accordance with Section IX.

(h) Postweld heat treatment is neither required nor prohibited. When heat treatment is performed, it shall be performed at 1,920°F (1,050°C) minimum.

(i) This Case number shall be shown on the Manufacturer's Data Report.

**CAUTION: Austenitic alloys are subject to stress-corrosion cracking, intergranular attack, pitting, and crevice corrosion when used in boiler applications in aqueous environments. Factors that affect the susceptibility of these materials are applied or residual stress, water chemistry, deposition of solids, and material condition. Susceptibility to attack is enhanced when the material is used in a sensitized condition or with residual cold work. Concentration of corrosive agents (e.g., chlorides, caustic or reduced sulfur species) can occur under deposits formed on the surface of these materials and can result in severe underdeposit wastage and cracking. For successful operation in water environments, careful attention must be paid to continuous control of water chemistry.**

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1  
Yield and Customary Strength Values**

For Metal Temperature Not Exceeding, °F	Yield Strength, ksi [Note (1)]	Tensile Strength, ksi [Note (2)]
100	35.0	85.0
200	29.7	85.0
300	26.9	79.8
400	24.7	75.6
500	23.0	72.8
600	21.6	71.1
650	21.0	70.5
700	20.5	70.1
750	20.1	69.7
800	19.8	69.2
850	19.6	68.6
900	19.5	67.8
950	19.4	66.7
1,000	19.4	65.2
1,050	19.4	63.3
1,100	19.4	61.0

NOTES:

- (1) General Note (b) of Table Y-1 in Section II, Part D applies to these values.
- (2) General Note (b) of Table U in Section II, Part D applies to these values.

**Table 1M  
Yield and Customary Strength Values**

For Metal Temperature Not Exceeding, °C	Yield Strength, MPa [Note (1)]	Tensile Strength, MPa [Note (2)]
40	241	586
65	217	586
100	202	586
125	193	586
150	185	569
175	178	553
200	172	539
225	166	527
250	161	517
275	156	510
300	151	504
325	148	500
350	144	497
375	141	494
400	139	491
425	137	488
450	135	484
475	134	478
500	134	471
525	134	463
550	134	452
575	134	441

NOTES:

- (1) General Note (b) of Table Y-1 in Section II, Part D applies to these values.
- (2) General Note (b) of Table U in Section II, Part D applies to these values.

**Table 2  
Maximum Allowable Stresses**

For Metal Temperature Not Exceeding, °F	Allowable Stress Values, ksi	Allowable Stress Values, ksi
-20 to 100	23.3	23.3
200	19.8	23.3 [Note (1)]
300	17.9	23.3 [Note (1)]
400	16.5	21.6 [Note (1)]
500	15.3	20.7 [Note (1)]
600	14.4	19.4 [Note (1)]
650	14.0	18.9 [Note (1)]
700	13.7	18.5 [Note (1)]
750	13.4	18.1 [Note (1)]
800	13.2	17.8 [Note (1)]
850	13.1	17.6 [Note (1)]
900	13.0	17.5 [Note (1)]
950	12.9	17.5 [Note (1)]
1000	12.9	17.5 [Note (1)]
1050	12.9	...

GENERAL NOTE: The revised criterion of 3.5 on tensile strength was used in establishing these values.

NOTE:

- (1) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed 66<sup>2</sup>/<sub>3</sub>%, but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.

**Table 2M**  
**Maximum Allowable Stresses**

For Metal Temperature Not Exceeding, °C	Allowable	
	Stress Values, MPa	Allowable Stress Values, MPa
-30 to 40	161	161
65	148	161 [Note (1)]
100	135	161 [Note (1)]
125	129	161 [Note (1)]
150	123	161 [Note (1)]
175	119	158 [Note (1)]
200	114	154 [Note (1)]
225	111	149 [Note (1)]
250	107	144 [Note (1)]
275	104	140 [Note (1)]
300	101	136 [Note (1)]
325	98	133 [Note (1)]
350	96	130 [Note (1)]
375	94	127 [Note (1)]
400	93	125 [Note (1)]
425	91	123 [Note (1)]
450	90	122 [Note (1)]
475	90	121 [Note (1)]
500	89	120 [Note (1)]
525	89	120 [Note (1)]
550	89	120 [Note (1)]
575	89 [Note (2)]	...

GENERAL NOTE: The revised criterion of 3.5 on tensile strength was used in establishing these values.

NOTES:

- (1) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed  $66\frac{2}{3}\%$ , but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.
- (2) This value is provided for interpolation purposes only. The maximum design temperature is as stated in (d).

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Approval Date: August 4, 2006

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2520**  
**ASTM B444-04 UNS N06852, 50Ni-21.5Cr-17.5Fe-9Mo-Nb, Solution Annealed Seamless Pipes and Tubes Section I**

*Inquiry:* Under what conditions may ASTM B444-04 UNS N06852, 50Ni-21.5Cr-17.5Fe-9Mo-Nb, solution annealed seamless pipes and tubes be used in welded construction under the rules of Section I?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used in welded construction under the rules of Section I, provided the following additional requirements are met:

(a) The rules of PG-19 for UNS N06690 shall apply for this material.

(b) The  $y$  value shall be that for UNS N06690 in Note 6 of PG-27.4.

(c) The maximum allowable stress values shall be as given in Tables 1 and 1M. The maximum design temperature is 1,050°F (565°C) when the high set of stresses is used and 1,100°F (593°C) when the low set of allowable stresses is used.

(d) For external pressure design, Fig. NFN-15 in Section II, Part D, shall be used.

(e) Separate welding procedure and performance qualifications shall be performed in accordance with Section IX.

(f) Postweld heat treatment is neither required nor prohibited. When heat treatment is performed, it shall be performed at 1,920°F (1 050°C) minimum.

(g) This Case number shall be included in the material documentation and marking and shall be shown on the Manufacturer's Data Report.

**CAUTION:** Austenitic alloys are subject to stress-corrosion cracking, intergranular attack, pitting, and crevice corrosion when used in boiler applications in aqueous environments. Factors that affect the susceptibility of these materials are applied or residual stress, water chemistry, deposition of solids, and material condition. Susceptibility to attack is enhanced when the material is used in a sensitized condition or with residual cold work. Concentration of corrosive agents (e.g., chlorides, caustic or reduced sulfur species) can occur under deposits formed on the surface of these materials and can result in severe underdeposit wastage and cracking. For successful operation in water environments, careful attention must be paid to continuous control of water chemistry.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stresses**

For Metal Temperature Not Exceeding, °F	Allowable Stress Values, ksi	Allowable Stress Values, ksi
-20 to 100	23.3	23.3
200	20.7	23.3 [Note (1)]
300	19.1	23.3 [Note (1)]
400	17.9	23.2 [Note (1)]
500	17.0	22.8 [Note (1)]
600	16.4	22.1 [Note (1)]
650	16.1	21.8 [Note (1)]
700	15.9	21.5 [Note (1)]
750	15.8	21.3 [Note (1)]
800	15.6	21.1 [Note (1)]
850	15.5	20.9 [Note (1)]
900	15.4	20.6 [Note (1)]
950	15.3	20.2 [Note (1)]
1,000	15.1	19.8 [Note (1)]
1,050	15.0	19.3
1,100	14.8	...

GENERAL NOTE: The revised criterion of 3.5 on tensile strength was used in establishing these values.

NOTE:

- (1) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed 66<sup>2</sup>/<sub>3</sub>%, but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.

**Table 1M**  
**Maximum Allowable Stresses**

For Metal Temperature Not Exceeding, °C	Allowable Stress Values, MPa	Allowable Stress Values, MPa
-30 to 40	161	161
65	149	161 [Note (1)]
100	141	161 [Note (1)]
125	136	161 [Note (1)]
150	132	161 [Note (1)]
175	128	160 [Note (1)]
200	124	160 [Note (1)]
225	121	159 [Note (1)]
250	118	158 [Note (1)]
275	116	157 [Note (1)]
300	114	154 [Note (1)]
325	112	152 [Note (1)]
350	111	150 [Note (1)]
375	110	148 [Note (1)]
400	109	147 [Note (1)]
425	108	146 [Note (1)]
450	107	145 [Note (1)]
475	106	142 [Note (1)]
500	106	140 [Note (1)]
525	105	138 [Note (1)]
550	104	135 [Note (1)]
575	103 [Note (2)]	132 [Note (1)], [Note (2)]
600	102 [Note (2)]	...

GENERAL NOTE: The revised criterion of 3.5 on tensile strength was used in establishing these values.

NOTES:

- (1) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed 66<sup>2</sup>/<sub>3</sub>%, but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.
- (2) This value is provided for interpolation purposes only. The maximum design temperature is as stated in (c).

Approval Date: August 30, 2018

*Code Cases will remain available for use until annulled by the applicable Standards Committee.***Case 2523-2**  
**Use of Metric Units**  
**Section I; Section IV; Section IX; Section X; Section XII**

*Inquiry:* Under what conditions may a Manufacturer use a mixed system of units (e.g. a combination of U.S. Customary units, SI units and/or local customary units) to demonstrate compliance with all of the requirements of Sections I; IV; IX; X; and XII of the Boiler and Pressure Vessel Code?

*Reply:* It is the opinion of the Committee that a Manufacturer may use a mixed system of units (e.g., a combination of U.S. Customary Units, SI units, and/or local customary units) to demonstrate compliance with all the requirements of Sections under the following conditions:

(a) For any single equation, all variables must be expressed in a single system of units. In general, it is expected that a single system of units shall be used for all aspects of design except where infeasible or impractical. When components are manufactured at different locations where local customary units are different than those used for the general design, the local units may be used for the design and documentation of that component. Similarly, for proprietary components or those uniquely associated with a system of units different than that used for the general design, the alternate units may be used for the design and documentation of that component.

(b) When separate equations are provided for U.S. Customary and SI units, those equations must be executed using variables in the units associated with the specific equation. Data expressed in other units shall be converted to U.S. Customary or SI units for use in these equations. The result obtained from execution of these equations may be converted to other units.

(c) Production, measurement and test equipment, drawings, welding procedure specifications, welding procedure and performance qualifications, and other fabrication documents may be in U.S. Customary, SI, or local customary units in accordance with the fabricator's practice. When values shown in calculations and analysis, fabrication documents, or measurement and test equipment

are in different units, any conversions necessary for verification of Code compliance shall be in accordance with paras. (g) and (h).

(d) Material that has been manufactured and certified to either the U.S. Customary or SI material specification (e.g., SA-516 or SA-516M) may be used regardless of the unit system used in design.

(e) Standard fittings (e.g., flanges, elbows, etc.) that have been certified to either U.S. Customary units or SI units may be used regardless of the units system used in design.

(f) Conversion of units, using the precision specified in paras. (g) and (h) shall be performed to assure that dimensional consistency is maintained. Conversion factors between U.S. Customary and SI units may be found in the Nonmandatory Appendix, Guidance for the Use of U.S. Customary and SI Units in the ASME Boiler and Pressure Vessel Code. Whenever local customary units are used the Manufacturer shall provide the source of the conversion factors that shall be subject to verification and acceptance by the Authorized Inspector or Certified Individual.

(g) Conversion factors shall be accurate to at least four significant figures.

(h) The results of conversions of units shall be expressed to a minimum of three significant figures.

(i) All entries on a Manufacturer's Data Report shall be in units consistent with the fabrication drawings for the component using U.S. Customary, SI, or local customary units. It is acceptable to show alternate units parenthetically. Users of this Case are cautioned that the receiving Jurisdiction should be contacted to ensure the units are acceptable.

(j) U.S. Customary, SI, or local customary units may be used for the Code-required nameplate marking consistent with the units used on the Manufacturer's Data Report. It is acceptable to show alternate units parenthetically. Users of this Case are cautioned that the receiving Jurisdiction should be contacted to ensure the units are acceptable.

(k) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: April 26, 2007

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2527**  
**Pneumatic Testing of Pressure Vessels, U-1(j), UM**  
**Vessels**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions may single chamber pressure vessels, fabricated by a manufacturer authorized under the provisions of Section VIII, Division 1, U-1(j), UM vessels, be routinely pneumatically tested in lieu of the provisions of UG-20(f)(2) and UG-100?

*Reply:* It is the opinion of the Committee that the pneumatic test provisions prescribed in UG-100 and the restrictions of UG-20(f)(2) may be waived, provided the following requirements are met:

(a) The maximum allowable working pressure of the vessel is no greater than 500 psig (3.5 MPa).

(b) The materials used for pressure retaining portions of the vessel and for nonpressure parts attached to pressure parts by welds having a throat thickness greater than  $\frac{1}{4}$  in. (6 mm) are restricted to those listed in the notes to Fig. UCS-66.

(c) The following thickness limitations apply when using this Code Case:

(1) For butt joints, the nominal thickness at the thickest welded joint shall not exceed  $\frac{1}{2}$  in. (13 mm).

(2) For corner joints or lap welds, the thinner of the two parts joined shall not exceed  $\frac{1}{2}$  in. (13 mm).

(3) ASME B16.5 ferritic steel flanges used at design metal temperature no colder than  $-20^{\circ}\text{F}$  ( $-29^{\circ}\text{C}$ ) may be used without thickness limitation.

(d) The minimum metal temperature during the pneumatic test shall be maintained at least  $30^{\circ}\text{F}$  ( $17^{\circ}\text{C}$ ) above that given in Fig. UCS-66 for the governing material classification and thickness combination in UCS-66(a).

(e) The pneumatic test pressure shall be at least equal to 1.3 times the maximum allowable working pressure, to be stamped on the vessel, multiplied by the lowest ratio (for the materials of which the vessel is constructed) of the stress value  $S$  for the test temperature of the vessel to the stress value  $S$  for the design temperature (see UG-21). In no case shall the pneumatic test pressure exceed 1.3 times the basis for calculated test pressure by more than 10% as defined in Appendix 3-2. The provisions of UG-100 shall not apply.

(f) The pressure in the vessel shall be gradually increased to not more than one-half of the test pressure. Thereafter, the test pressure shall be increased in steps of approximately one-tenth of the test pressure until the required test pressure has been reached. Then the pressure shall be reduced to a value equal to the test pressure divided by 1.3 and held for a sufficient time to permit inspection of the vessel. This inspection for leakage may be performed outside of the test facility defined in (g)(1). The visual inspection of the vessel at the required test pressure divided by 1.3 may be waived, provided:

(1) a suitable gas leak test is applied.

(2) substitution of the gas leak test is by agreement reached between Manufacturer and Inspector.

(3) all welded seams that will be hidden by assembly are given a visual examination for workmanship prior to assembly.

(4) the vessel will not be constructed and stamped for "lethal" service [see UG-116(d)].

(g) The Manufacturer is responsible for performing the pneumatic test in accordance with one of the following two options:

(1) in a test facility that is capable of containing, including the pressure wave and projectiles, a catastrophic failure of the vessel under the maximum pneumatic test pressure permitted in (e). The Manufacturer shall attest to the adequacy of such a facility by one of the following signed certifications:

(-a) For test facilities installed inside the United States or Canada, certification by a Professional Engineer experienced in the design of blast-resistant enclosures and registered in either one or more states of the United States or provinces of Canada, or;

(-b) For test facilities installed outside the United States and Canada, certification by an Engineer experienced in the design of blast-resistant enclosures with qualifications acceptable to the concerned legal jurisdiction.

The signed certification shall be identified in the written description of the Quality Control System [see UG-117(e)] for information to the Authorized Inspector as a part of the UG-117(f) authorization and annual reviews.

The Manufacturer shall ensure that the test facility is constructed and installed in accordance with the design as certified above.

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(2) or the Manufacturer shall ensure the distances required by ASME PCC-2, Article 5.1, Appendices II and III are adhered to between the pressure vessel and all personnel during the pressure test.

(h) This Case number shall be shown on the Manufacturer's Data Report.

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Approval Date: October 27, 2005

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2529**  
**Drain Valve on Horizontal Helical Coil Watertube**  
**Boilers**  
**Section IV**

*Inquiry:* May a drain valve be connected at a location other than the lowest practicable water containing space on a horizontally mounted helical coil heating boiler or HLW stamped water heater?

*Reply:* It is the opinion of the Committee that a drain valve may be connected at a location other than the lowest practicable water containing space on a horizontally mounted helical coil heating boiler or HLW stamped water heater, provided the following conditions are met:

(a) The boiler or water heater shall be a watertube type with a horizontally mounted helical coil heat exchanger.

(b) A drain valve shall be connected at the lowest practicable point in the piping connected to the heat exchanger.

(c) Helical Coil heat exchanger must be made of a corrosion resistant material.

(d) All other requirements of Section IV shall apply.

(e) This Case number shall be included on the Manufacturer's Data Report Form H-3 or Form HLW-6.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: December 15, 2011

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2532-4**  
**Titanium Aluminum Vanadium Iron Alloy, Grade 38 (Ti 4Al-2.5V-1.5Fe) UNS R54250**  
**Section VIII, Division 1**

*Inquiry:* May titanium Grade 38 (Ti 4Al-2.5V-1.5Fe) alloy be used in Section VIII, Division 1 construction?

*Reply:* It is the opinion of the Committee that the titanium Grade 38 Ti 4Al-2.5V-1.5Fe alloy may be used in Section VIII, Division 1 construction, provided the following requirements are met:

(a) The material shall meet the requirements of the ASME Specifications in [Table 1](#).

(b) The maximum allowable stress values shall be as shown in [Table 2](#) or [2M](#). The maximum design temperature shall not exceed 650°F (343°C).

(c) The charts for determining thickness for those components under external pressure are shown in [Figures 1](#) and [1M](#) and the corresponding tabular values are shown in [Table 3](#).

(d) Welding procedure and performance qualifications shall be conducted in accordance with Section IX. Separate welding procedure and performance qualification are required for this material, and the minimum tensile strength shall be 130 ksi (895 MPa).

(e) All other rules for Section VIII, Division 1, Part UNF applicable to titanium shall be met.

(f) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

Product	Specification	Grade
Bar, billet	SB-348	38
Forgings	SB-381	38
Plate, sheet, strip	SB-265	38
Seamless and welded fittings	SB-363	WPT38, WPT38W
Seamless pipe	SB-861	38
Seamless tube	SB-338	38
Welded pipe	SB-862	38
Welded tube	SB-338	38

For Metal Temperature Not Exceeding, °F	Allowable Stress Values, ksi	
	Wrought	Wld Pipe, Tube, Fittings [Note (1)]
100	37.1	31.6
150	37.1	31.6
200	37.1	31.6
250	35.6	30.3
300	34.2	29.0
350	32.8	27.8
400	31.5	26.8
450	30.4	25.8
500	29.5	25.0
550	28.7	24.4
600	28.1	23.9
650	27.6	23.5

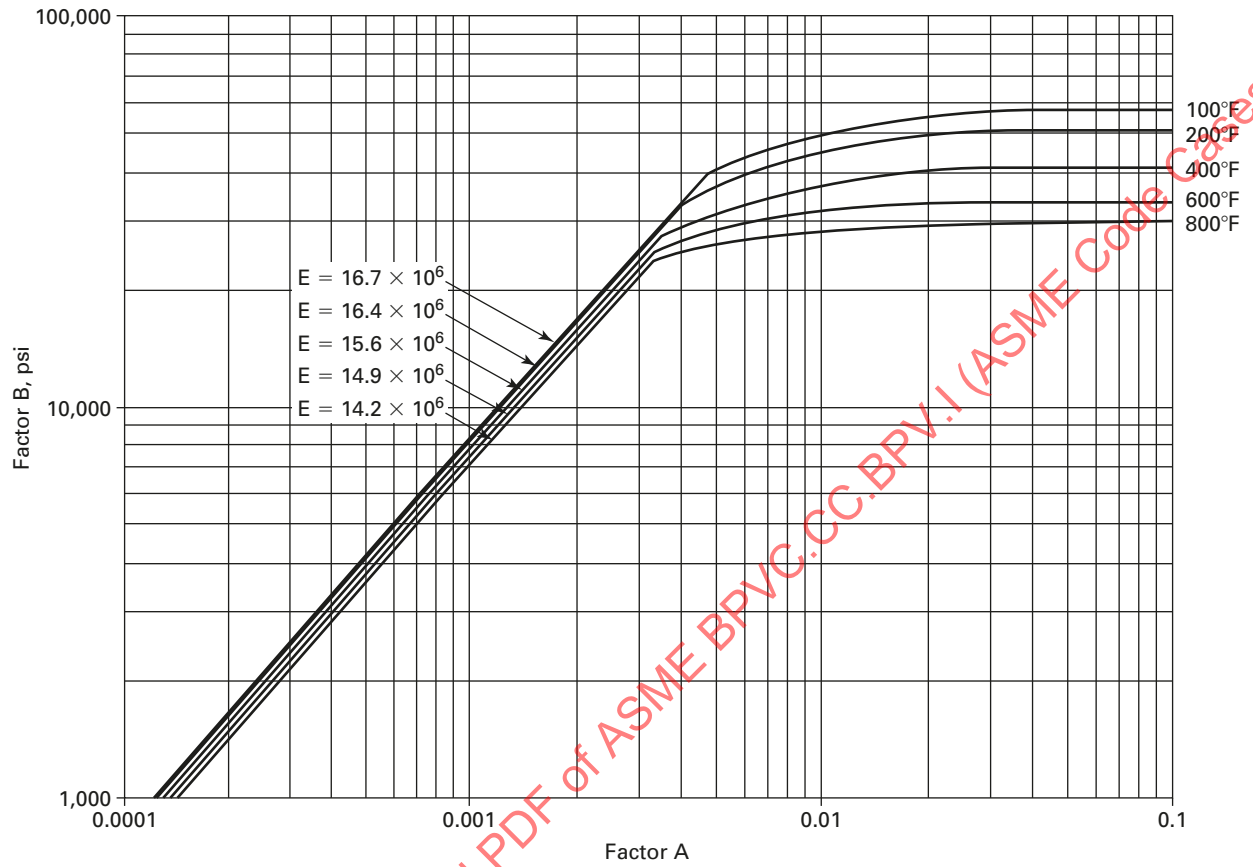
NOTE:  
(1) A factor of 0.85 has been used in establishing these allowable stresses.

For Metal Temperature Not Exceeding, °C	Allowable Stress Values, MPa	
	Wrought	Wld Pipe, Tube, Fittings [Note (1)]
40	256	218
65	256	218
100	254	216
125	244	208
150	235	200
175	226	192
200	218	186
225	211	180
250	205	175
275	200	170
300	196	167
325	193	164
350 [Note (2)]	190	161

NOTES:  
(1) A factor of 0.85 has been used in establishing these allowable stresses.  
(2) Values for 350°C temperature are provided for interpolation purposes.

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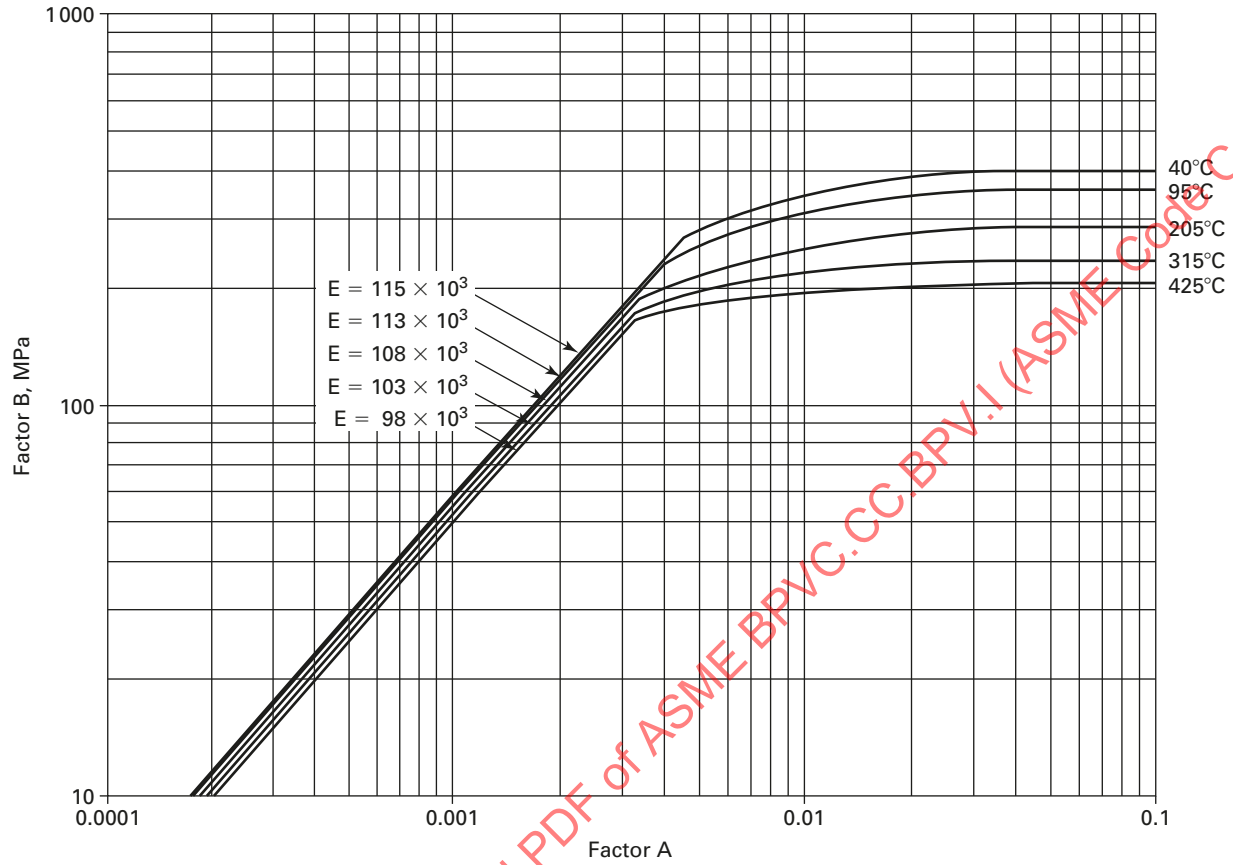
**Figure 1**  
**Chart for Determining Shell Thickness of Components Under External Pressure Developed for Titanium Grade 38, Ti 4Al-2.5V-1.5Fe**



GENERAL NOTE: When unidirectionally produced bar product is utilized for stiffening rings, Factor A, elastic or inelastic, shall be multiplied by 1.1 to account for reduced stiffness.

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**Figure 1M**  
**Chart for Determining Shell Thickness of Components Under External Pressure Developed for Titanium Grade 38, Ti 4Al-2.5V-1.5Fe**



GENERAL NOTE: When unidirectionally produced bar product is utilized for stiffening rings, Factor A, elastic or inelastic, shall be multiplied by 1.1 to account for reduced stiffness.

**Table 3**  
**Tabular Values for Figure 1 and 1M**

Temp., °F	A	B, psi	Temp., °C	A	B, MPa
100	1.00E-05	8.35E+01	40	1.00E-05	5.76-01
	1.20E-04	1.00E+03		1.74E-04	1.00+01
	4.67E-03	3.90E+04		4.67E-03	2.69+02
	7.26E-03	4.60E+04		7.26E-03	3.17
	1.05E-02	5.00E+04		1.05E-02	3.45
	1.83E-02	5.48E+04		1.83E-02	3.78
	3.83E-02	5.75E+04		3.83E-02	3.96
	1.00E-01	5.75E+04		1.00E-01	3.96
200	1.00E-05	8.20E+01	95	1.00E-05	5.65-01
	1.22E-04	1.00E+03		1.77E-04	1.00+01
	4.09E-03	3.35E+04		4.09E-03	2.31+02
	5.97E-03	3.90E+04		5.97E-03	2.69
	1.01E-02	4.50E+04		1.01E-02	3.10
	2.44E-02	5.00E+04		2.44E-02	3.45
	4.11E-02	5.14E+04		4.11E-02	3.54
	1.00E-01	5.14E+04		1.00E-01	3.54
400	1.00E-05	7.80E+01	205	1.00E-05	5.38-01
	1.28E-04	1.00E+03		1.85E-04	1.00+01
	3.53E-03	2.75E+04		3.53E-03	1.90+02
	6.57E-03	3.35E+04		6.57E-03	2.31
	1.17E-02	3.75E+04		1.17E-02	2.59
	2.00E-02	4.00E+04		2.00E-02	2.76
	3.00E-02	4.11E+04		3.00E-02	2.83
	1.00E-01	4.11E+04		1.00E-01	2.83
600	1.00E-05	7.45E+01	315	1.00E-05	5.14-01
	1.34E-04	1.00E+03		1.94E-04	1.00+01
	3.36E-03	2.50E+04		3.36E-03	1.72+02
	4.78E-03	2.79E+04		4.78E-03	1.92
	1.23E-02	3.25E+04		1.23E-02	2.24
	4.50E-02	3.41E+04		4.50E-02	2.35
	1.00E-01	3.41E+04		1.00E-01	2.35
	800	1.00E-05		7.10E+01	425
1.41E-04		1.00E+03	2.04E-04	1.00+01	
3.38E-03		2.40E+04	3.38E-03	1.65+02	
3.88E-03		2.50E+04	3.88E-03	1.72	
8.82E-03		2.80E+04	8.82E-03	1.93	
5.45E-02		3.00E+04	5.45E-02	2.07	
1.00E-01		3.00E+04	1.00E-01	2.07	

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Approval Date: January 3, 2006

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2534**  
**Use of SA-240 (UNS S43932) in Thickness Less Than**  
 **$\frac{1}{4}$  in.**  
**Section IV**

*Inquiry:* Under what conditions may SA-240 (UNS S43932) in thickness less than  $\frac{1}{4}$  in. (6 mm) be used in Section IV construction?

*Reply:* It is the opinion of the Committee that SA-240 (UNS S43932) in thickness less than  $\frac{1}{4}$  in. (6 mm) be used in Section IV construction, provided:

(a) The operative service shall be limited to closed hot water heating systems at a maximum pressure of 80 psi (550 kPa).

(b) The cylindrical parts for combustion chamber and pressure vessel shall be limited to a maximum of 38 in. (950 mm) outside diameter.

(c) The material thickness shall not be less than  $\frac{3}{32}$  in. (2.5 mm) (actual thickness) for the combustion chamber design.

(d) The material thickness shall not be less than 0.0394 in. (1 mm) (actual thickness) for the secondary flue gas heat exchange surfaces.

(e) Separate procedure and performance qualifications shall be performed in accordance with Section IX.

(f) The maximum allowable stress value shall be as shown in Table 1.

(g) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress**

<u>Spec. No.</u>	<u>Grade</u>	<u>Spec. Min. Tensile Strength,</u> <u>ksi (MPa)</u>	<u>Spec. Min. Yield Strength</u> <u>ksi (MPa)</u>	<u>Max. Allowable</u> <u>Stress Value ksi</u> <u>(MPa)</u>
SA-240	S43932	65 (448)	30 (207)	13 (89)

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Approval Date: October 27, 2005

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2537**  
**Alternative Rules for Ellipsoidal or Torispherical Heads Having Integral Backing Strip Attached to Shells**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions may ellipsoidal or torispherical heads having an integral backing strip be attached to shells?

*Reply:* It is the opinion of the Committee that an ellipsoidal or torispherical head having an integral backing strip be attached to shells provided the following requirements are met:

- (a) MAWP on the vessel shall not exceed 470 psig (1.1 MPa).
- (b) Maximum design metal temperature shall not exceed 400°F (205°C).
- (c) MDMT stamped on the nameplate shall not be colder than -20°F (-29°C).
- (d) Cyclic loading is not a controlling design requirement (see UG-22).

(e) The vessel is not in lethal service (see UW-2).

(f) The straight flange (skirt) of the head is machined to form an integral backing strip meeting the requirements of Figure 1.

(g) Outside diameter of the formed head and shell shall not exceed 30 in. (750 mm).

(h) The required thickness of the formed head shall not exceed  $\frac{1}{2}$  in. (13 mm). The thickness of the head straight flange shall be at least that required for a seamless shell of the same outside diameter.

(i) The required thickness of the shell shall not exceed  $\frac{3}{16}$  in. (5 mm).

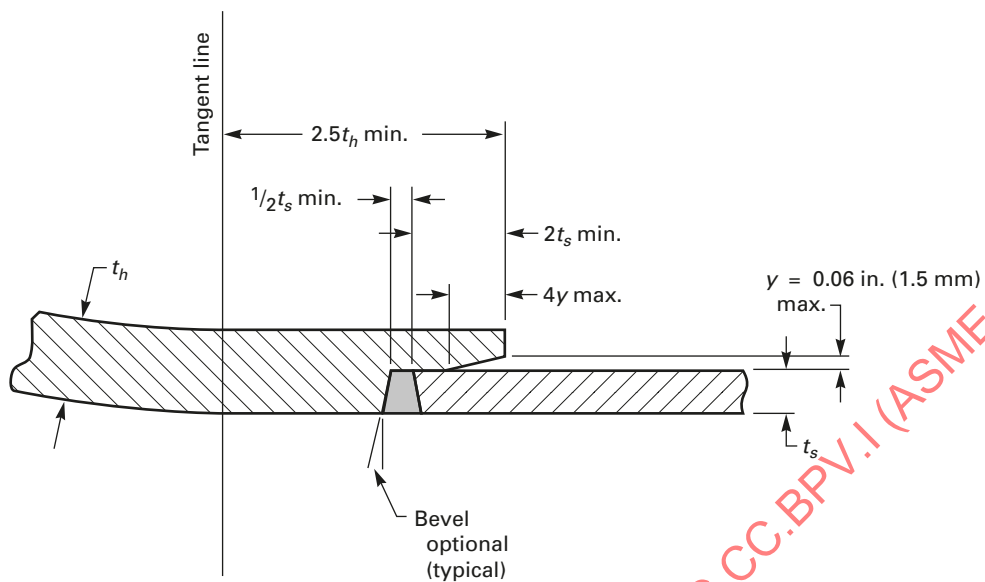
(j) Heads shall have a driving force fit before welding.

(k) The joint efficiency of the head-to-shell joint shall be determined from Table UW-12 for a Type 2 joint depending on the degree of radiographic examination. The limitations in Table UW-12 for the Type 2 joints do not apply.

(l) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Figure 1**  
**Integral Backing Strip**



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Approval Date: January 19, 2006

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2538**  
**Minimum Thickness of Furnace Brazed Plate Heat Exchanger Heads**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions may a furnace brazed plate heat exchanger head be produced below the minimum thickness specified by UG-16?

*Reply:* It is the opinion of the Committee that a furnace brazed plate heat exchanger may be produced with a thickness less than that specified by UG-16 under the following conditions:

(a) The head has a minimum thickness of 0.016 in. (0.4 mm).

(b) The head is integrally brazed to and supported by a series of adjoining heat transfer plate(s).

(c) All other applicable requirements of Section VIII, Division 1 have been met.

(d) The head is protected from mechanical damage by the finned portion of the heat exchanger and by the integral underlying brazed structure.

(e) This Case number shall be shown on the Manufacturer's Data Report.

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Approval Date: July 2, 2010

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2540**  
**2.5Cr-1Mo-V-B-Ti Material**  
**Section I**

*Inquiry:* May 2.5Cr-1Mo-V-B-Ti (UNS K30736) seamless tubes with the chemical analysis shown in Table 1 and minimum mechanical properties shown in Table 2 that otherwise conform to SA-213 be used for Section I construction?

*Reply:* It is the opinion of the Committee that normalized and tempered seamless 2.5Cr-1Mo-V-B-Ti tubes with the chemical analysis shown in Table 1 and minimum mechanical properties shown in Table 2 that otherwise conform to SA-213/SA-213M may be used for Section I construction, provided the following requirements are met:

(a) The wall thickness of the tubes shall not be greater than 0.5 in. (12.7 mm).

(b) The material shall be austenitized within the temperature range from 1800°F–1870°F (980°C–1020°C) followed by air cooling or accelerated cooling and tempered within the range from 1325°F–1425°F (720°C–775°C).

(c) The material in the final tempered condition shall not exceed a Brinell Hardness Number of 250 HBW (HRC 25).

(d) The maximum design temperature shall be 1067°F (575°C).

(e) The maximum allowable stress values for the material shall be those given in Table 3 or Table 3M.

(f) Separate weld procedure qualification shall apply for this material. For the purpose of performance qualification, the material shall be considered P-No. 5A. The performance qualification shall be conducted as prescribed in Section IX.

(g) Exemptions to postweld heat treatment for this material shall be in accordance with the rules for P-No. 5A materials in PW-39. When postweld heat treatment is required, the time requirements shall be in accordance with the rules for P-No. 5A, and the PWHT temperature range shall be 1325°F–1425°F (720°C–775°C).

(h) All cold-formed material that is designed for service at a nominal temperature of 900°F (480°C) or higher shall be heat treated in accordance with the following rules. Cold-bending or -forming is defined as any method that

produces strain in the material and is performed at a temperature below 1200°F (650°C). The calculations of cold strains shall be made as described in Section I, PG-19.

(1) For tubes of diameter smaller or equal to 3 in. (76.1 mm) with greater than 28% strain, the cold-formed area, including the transition to the unstrained portion, shall be stress relieved at a temperature between 1200°F and 1380°F (650°C and 750°C), with a soaking time of 1 hr/in. (1 h/25 mm), minimum of 1 hour, followed by cooling in air.

(2) For all cold swages, flares, and upsets regardless of the dimension and the amount of cold reduction, and for tubes of diameter greater than 3 in. (76.1 mm) with greater than 17% strain, the material shall be re-austenitized and tempered in accordance with (b). This heat treatment shall not be performed locally. The material shall be either heat treated in its entirety, or the cold-strained area (including the transition) shall be cut away from the balance of the tube or component, and heat treated separately or replaced.

(3) In all other cases, heat treatment is neither required nor prohibited.

(i) All material formed at or above 1200°F (650°C) shall be re-austenitized and tempered in accordance with (b). This heat treatment shall not be performed locally. The material shall be either heat treated in its entirety, or the hot-formed area (including the transition) shall be cut away from the balance of the tube or component, and heat treated separately or replaced.

(j) Except as provided in (k), if during manufacturing any portion of the component is heated to a temperature greater than 1425°F (775°C), then the component heated above 1425°F (775°C), including the heat-affected zone created by the local heating, shall be removed, renormalized and tempered, and then replaced in the component.

(k) If the allowable stresses to be used are less than or equal to those provided in Table 1A in Section II, Part D for Grade 22 (SA-213/SA-213M, T22) at the design temperature, then the requirements of (j) may be waived, provided that the portion of the component heated to a temperature greater than 1470°F (800°C) is reheat treated within the temperature range 1325°F–1425°F (720°C–775°C).

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

(1) This Case number shall be referenced in the documentation and marking of the material and shall be shown on the Manufacturer's Data Report.

Element	Composition Limits, %
Carbon	0.05-0.10
Manganese	0.30-0.70
Phosphorus, max.	0.020
Sulfur, max.	0.010
Silicon	0.15-0.45
Chromium	2.20-2.60
Molybdenum	0.90-1.10
Vanadium	0.20-0.30
Titanium	0.06-0.10
Nitrogen, max.	0.012
Aluminum, max.	0.02
Boron	0.0015-0.007

**Table 2  
Mechanical Property Requirements**

Tensile strength, min., ksi (MPa)	85 (585)
Yield strength, min., ksi (MPa)	60 (415)
Elongation in 2 in., min., % [Note (1)]	20

NOTE:

(1) For longitudinal strip tests, a deduction from the basic values of 1.00% for each  $\frac{1}{32}$  in. decrease in wall thickness below  $\frac{5}{16}$  in. (7.8 mm) shall be made. The following table gives the computed values.

Wall Thickness, in.	Elongation in 2 in., min., %
$\frac{5}{16}$ (0.312)	20.0
$\frac{9}{32}$ (0.281)	19.0
$\frac{1}{4}$ (0.250)	18.0
$\frac{7}{32}$ (0.219)	17.0
$\frac{3}{16}$ (0.188)	16.0
$\frac{5}{32}$ (0.156)	15.0
$\frac{1}{8}$ (0.125)	14.0
$\frac{3}{32}$ (0.094)	13.0
$\frac{1}{16}$ (0.062)	12.0
0.062 to 0.035, excl.	11.6
0.035 to 0.022, excl.	10.9
0.022 to 0.015, incl.	10.6

GENERAL NOTE: The above table gives the computed minimum elongation values for each  $\frac{1}{32}$  in. decrease in wall thickness. Where the wall thickness lies between two values shown above, the minimum elongation value shall be determined by the following equation:

$$E = 32t + 10.0$$

$E$  = elongation in 2 in., %

$t$  = actual thickness of specimen, in.

**Table 3**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Max. Allowable Stress Values, ksi
100	24.3
200	24.3
300	23.9
400	23.3
500	23.0
600	22.9
650	22.8
700	22.7
750	22.4
800	22.1
850	21.5
900	20.9
950	<i>19.1</i>
1000	<i>14.6</i>
1050	<i>9.8</i>
1100 [Note (1)]	<i>5.8</i>

GENERAL NOTE: Values shown in italics are obtained from time-dependent properties.

NOTE:

(1) The stress value at 1100°F is provided for interpolation only. The maximum design is stated in (d) of the Reply.

**Table 3M**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Max. Allowable Stress Values, MPa
100	167
200	161
300	158
400	154
425	152
450	149
475	145
500	140
525	115
550	86.2
575	57.2

GENERAL NOTE: Values shown in italics are obtained from time-dependent properties.

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Approval Date: January 22, 2007

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**Case 2543**  
**25Cr-6Ni-Mo-N, UNS S32506, Austenitic-Ferritic Duplex**  
**Stainless Steel**  
**Section VIII, Division 1**

*Inquiry:* May 25Cr-6Ni-Mo-N, UNS S32506, austenitic-ferritic duplex stainless steel sheet, strip, plate, pipe, tube, and bar, meeting the chemical composition and mechanical property requirements shown in [Tables 1](#) and [2](#), and otherwise conforming to one of the specifications given in [Table 3](#), be used in welded construction under the rules of Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used in Section VIII, Division 1 construction, provided the following additional requirements are met:

(a) The material shall be heat treated at a temperature of 1870°F to 2050°F (1020°C to 1120°C) followed by rapid cooling in air or water.

(b) The rules for austenitic-ferritic duplex stainless steels in Subsection C, Part UHA shall apply.

(c) The maximum allowable stress values for the material shall be those given in [Tables 4](#) and [4M](#).

(d) For welded pipe and tube products, a joint efficiency factor of 0.85 shall be used.

(e) For external pressure design, Fig. HA-5 of Section II, Part D shall be used.

(f) Maximum design temperature of the material shall be 600°F (316°C).

(g) This material shall be considered as P-No. 10H, Group 1.

(h) Heat treatment after forming or fabrication is neither required nor prohibited. When heat treatment is performed, it shall be performed as noted in [\(a\)](#).

(i) This Case number shall be shown on the documentation and marking of the material and on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Chemical Requirements**

Element	Composition, %
Carbon, max.	0.030
Manganese, max.	1.00
Phosphorus, max.	0.040
Sulfur, max.	0.015
Silicon, max.	0.90
Nickel	5.50-7.20
Chromium	24.00-26.00
Molybdenum	3.00-3.50
Tungsten	0.05-0.30
Nitrogen	0.08-0.20

**Table 2**  
**Mechanical Property Requirements**

Tensile strength, min. ksi (MPa)	90 (620)
Yield strength, min. ksi (MPa)	65 (450)
Elongation in 2 in. or 50 mm, min., %	18
Hardness HRC, max.	32

**Table 3**  
**Product Requirements**

Bars and shapes	SA-479
Forgings	SA-182
Seamless and welded pipes	SA-790
Seamless and welded tubes	SA-789
Sheet, strip, and plate	SA-240

**Table 4**  
**Maximum Allowable Stresses**

For Metal Temperature Not Exceeding, °F	Allowable Stress Values, Max., ksi [Note (1)]
100	25.7
200	25.7
300	24.4
400	24.1
500	24.1
600	24.1

GENERAL NOTE: This material may embrittle by exposure to moderately elevated temperatures. See paras. A-340 and A-360 in Appendix A of Section II, Part D.

NOTE:

(1) The revised criterion of 3.5 on tensile strength was used in establishing these values.

**Table 4M**  
**Maximum Allowable Stresses**

For Metal Temperature Not Exceeding, °C	Allowable Stress Values, Max., MPa [Note (1)]
40	177
65	177
125	175
150	171
175	168
200	166
225	166
250	166
275	166
300	166
325	166 [Note (2)]

GENERAL NOTE: This material may embrittle by exposure to moderately elevated temperatures. See paras. A-340 and A-360 in Appendix A of Section II, Part D.

NOTES:

(1) The revised criterion of 3.5 on tensile strength was used in establishing these values.

(2) This value is provided for interpolation purposes only. The maximum use temperature is 600°F (316°C).

Approval Date: January 26, 2009

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2544-2**  
**Tolerance for Formed Heads for External Pressure**  
**Design Conditions**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions may the requirements of UG-81(b) be waived?

*Reply:* It is the opinion of the Committee that requirements of UG-81(b) may be waived, provided the following conditions are met:

(a)  $t/r$  is greater than 0.01

where

$r$  = outer radius

$t$  = nominal thickness of the formed head

(b) The maximum allowable external pressure calculated in accordance with UG-33 of Division 1 is more than five times the required design external pressure.

(c) The external pressure to be stamped on the nameplate shall be no greater than 20% of the calculated maximum allowable external pressure.

(d) This Case number shall be shown on the Manufacturer's Data Report.

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Approval Date: January 19, 2006

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2546**  
**Use of SA-240 Grade 904L (UNS N08904)**  
**Section IV**

*Inquiry:* Under what conditions may SA-240 Grade 904L (UNS N08904) be used in the construction of Section IV boilers?

*Reply:* It is the opinion of the Committee that SA-240 Grade 904L (UNS N08904) may be used for Section IV construction, provided the following requirements are met:

(a) The operating service shall be limited to closed hot water heating systems at a maximum pressure of 80 psi (550 kPa).

(b) The cylindrical parts for combustion chamber and pressure vessel shall be limited to a maximum of 38 in. (950 mm) outside diameter.

(c) The material thickness shall not be less than  $\frac{3}{32}$  in. (2.5 mm) (actual thickness) for combustion chamber design.

(d) The material thickness shall not be less than 0.0394 in. (1 mm) (actual thickness) for secondary flue gas heat exchange surfaces.

(e) The maximum allowable stress value shall be as shown in Tables 1 and 1M.

(f) P-No. 45 shall be assigned to this material for welding procedure and performance qualification.

(g) This Case number shall be shown on the Manufacturer's Data Report.

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**Table 1**  
**Maximum Allowable Stress Values**

Specification Number	Grade	Spec. Min. Tensile Strength, ksi	Spec. Min. Yield Strength, ksi	Allowable Stress Value, ksi For Metal Temperatures Not Exceeding °F				
				-20 to 100	200	300	400	500
SA-240	904L	71	31	14.2	14.2	13.6	13.1	12.7

**Table 1M**  
**Maximum Allowable Stress Values**

Specification Number	Grade	Spec. Min. Tensile Strength, MPa	Spec. Min. Yield Strength, MPa	Allowable Stress Value, MPa For Metal Temperatures Not Exceeding °C				
				-30 to 40	100	150	200	250
SA-240	904L	490	220	98	97.8	93.4	90.4	88.2

Approval Date: January 3, 2006

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2554**  
**Alternative Method to Area Replacement Rules for**  
**Openings Under Internal Pressure**  
**Section XII**

*Inquiry:* In Section XII vessels, may openings in cylindrical shells subjected to internal pressure be designed to rules other than those given in TD-610?

*Reply:* It is the opinion of the Committee that Section XII vessel openings in cylindrical shells subjected to internal pressure as shown in Fig. TW-140.2-1 with full penetration welds and integral reinforcement may be designed for internal pressure using the following rules instead of those given in TD-610.

(a) *Nomenclature* (See Figure 1)

$$B_1 = 162 \text{ for } t_n/t \leq 1.0$$

$$= 54 \text{ for } t_n/t > 1.0$$

$$B_2 = 210 \text{ for } t_n/t \leq 1.0$$

$$= 318 \text{ for } t_n/t > 1.0$$

$d_m$  = mean diameter of connecting pipe, (corroded condition), [see (b)(9)]

$D_m$  = mean diameter of cylindrical vessel (corroded condition)

$t_p$  = nominal wall thickness of connecting pipe, less corrosion allowance

$t_n$  = nominal wall thickness of nozzle, less corrosion allowance

$t$  = nominal wall thickness of vessel, less corrosion allowance

$t_r$  = required thickness of vessel wall calculated per TD-300.2, with  $E = 1.00$

$L$  = axial length of nozzle with thickness  $t_n$

$$\lambda = (d_m/D_m)(D_m/t)^{1/2}$$

$t_{std}$  = nominal wall thickness of ASME B36.10 standard weight pipe

(b) The following conditions shall be met:

(1) Use of this Case is limited to temperatures where time-dependent properties do not control the allowable stress. See Section II, Part D, Table 1A Notes (Time-Dependent Properties).

(2) Material shall be ferrous steel with allowable stress in tension per Table 1A of Section II, Part D. The specified minimum yield strength/specified minimum tensile strength (YS/TS) shall be  $\leq 0.80$ .

(3) The openings shall not exceed the DN 600 (NPS 24).

(4) The ratio of opening diameter to vessel diameter ( $d_m/D_m$ ) and the ratio of vessel diameter to vessel thickness ( $D_m/t$ ) shall meet the following limits:

$$(-a) \text{ For } (d_m/D_m) > 0.5 \quad (D_m/t) \leq 100$$

$$(-b) \text{ For } (d_m/D_m) \leq 0.5 \quad (D_m/t) \leq 250$$

(5) Cyclic loading is not a controlling design requirement (see TD-200).

(6) The opening is in a cylindrical vessel. It shall be located not less than  $1.8 (D_m t)^{1/2}$  from any other gross structural discontinuity such as a head or stiffener.

(7) The spacing between the centerlines of the openings and any other opening is not less than three times their average diameter.

(8) The opening is circular in cross section and the nozzle axis is normal to the surface of the cylindrical vessel. These rules do not apply to laterals, non-uniform-wall nozzles, or pad reinforcements.

(9) If  $L < 0.5 (d_m t_n)^{1/2}$ , use  $t_n = t_p$  in eq. (11)(1) and (11)(2) below.

(10)  $t_n$  shall not be less than  $7/8 t_{std}$  through an axial length of  $(d_m t_n)^{1/2}$ . The other applicable rules of TD-680 shall be met.

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**CASE (continued)**  
**2554**

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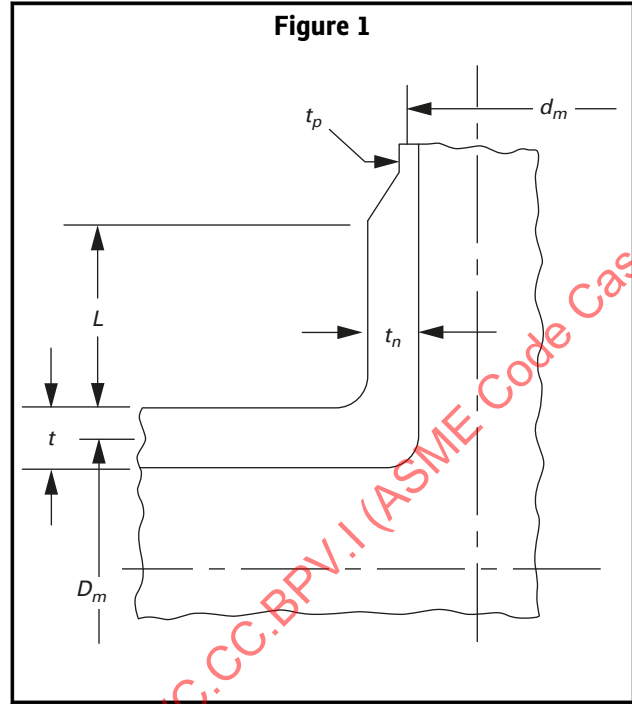
(11) The opening shall satisfy eqs. (1) and (2), as follows:

$$\frac{2 + 2\left(\frac{d_m}{D_m}\right)^{3/2}\left(\frac{t_n}{t}\right)^{1/2} + 1.25\lambda}{1 + \left(\frac{d_m}{D_m}\right)^{1/2}\left(\frac{t_n}{t}\right)^{3/2}} \leq 2.95\left(\frac{t}{t_r}\right) \quad (1)$$

$$\frac{\left[ B_1\left(\frac{t_n}{t}\right)^2 + 228\left(\frac{t_n}{t}\right)\left(\frac{d_m}{D_m}\right) + B_2\right]\lambda + 155}{108\lambda^2 + \left[ 228\left(\frac{d_m}{D_m}\right)^2 + 228\right]\lambda + 152} \geq (0.9\epsilon + 0.005\lambda)\left(\frac{t_r}{t}\right) \quad (2)$$

(12) This Case number shall be shown on the Manufacturer's Data Report.

(c) This Code Case was developed from WRC Bulletin 335.



Approval Date: September 15, 2009

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2556-2**  
**Method for Basing Design Values on Material Properties**  
**Affirmed by Material Manufacturers**  
**Section I; Section VIII, Division 1; Section VIII, Division 2;**  
**Section VIII, Division 3**

*Inquiry:* The European Pressure Equipment Directive (PED) has provisions that require the values used in the design of pressure equipment to be based on material properties affirmed by the material manufacturer. By what rules are the values provided in the ASME Boiler and Pressure Vessel Code related to the properties affirmed by the material manufacturer in accordance with the requirements of the applicable SA/SB specification?

*Reply:* It is the opinion of the Committee that the values provided in the ASME Boiler and Pressure Vessel Code that are used in the design of boilers and pressure vessels are based on the properties affirmed by the material manufacturer (in accordance with the requirements of the applicable SA/SB specification) according to the following:

(a) Mandatory references<sup>1</sup> to Code Sections that contain values to be used in the design of boilers and pressure vessels are listed below.

(1) Section I

(2) Section VIII, Division 1

(3) Section VIII, Division 2

(4) Section VIII, Division 3

(5) Section II, Part D

NOTE: All requirements for the above referenced standards shall also be met.

(b) A description of the method for determining the values provided in the ASME Boiler and Pressure Vessel Code that are used in the design of boilers and pressure vessels and based on the properties affirmed by the material manufacturer (in accordance with the requirements of the applicable SA/SB specification) is provided in Mandatory Appendices 1 through 5 and 10 of Section II, Part D.

(c) Material test reports shall be obtained from the material manufacturer for all materials and contain an affirmation that the material complies with the stated specification.

(d) When invoked, this Code Case is a supplement to each of the SA/SB specifications listed on the Manufacturer's Data Report as required by (e).

(e) This Case number and an itemized list of the material specifications to which it applies shall be shown on the Manufacturer's Data Report.

<sup>1</sup> Within European standards, references to other standards that give the named standard the same status as the host are referred to as Normative References.

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Approval Date: December 30, 2006

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2563**  
**Aluminum Alloy, UNS A96061 Temper T6 and UNS**  
**A96061 Temper T651**  
**Section VIII, Division 3**

*Inquiry:* May Aluminum Alloy, UNS A96061 Temper T6 and UNS A96061 Temper T651 be used for Section VIII, Division 3 construction?

*Reply:* It is the opinion of the Committee that A96061-T6 and A96061-T651 aluminum may be used for the construction of Section VIII, Division 3 components, provided the following conditions are satisfied:

(a) Materials shall conform to the specifications listed in Table 1 and shall not exceed 3 in. (75 mm) in thickness.

(b) Vessels may be manufactured from O and F temper material from sheet, plate bar, rod, drawn seamless tube, and seamless extruded tube conforming to Table 1 specification. Finished vessels shall be heat treated in accordance with the requirements of the specifications listed in Table 1 and shall meet the specified mechanical properties for T6 or T651 temper, as applicable.

(c) Material shall be qualified by the following notch tensile test for T6 or T651 temper.

(1) The Sharp-Notch Strength/Yield Strength Ratio shall be determined using the ASTM E338 or ASTM E602 test method. Specimens shall be cut from a production vessel. Two specimens from a production vessel shall be tested to qualify a single heat of material. The samples shall be obtained from the production vessel after the all forming and heat treating is completed.

(2) The geometry of the specimen shall meet the dimensional requirement of ASTM E338, para. 6, Fig. 3 or ASTM E602, Figure 1. The specimen shall be cut such that the longitudinal axis of the production vessel is parallel to the long axis of the specimen. The following exemptions to the dimensional requirements of the above specimens may be applied:

(-a) For ASTM E338 specimen, the test section width less than 2 in. (50 mm) may be used, however the ratio of the notch depth to specimen net ligament width shall not be less than 0.25. The specimen thickness limitation in the test section need not be satisfied.

(-b) For ASTM E602 specimen, the test section diameter less than 0.5 in. (12.5 mm) may be used, however the ratio of notch depth to the specimen net ligament diameter shall not be less than 0.25.

(3) The tensile test methods in ASTM B557 shall be used in lieu of ASTM E8 where specified in ASTM E338 and ASTM E602.

(4) Sharp-Notch Strength/Yield Strength Ratio shall not be less than 0.9.

(d) Maximum metal temperature shall not exceed 225°F (107°C).

(e) Yield strength values shall be as shown in Table 2, Table 2M, Table 3, and 3M.

(f) The following properties shall be used in the fracture mechanics evaluation. The material is exempted from Charpy V Notch testing requirements.

(1) A value of 23 ksi - in.<sup>1/2</sup> (25 MPa-m<sup>1/2</sup>) shall be used for critical, or reference, stress intensity factor.

(2) The fatigue crack growth rate and threshold stress-intensity properties given in KD-430 shall be used with the following values of the constants:

(-a) U.S. Customary units:

$$C = 7.01 \text{ E-}9 \text{ (in./cycle)(ksi-in.}^{1/2} \text{)}^{-m}$$

$$m = 3.26$$

$$G = 2.13 \text{ ksi-in.}^{1/2}$$

$$I = 1.83 \text{ ksi-in.}^{1/2}$$

$$\Delta K_{th} \text{ need not be less than } 0.67 \text{ ksi - in.}^{1/2}.$$

(-b) SI units:

$$C = 1.31 \text{ E-}10 \text{ (m/cycle)(MPa-m}^{1/2} \text{)}^{-m}$$

$$m = 3.26$$

$$G = 2.34 \text{ MPa-m}^{1/2}$$

$$I = 2.01 \text{ MPa-m}^{1/2}$$

$$\Delta K_{th} \text{ need not be less than } 0.73 \text{ MPa - m}^{1/2}.$$

(g) All other requirements of Section VIII, Division 3 shall apply.

(h) The fatigue design data given in Figure 1 or 1M or in Table 4 shall be used in the fatigue evaluation.

(i) Welding and thermal cutting are not permitted.

(j) The tensile test methods (ASTM B557) required in the product specifications in Table 1 shall be used in lieu of SA-370 as specified in KM-232.

(k) This Case number shall be shown on the Manufacturer's Data Report.

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**Table 1**  
**Product Specifications**

Specification Number	UNS Number	Product Form
SB-209, T6 or T651 temper	A96061	Sheet and plate
SB-210, T6 temper	A96061	Drawn seamless tube
SB-221, T6 temper	A96061	Bars, rods and profiles
SB-241/SB-241M, T6 temper	A96061	Seamless extruded tubes
SB-308/SB-308M, T6 temper	A96061	Bar, rod, shapes

**Table 2**  
**Yield Strength Values, A96061 Aluminum — T6 Temper**

Material Specification (Thickness)	Specified Yield Strength, ksi	Specified Minimum Yield Strength Values for Metal Temperature, °F			
		-20 to 100	150	200	250 [Note (1)]
SB-209 Sheet, Plate (0.051 in. to 0.249 in.)	35	35	34.6	33.7	32.4
SB-210 Drawn, seamless tube (0.025 in. to 0500 in.)	35	35	34.6	33.7	32.4
SB-221 Bar, rod, shapes	35	35	34.6	33.7	32.4
SB-308 Shapes	35	35	34.6	33.7	32.4

NOTE:

(1) These values are provided for extrapolation only. The maximum design temperature is 225°F.

**Table 2M**  
**Yield Strength Values, A96061 Aluminum — T6 Temper**

Material Specification (Thickness)	Specified Yield Strength, MPa	Specified Minimum Yield Strength Values for Metal Temperature, °C			
		-30 to 40	65	100	125 [Note (1)]
SB-209 Sheet, plate (1.30 mm to 6.34 mm)	241	241	239	231	220
SB-210 Drawn, seamless tube (0.64 mm to 12.7 mm)	241	241	239	231	220
SB-221 Bar, rod, shapes	241	241	239	231	220
SB-241 Seamless extruded tube	241	241	239	231	220
SB-308 Shapes	241	241	239	231	220

NOTE:

(1) These values are provided for extrapolation only. The maximum design temperature is 107°C.

**Table 3**  
**Yield Strength Values, A96061 Aluminum — T651 Temper**

Material Specification (Thickness)	Specified Yield Strength, ksi	Specified Minimum Yield Strength Values for Metal Temperature, °F			
		-20 to 100	150	200	250 [Note (1)]
SB-209 Sheet, plate (0.25 in. to 4.000 in.)	35	35	34.6	33.7	32.4
SB-209 Sheet, plate (4.001 in. to 6.000 in.)	35	35	34.6	33.7	32.4

NOTE:

(1) These values are provided for extrapolation only. The maximum design temperature is 225°F.

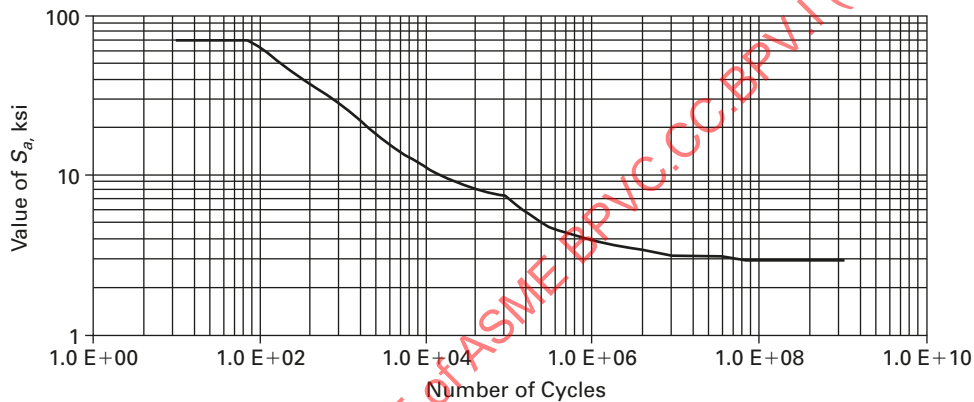
**Table 3M**  
**Yield Strength Values, A96061 Aluminum — T651 Temper**

Material Specification (Thickness)	Specified Yield Strength, MPa	Specified Minimum Yield Strength Values for Metal Temperature, °C			
		-30 to 40	65	100	125 [Note (1)]
SB-209 Sheet, plate (6.34 mm to 100 mm)	241	241	239	231	220
SB-209 Sheet, plate (101 mm to 150 mm)	241	241	239	231	220

NOTE:

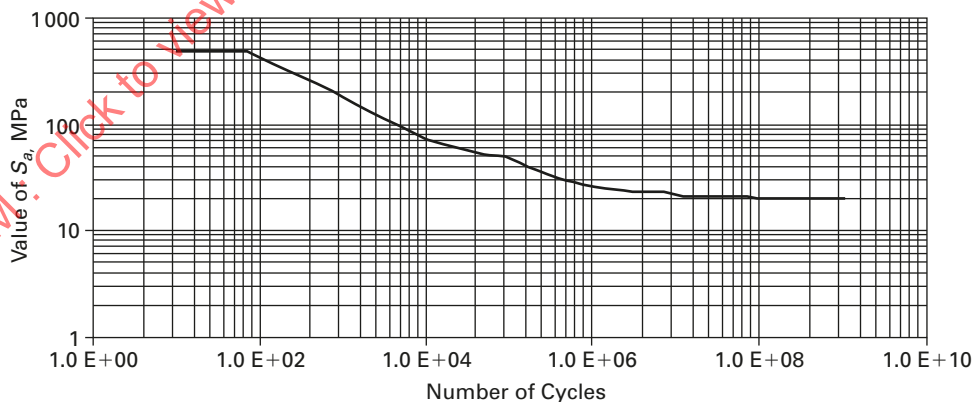
(1) These values are provided for extrapolation only. The maximum design temperature is 107°C.

**Figure 1**  
**Design Fatigue Curve for Nonwelded 6061-T6 Aluminum Construction**



GENERAL NOTE: Modulus of elasticity -  $E = 10 \times 10^6$  psi.

**Figure 1M**  
**Design Fatigue Curve for Nonwelded 6061-T6 Aluminum Construction**



GENERAL NOTE: Modulus of elasticity -  $E = 69 \times 10^3$  MPa.

**Table 4**  
**Tabulated Values of  $S_a$  Alternating Stress Intensity from Figure 1 and 1M**

N, Number of Cycles	$S_a$ With Maximum Mean	$S_a$ With Maximum Mean
	Stress, ksi	Stress, MPa
1.0E+01	70.00	483
2.0E+01	70.00	483
5.0E+01	70.00	483
7.0E+01	70.00	483
1.0E+02	60.96	420
2.0E+02	47.20	325
5.0E+02	34.80	240
1.0E+03	26.79	185
2.0E+03	20.00	138
5.0E+03	13.78	95
7.0E+03	12.40	85
1.0E+04	10.93	75
2.0E+04	9.14	63
5.0E+04	7.74	53
9.0E+04	7.18	50
1.0E+05	6.89	48
2.0E+05	5.47	38
5.0E+05	4.36	30
1.0E+06	3.87	27
2.0E+06	3.55	24
5.0E+06	3.29	23
1.0E+07	3.16	22
2.0E+07	3.07	21
5.0E+07	3.00	21
1.0E+08	2.96	20
2.0E+08	2.93	20
5.0E+08	2.91	20
1.0E+09	2.90	20

GENERAL NOTES:

- (a) Number of design cycles indicated shall be as follows:  $1.0E + J = 1 \times 10^J$ ,  
 e.g.,  $5.0E + 2 = 5 \times 10^2$
- (b) Interpolation between tabular values is permissible based upon data representation by straight lines on a log-log plot. Accordingly, for  $S_i > S > S_j$ ,  
 $(N/N_i) = (N_j/N_i)^{[\log(S_i/S)/\log(S_i/S_j)]}$

Approval Date: March 24, 2016

Code Cases will remain available for use until annulled by the applicable Standards Committee.

## Case 2564-5 Impulsively Loaded Pressure Vessels Section VIII, Division 3

*Inquiry:* Under what conditions may pressure vessels subjected to internal impulsive loadings be designed and constructed under the rules of Section VIII, Division 3?

*Reply:* It is the opinion of the Committee that pressure vessels subjected to internal impulsive loadings may be constructed under the rules of Section VIII, Division 3 and the additional requirements of this Case.

## 1 SCOPE AND BASIS OF THE CODE CASE

### 1.1 APPLICABILITY

This Case applies to pressure vessels that are subjected to internal impulsive loadings that may consist of blast pressure from a detonation source and mechanical loadings caused by detonation fragments. The requirements of sections 2 and 3 do not apply to the quasi-steady residual internal pressure following the impulsive loading, or to other nonimpulsive loading. Such loading is covered by existing rules of Section VIII, Division 3.

### 1.2 CONSTRUCTION RULES

Each pressure vessel to which this Case applies shall comply with the existing rules of Section VIII, Division 3 and the additional requirements in this Case.

### 1.3 OVERPRESSURE PROTECTION

In accordance with KG-311.11, the User, or his Designated Agent, shall be responsible for the provision in the Design Specification of the administrative or engineered controls that provide overpressure protection, as specified in section 5 of this Case.

## 2 GENERAL

### 2.1 LOADINGS

The User's Design Specification (see KG-311) shall provide

(a) the impulsive loading design basis.  
(b) impulse source location within the vessel (i.e., vessel center, off-center, etc.).

(c) the basis for administrative controls limiting impulse source.

(d) any protective liner requirements, such as for fragment shielding. For vessels without protective liners, such as single-use vessels, guidance for evaluation of postulated localized wall thinning from fragment partial penetration is provided in API-579-1/ASME FFS-1 [see 3.4].

The term *impulsive loading* is defined as a loading whose duration is a fraction of the periods of the significant dynamic response modes of the vessel components. For the vessel, this fraction is limited to less than 35% of the fundamental, membrane-stress dominated (breathing) mode.

### 2.2 MATERIALS AND COMBINATIONS OF MATERIALS

Each pressure vessel to which this Case applies shall comply with the requirements of KD-101, except that diagnostic covers and instrumentation penetrations may be constructed of materials that are not permitted in Part KM.

## 3 DESIGN

### 3.1 ELASTIC-PLASTIC ANALYSIS

The limits of KD-230 shall be met with the following additional requirements:

(a) All elastic-plastic analyses under 3.1 shall be conducted using vessel material mechanical properties evaluated at metal temperature just prior to impulsive event.

(b) Strain-rate material dependent stress-strain curve data shall be used where available and as justified by the designer. Otherwise, static stress-strain curve data shall be used for all analyses.

(c) The design margin against a plastic instability state for the specified impulsive load shall be 1.732. For example, this margin may be demonstrated by an elastic-plastic dynamic analysis, with an impulse equal to 175% of the design-basis impulse, which does not result in the formation of a plastic instability state (e.g., the formation of a complete plastic hinge around an opening or closure).

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

(d) For vessels subjected to either single or multiple impulsive loading events, the plastic strain components through the entire wall thickness shall be accumulated over strain cycles within a single loading event, or strain cycles within successive loading events, respectively. These components are used to determine the average through-thickness components. The equivalent plastic strain is calculated from those average components. The maximum equivalent plastic strain during the transient, averaged through the thickness of the vessel, as the result of the design basis impulsive loading shall not exceed 0.2%. The maximum plastic strain components during the transient, linearized through the thickness of the vessel, as the result of the design basis impulsive loading, shall not exceed 2% (1% at welds). The maximum peak equivalent plastic strain during the transient at any point in the vessel, as the result of the design basis impulsive loading, shall not exceed 5% (2.5% at welds). The Designer shall consider the need to reduce these strain limits for areas of high biaxial or triaxial tension.

(e) Bolt loading shall be in accordance with KD-231. Where bolted joints that form part of the pressure boundary are sealed with face seals or gaskets, the design analysis shall demonstrate there is no separation of the joint faces during the transient. Where bolted components are sealed with piston seals, the relative motion shall be considered by the designer.

(f) Thermal-induced skin stresses on the inner surface of the vessel resulting from the design basis impulse detonation event need not be limited, as these are predominantly under compression during the transient.

(g) A fracture mechanics fatigue evaluation shall be conducted in accordance with Article KD-4. One method of performing this is given in 3.3 of this Case.

(h) Residual stresses shall be taken into account. Weld residual stresses shall be analyzed in accordance with guidance provided in Annex E of API 579-1/ASME FFS-1.

(i) An elastic-plastic analysis shall be conducted using the greater of the following hydrostatic test pressures:

(1) 125% of the quasistatic residual overpressure generated as a result of the design basis impulse detonation event

(2) hydrostatic pressure as determined in accordance with KT-312.1 or KT-312.2, as applicable

Plastic strain accumulation limits of (d) are applicable.

(j) An elastic-plastic analysis of the dynamic test (see 4.2) shall be conducted using 125% of the design basis impulse loading for the worst case operational load combination resulting at the limiting section of the vessel. Plastic strain accumulation limits of (d) are applicable.

(k) It shall be verified that fragment-induced damage to the inner surface of vessels subjected to multiple impulsive loading events is not more severe than the flaws assumed in the fatigue evaluation. If this verification cannot be established, internal protective lining is required.

### 3.2 EXPERIMENTAL DESIGN VERIFICATION

The design of diagnostic covers and instrument penetrations constructed from materials not permitted by Part KM shall be verified by an over-test of 173% of the design basis impulse. The over-test impulse may be reduced to 125% of the design basis impulse for diagnostic covers and instrument penetrations with external secondary containment or a barrier for personnel protection. The requirements of Article KD-12 of this Division for determining governing stresses by experimental stress analysis shall be met, with the following exceptions:

(a) Only one-half-scale to full-scale models, prototypical in all respects, are permitted. The component used for the testing shall be made from the same materials as the actual component.

(b) The requirements of KD-1241(a) shall be met, except that the location of the critical areas and the optimum orientation of test gages may be determined by analysis.

(c) The requirements of KD-1243 are not applicable to impulse loading.

(d) Experimental design verification requirements for diagnostic covers and instrument penetrations subject to multiple applications of impulsive loading can be found in KD-12, with the added requirement that the number of stress/strain cycles includes a conservative representation of the stress/strain cycles within each application of impulsive load.

### 3.3 NONMANDATORY GUIDANCE ON FATIGUE AND FRACTURE ASSESSMENT

$a$  = crack depth, in. (m)

$2c$  = crack length, in. (m)

$C$  = Paris Law constant,  $(\text{ksi}\cdot\text{in.}^{1/2})^m$  [ $(\text{MPa}\cdot\text{m}^{1/2})^m$ ]

$K_I$  = stress intensity factor,  $\text{ksi}\cdot\text{in.}^{1/2}$  ( $\text{MPa}\cdot\text{m}^{1/2}$ )

$\dot{K}$  = stress intensity factor rate,  $\text{ksi}\cdot\text{in.}^{1/2}/\text{s}$  ( $\text{MPa}\cdot\text{m}^{1/2}/\text{s}$ )

$K_{Ic}$  = transition fracture toughness, <sup>1</sup>  $\text{ksi}\cdot\text{in.}^{1/2}$  ( $\text{MPa}\cdot\text{m}^{1/2}$ )

$K_{Jc}$  = upper shelf fracture toughness, <sup>1</sup>  $\text{ksi}\cdot\text{in.}^{1/2}$  ( $\text{MPa}\cdot\text{m}^{1/2}$ )

$L_r$  = reference stress load ratio, nondimensional

$m$  = index in Paris crack law, nondimensional

$MDMT$  = minimum design metal temperature, °F (°C)

$S_y$  = yield strength, ksi (MPa)

$S_u$  = ultimate strength, ksi (MPa)

$t$  = wall thickness, in. (m)

$T_o$  = reference temperature for Master Curve, °F (°C) [see 3.4]

$\Delta T_M$  = extent that MDMT is above upper shelf temperature, °F (°C)

$\Delta T_{SR}$  = temperature shift due to strain rate, °F (°C)

$\delta$  = damping decay constant, nondimensional

$\sigma$  = stress, ksi (MPa)

<sup>1</sup> This usage of nomenclature only applies to this Code Case; these terms have other definitions elsewhere.

$\dot{\sigma}$  = stress rate of change, ksi/sec (MPa/s)  
 $\sigma_m$  = membrane stress, ksi (MPa)  
 $\sigma_b$  = bending stress, ksi (MPa)

(a) This analysis determines a pair of impulsive membrane and bending stresses that can be used conservatively to assess fracture at the section. Determine the in-plane principal components of the stress-time histories at the surface points of the section of interest and determine the absolute greatest of the components to obtain a new surface stress time history, retaining the components original sign. For example, if at one surface and at one time the components are 10 and -15, as  $|-15| > |10|$  use -15 in the new surface time history. Assume the stresses across any section are linear and obtain the resulting membrane and bending histories from the new surface values at all times. Determine the largest tensile value of the membrane stress history  $\sigma_m$  and the largest tensile value of the new surface stress histories on the inner and outer surfaces,  $\sigma_t$ , and take the absolute value of  $\sigma_t - \sigma_m$  as a conservative value of maximum bending stress  $\sigma_b$  for fracture analysis. This approach may be very conservative at local surface stress concentrations.

(b) Select a given crack size of depth  $a$ , based upon the detection limits of the nondestructive examinations methods used, with an aspect ratio as given in KD-411 for the geometry at the section, in a section thickness of  $t$ , and apply a stress distribution given by

$$\sigma = (\sigma_m + \sigma_b) + (-2\sigma_b)(a/t) \quad (1)$$

(c) Use API-579-1/ASME FFS-1 to determine the stress intensity factor,  $K_I$ . For semi-elliptic surface cracks, obtain two values, one at the surface and one at maximum depth. The largest of these values should be selected.

(d) Evaluate any steady pressure stress also applied to the section, which may have membrane and bending components, and use API-579-1/ASME FFS-1 to determine the stress intensity factor  $K_I^P$  and the references stress load ratio  $Lr^P$  for these stresses.

(e) Determine the the upper shelf fracture toughness,  $K_{Jc}$ .

(f) For ferritic steels, determine the stress intensity factor rate of change,  $\dot{K}$ , and the Master Curve Reference Temperature,  $T_0$  for the material. See 3.4.  $\dot{K}$  can be determined from the stress rate of change with time,  $\dot{\sigma}$ , when the stress and stress intensity factor are known, from eq. (2). See Figure 1.

$$\dot{K} = K \dot{\sigma} / \sigma \quad (2)$$

The fracture toughness transition shift due to high strain rate can be obtained from eq. (g)(3).

(g) For austenitic steels,  $K_{Ic} = K_{Jc}$ .

$$\Delta T_{SR} = \frac{(T_0 + 460) \ln(1.1 \dot{K})}{\Gamma - \ln(1.1 \dot{K})} \quad (^\circ\text{F, ksi in.}^{1/2}\text{s}^{-1} \text{ units}) \quad (3)$$

where

$$\Gamma = 9.8 \exp \left[ \left( \frac{T_0 + 460}{342} \right)^{1.66} + \left( \frac{S_y}{105} \right)^{1.09} \right] \quad (^\circ\text{F, ksi units}) \quad (4)$$

or

$$\Delta T_{SR} = \frac{(T_0 + 273) \ln(\dot{K})}{\Gamma - \ln(\dot{K})} \quad (^\circ\text{C, MPa m}^{1/2}\text{s}^{-1} \text{ units}) \quad (5)$$

where

$$\Gamma = 9.8 \exp \left[ \left( \frac{T_0 + 273}{190} \right)^{1.66} + \left( \frac{S_y}{722} \right)^{1.09} \right] \quad (^\circ\text{C, MPa units}) \quad (6)$$

(h) For ferritic steels, determine the extent to which the material is on the upper shelf at low strain rates. See Figure 2.

$$\Delta T_M = MDMT - \frac{\ln \left( \frac{K_{Jc} - 22.9}{33.3} \right)}{0.01055} - T_0 \quad (^\circ\text{F, ksi in.}^{1/2} \text{ units}) \quad (7)$$

$$\Delta T_M = MDMT - \frac{\ln \left( \frac{K_{Jc} - 25.2}{36.6} \right)}{0.019} - T_0 \quad (^\circ\text{C, MPa m}^{1/2} \text{ units}) \quad (8)$$

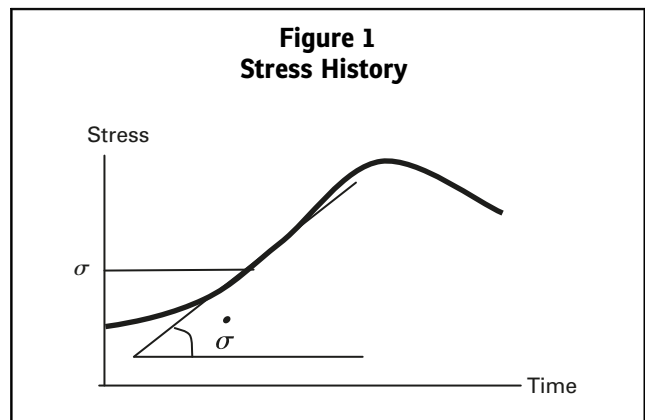
where  $MDMT$  is the minimum design metal temperature.

The fracture toughness  $K_{Ic} = K_{Jc}$  if  $\Delta T_M > \Delta T_{SR}$  otherwise

$$K_{Ic} = 22.9 + 33.3 \exp [0.0106 (MDMT - T_0 - \Delta T_{SR})] \quad (^\circ\text{F, ksi in.}^{1/2} \text{ units}) \quad (9)$$

$$K_{Ic} = 25.2 + 36.6 \exp [0.019 (MDMT - T_0 - \Delta T_{SR})] \quad (^\circ\text{C, MPa m}^{1/2} \text{ units}) \quad (10)$$

(i) Use the procedures in API-579-1/ASME FFS-1, Part 9 with partial safety factors set at unity, treating the dynamic stress as secondary and the steady pressure stress as primary to obtain a point on the Failure Assessment



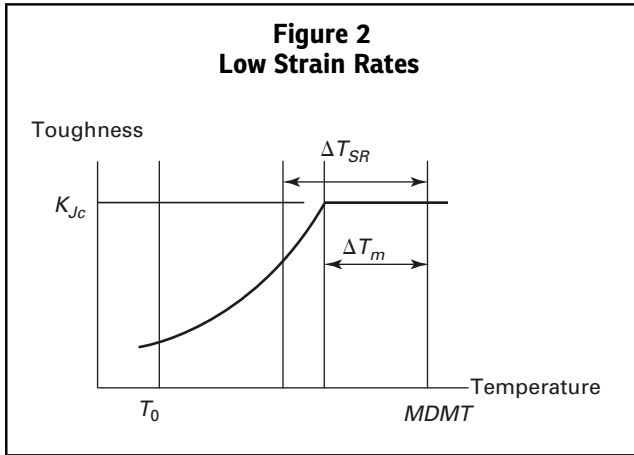


Diagram (FAD), and adjust the crack size, and repeat 3.3 (c) to (h) until the point lies on the FAD line, when  $a$  is the critical size.

(j) Fatigue crack size  $a_{i+1}$  after all cycles of one impulsive load is obtained from

$$a_{i+1} = a_i \left[ 1 + \left( 1 - \frac{m}{2} \right) \frac{C(1.2 K_I)^m}{m \delta a_i} \right]^{2 - \frac{2}{m}} \quad (11)$$

where  $a_i$  is the starting crack size,  $C$  and  $m$  are the Paris Law constants given in Table KD-430,  $d$  is the decay constant taken as 4% unless experimental data indicates otherwise, and  $K_I$  is the stress intensity factor for the crack size  $a_i$  and the stress given in 3.2(b). This equation assumes that the cycles have a range of  $\pm K_I$  and incorporates the  $f(RK)$  values in D-500. The equation is used starting with the crack size at the limit of detection and repeated until the crack reaches the number of design cycles defined as the lesser of

(1) the number of cycles corresponding to one-half the number of cycles required to propagate a flaw from the limit of detection to the critical crack length, or

(2) the number of cycles to propagate a crack from the limit of detection to either one-quarter of the critical depth or one-quarter of the wall thickness, whichever occurs earlier

### 3.4 REFERENCE FOR SECTION 3

ASTM E1921-05, "Standard Test Method for Determination of Reference Temperature,  $T_o$ , for Ferritic Steels in the Transition Range," American Society for Testing and Materials, West Conshohocken, PA

## 4 VESSEL PRESSURE TESTS

### 4.1 HYDROSTATIC TEST

Hydrostatic test pressure shall be the greater of

(a) pressure equivalent to 125% of the quasistatic residual overpressure generated as a result of the design basis impulse (or detonation) event

(b) hydrostatic pressure as determined in accordance with KT-312.1 or KT-312.2, as applicable

### 4.2 DYNAMIC TEST

(a) For multiple-event detonation vessels, a dynamic (i.e., impulsive) test shall be conducted at 125% of the design basis impulse loading for the worst case operational load combination resulting at the limiting section of the vessel.

(b) Single-event detonation vessels are exempt from the dynamic test, provided that a representative vessel from the same material lot is tested in accordance with (a).

## 5 OVERPRESSURE PROTECTION

### 5.1 REQUIREMENTS

Since impulsive pressure loading durations are short in comparison to the reaction time of overpressure protection systems, overpressure protection requirements for the pressure vessels to which this Code Case applies are provided in the following paragraphs. The User, or his Designated Agent, shall specify overpressure protection by administrative controls and system design, and shall reference this Code Case in writing in the purchase documents.

The Manufacturer is responsible only for verifying that the User or his Designated Agent has specified overpressure protection by administrative controls and system design, and for listing this Case number on the Manufacturer's Data Report.

(a) The User, or his Designated Agent, shall conduct a detailed analysis that examines all credible scenarios that could result in an overpressure condition. The "Causes of Overpressure" described in Section 4 of API Standard 521, "Pressure-Relieving and Depressurizing Systems" shall be considered. An organized, systematic approach by a multidisciplinary team employing one or more of the following methodologies shall be used:

- (1) Hazards and Operability Analysis (HazOp)
- (2) Failure Modes, Effects, and Criticality Analysis (FMECA)
- (3) Fault Tree Analysis
- (4) Event Tree Analysis
- (5) "What-If" Analysis

In all cases, the User or his Designated Agent shall determine the potential for overpressure due to all credible operating and upset conditions, including equipment and instrumentation malfunctions.

(b) The analysis described in (a) shall be conducted by an engineer experienced in the applicable analysis methodology. Any overpressure concerns that are identified shall be evaluated by an engineer experienced in pressure vessel design and analysis. The results of the analysis

shall be documented and signed by the individual in charge of operation of the vessel. The documentation shall include:

(1) detailed Process and Instrument Flow Diagrams (P&IDs), showing all pertinent elements of the system associated with the vessel

(2) a description of all credible operating and upset scenarios, including scenarios involving fire, and those that result from equipment and instrumentation malfunctions

(3) an analysis showing the maximum short-term impulsive loading and long-term pressure that can result from each of the scenarios examined in (2) above

(4) a detailed description of any administrative controls and/or instrumentation and control system that is used to limit the impulsive loading and long-term

pressure to the system, including the identification of all truly independent redundancies and a reliability evaluation (qualitative or quantitative) of the overall safety system

(c) The documentation shall be made available to the regulatory and enforcement authorities having jurisdiction at the site where the vessel will be installed. The User of this Code Case is cautioned that prior jurisdictional acceptance may be required.

(d) This Case number shall be shown on the Manufacturer's Data Report for pressure vessels that will be provided with overpressure protection by administrative controls and system design, and it shall be noted on the Data Report that prior jurisdictional acceptance may be required.

ASME Case 2564-5 (ASME BPVC.CC.BPV) 2019  
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Approval Date: December 30, 2006

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2565**  
**Mounting Safety and Safety Relief Valves for Coil Type Heating Boilers**  
**Section IV**

*Inquiry:* Section IV, HG-701.1 requires that coil type boilers shall have the safety valve or safety relief valves located on the steam or hot water outlet end. Under what circumstances is it permissible to mount safety or safety relief valves downstream of the outlet end of the heated tubing in coil type boilers?

*Reply:* It is the opinion of the Committee that it is permissible to mount safety and safety relief valves downstream of the outlet end of the heated tubing of coil type boilers under the following conditions:

(a) The safety or safety relief valves cannot be isolated from the heated tubing.

(b) The water volume contained in the heated tubing and the pipe or tubing connecting the heated tubing and the safety or safety relief valve shall not exceed 1 gal (3.8 L).

(c) The tubing and outlet tubing or piping shall not exceed NPS 1 (DN 25) diameter.

(d) This Case number shall be included on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: December 30, 2006

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**Case 2567**  
**SA-705, Type XM-12, Conditions H1075, H1025, H925,**  
**and H900 Forging Materials**  
**Section VIII, Division 3**

*Inquiry:* May SA-705, Type XM-12, Conditions H1075, H1025, H925, and H900 forging materials be used in Section VIII, Division 3 construction at temperatures up to 550°F (275°C)?

*Reply:* It is the opinion of the Committee that SA-705, Type XM-12, Conditions H1075, H1025, H925, and H900 forging materials may be used in Section VIII, Division 3 construction at a design temperature up to 550°F (275°C), provided the following additional requirements are met:

(a) Yield strength values to be used in design shall be those listed in Tables 1 and 1M.

(b) Type XM-12 forging materials in Conditions H1025, H925, and H900 are permitted only when used as an inner layer in a vessel whose design meets the leak-before-burst criteria of KD-141.

(c) Separate weld procedure and performance qualifications conducted in accordance with Section IX shall be required.

(d) All other requirements of Section VIII, Division 3 are applicable.

(e) This Case number shall be shown on the Manufacturer's Data Report.

**CAUTION: With increasing tensile strengths, these materials are highly susceptible to hydrogen embrittlement and stress corrosion cracking in moist environments.**

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Yield Strengths SA-705 Age Hardening Stainless Steel Forgings**

Type	Condition	Minimum Specified Tensile Strength, ksi	Minimum Specified Yield Strength, ksi	Yield Strength, ksi, for Metal Temperature, °F, Not Exceeding					
				100	200	300	400	500	550
XM-12	H1075	145	125	125	116.4	112.2	109.2	106.6	105.2
XM-12	H1025	155	145	145	135.0	130.2	126.7	123.7	122.1
XM-12	H925	170	155	155	144.3	139.1	135.4	132.2	130.5
XM-12	H900	190	170	170	158.3	152.6	148.5	145.0	143.1

GENERAL NOTE: This material has reduced toughness at room temperature after exposure at high temperature. The degree of embrittlement depends on composition, heat treatment, time, and temperature. The lowest temperature of concern is about 550°F. See Section II, Part D, Appendix A, A-360.

**Table 1M**  
**Yield Strengths SA-705 Age Hardening Stainless Steel Forgings**

Type	Condition	Minimum Specified Tensile Strength, Mpa	Minimum Specified Yield Strength, MPa	Yield Strength, MPa, for Metal Temperature, °C, Not Exceeding									
				40	65	100	125	150	175	200	225	250	275
XM-12	H1075	1 000	860	862	822	798	785	773	763	754	746	738	730
XM-12	H1025	1 070	1 000	1 000	954	926	910	897	885	875	866	856	845
XM-12	H925	1 170	1 070	1 069	1 020	990	973	959	946	935	925	915	905
XM-12	H900	1 310	1 170	1 172	1 118	1 086	1 067	1 051	1 038	1 026	1 015	1 004	993

GENERAL NOTE: This material has reduced toughness at room temperature after exposure at high temperature. The degree of embrittlement depends on composition, heat treatment, time, and temperature. The lowest temperature of concern is about 275°C. See Section II, Part D, Appendix A, A-360.

Approval Date: December 21, 2016

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2568-1**  
**HG-701.1 Permissible Mounting Safety Relief Valves for**  
**Coil-Type Water Boilers**  
**Section IV**

*Inquiry:* Section IV, HG-701.1 requires that a coil-type water boiler shall have the safety relief valve located on the hot water outlet end. Under what circumstances is it permissible to mount the safety relief valve on the header between the primary and secondary heat exchangers of a coil-type water boiler?

*Reply:* It is the opinion of the Committee that it is permissible to mount the safety relief valve on the header between the primary and secondary heat exchangers of a coil-type water boiler under the following conditions:

(a) The system circulator is installed on the hot water outlet piping.

(b) There are no intervening valves between the primary heat exchanger, secondary heat exchanger or safety relief valve.

(c) The water volume contained in the heated tubing and the piping and the safety relief valve shall not exceed 3 gal (11.4 L).

(d) A flow-sensing device is installed on the hot water outlet end of the coil-type water boiler to prevent burner operation at a water flow rate inadequate to protect the water boiler unit against overheating at all allowable firing rates.

(e) Temperature-sensing devices are installed on the cold inlet and hot outlet water ends of the coil-type water boiler for high temperature limit protection.

(f) The safety relief valve shall be placed at a location where the highest operating pressure occurs.

(g) All other requirements of Section IV shall apply.

(h) This Case number shall be included on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2570**  
**Copper Alloys**  
**Section IV**

*Inquiry:* Under what conditions may copper alloys other than UNS C10200 be used in Section IV construction?

*Reply:* It is the opinion of the Committee that copper alloys of UNS designations other than C10200 that are shown in [Table 1](#) and [Table 1M](#) may be used in

construction of Section IV hot water supply boiler and water heater construction, provided the following requirements are met:

(a) The material shall meet the requirements of SB-42, SB-75, SB-111, SB-152, or SB-395 as applicable.

(b) The material shall comply with the provisions of [Table 1](#) and [Table 1M](#).

(c) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values, ksi**

Spec. No.	Alloy Designation UNS No.	Form	Class/Condition/ Temper	P-No.	External Pressure Chart	Specified Tensile Strength, ksi	Specified Yield Strength, ksi	Note(s)	Up to 100°F	Maximum Allowable Stress Value, ksi for Temperatures						
										150°F	200°F	250°F	300°F	350°F	400°F	450°F
SB-42	C12000 or C12200	Pipe	Annealed/O61	31	NFC-1	30	9	(2)	6.0	4.9	4.8	4.7	4.0	3.0	...	
SB-42	C12000 or C12200	Pipe	Hard drawn/H80, 1/8 in. to 2 in. NPS, incl.	31	NFC-4	45	40	(1)(2)	9.0	9.0	9.0	8.8	8.3	4.3	...	
SB-42	C12000 or C12200	Pipe	Light drawn/H55, 2 1/2 in. to 12 in. NPS, incl.	31	NFC-3	36	30	(1)(2)	7.2	7.2	7.2	7.0	6.8	6.6	...	
SB-75	C12000 or C12200	Seamless tubes	Annealed/O50/O60	31	NFC-1	30	9	(2)	6.0	4.9	4.8	4.7	4.0	3.0	...	
SB-75	C12000 or C12200	Seamless tubes	Hard drawn/H80	31	NFC-4	45	40	(1)(2)	9.0	9.0	9.0	8.8	8.3	4.3	...	
SB-75	C12000 or C12200	Seamless tubes	Light drawn/H55	31	NFC-3	36	30	(1)(2)	7.2	7.2	7.2	7.0	6.8	6.6	...	
SB-111	C12000, C12200, or C14200	Seamless condenser tubes	Hard drawn/H80	31	NFC-4	45	40	(2)	9.0	9.0	9.0	8.8	8.3	4.3	...	
SB-111	C12000, C14200	Seamless condenser tubes	Light drawn/H55	31	NFC-6	36	30	(2)	7.2	7.2	7.2	7.0	6.8	6.6	...	
SB-152	C10400, C10500, C10700, or C12200	Plate, sheet, strip	Hot rolled/O25, annealed	31	NFC-1	30	10	(2)	6.0	5.4	5.2	5.0	4.0	3.0	...	
SB-152	C11000, C12300 or	Plate, sheet, strip, and bar	Hot rolled/O25, annealed	31	NFC-1	30	10	(2)	6.0	5.6	5.4	5.0	4.0	3.0	...	
SB-152	C14200	Plate, sheet, strip	Hot rolled/O25, annealed	31	NFC-1	30	10	(2)	6.0	5.4	5.2	5.0	...	...	...	
SB-395	C12000, C12200, or C14200	Seamless tubes	Light drawn/H55	31	NFC-6	36	30	(1)(2)	7.2	7.2	7.2	7.0	6.8	6.6	...	

NOTES:

(1) When nonferrous materials conforming to specifications given in Section II are used in welded or brazed construction, the maximum allowable working stress shall not exceed the values given herein for the material in the annealed condition.

(2) When material is to be welded, the phosphorous deoxidized types should be specified.

**Table IM**  
**Maximum Allowable Stress Values, MPa**

Spec. No.	Alloy Designation UNS No.	Form	Class/Condition/ Temper	P-No.	External Pressure Chart	Specified Min. Tensile Strength, MPa	Specified Min. Yield Strength, MPa	Maximum Allowable Stress Value, MPa for Temperatures							
								Up to 40°C	65°C	100°C	125°C	150°C	175°C	200°C	225°C
SB-42	C12000 or C12200	Pipe	Annealed/O61	31	NFC-1	205	62	41.4	35.0	33.4	32.9	32.3	27.8	21.7	...
SB-42	C12000 or C12200	Pipe	Hard drawn/H80 1/8 in. to 2 in. NPS, incl.	31	NFC-4	310	275	62.1	62.1	62.1	62.1	60.3	57.1	36.3	...
SB-42	C12000 or C12200	Pipe	Light drawn/H55, 2 1/2 in. to 12 in. NPS, incl.	31	NFC-3	250	205	49.6	49.6	49.6	49.6	48.1	46.9	45.7	...
SB-75	C12000 or C12200	Seamless tubes	Annealed/O50/ O60	31	NFC-1	205	62	41.4	35.0	33.4	32.9	32.3	27.8	21.7	...
SB-75	C12000 or C12200	Seamless tubes	Hard drawn/H80	31	NFC-4	310	275	62.1	62.1	62.1	62.1	60.3	57.1	36.3	...
SB-75	C12000 or C12200	Seamless tubes	Light drawn/H55	31	NFC-3	250	205	49.6	49.6	49.6	49.6	48.1	46.9	45.7	...
SB-111	C12000, C12200, or C14200	Seamless condenser tubes	Hard drawn/H80	31	NFC-4	310	275	62.1	62.1	62.1	62.1	60.3	57.1	36.3	...
SB-111	C12000, C12200, or C14200	Seamless condenser tubes	Light drawn/H55	31	NFC-6	250	205	49.6	49.6	49.6	49.6	48.1	46.9	45.7	...
SB-152	C10400, C10500, C10700, or C12200	Plate, sheet, strip	Hot rolled/O25, annealed	31	NFC-1	205	70	41.4	38.9	37.1	35.7	34.1	27.8	21.7	...
SB-152	C11000, C12300 or C14200	Plate, sheet, strip, and bar	Hot rolled/O25, annealed	31	NFC-1	205	70	41.4	38.9	37.1	35.7	34.1	27.8	21.7	...
SB-152	C14200	Plate, sheet, strip	Hot rolled/O25, annealed	31	NFC-1	205	70	41.4	38.9	37.1	35.7	34.1	...	...	...
SB-395	C12000, C12200, or C14200	Seamless tubes	Light drawn/H55	31	NFC-6	250	250	49.6	49.6	49.6	49.6	48.1	46.9	45.7	...

## NOTES:

(1) When nonferrous materials conforming to specifications given in Section II are used in welded or brazed construction, the maximum allowable working stress shall not exceed the values given herein for the material in the annealed condition.

(2) When material is to be welded, the phosphorous deoxidized types should be specified.

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Approval Date: January 26, 2009

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2571-1**  
**Use of SA-240, Grades 304L and 316L in Thickness Less Than  $\frac{1}{4}$  in. (6 mm)**  
**Section IV**

*Inquiry:* Under what conditions may SA-240 Plate Alloy Steel, Grades 304L and 316L in thickness less than  $\frac{1}{4}$  in. (6 mm) be used in Section IV construction?

*Reply:* It is the opinion of the Committee that SA-240 Plate Alloy Steel, Grades 304L and 316L in thickness less than  $\frac{1}{4}$  in. (6 mm) may be used in Section IV construction for maximum allowable working pressures up to 160 psi, provided:

- (a) The material shall be used only on hot water heating boilers or hot water supply boilers.
- (b) The material thickness shall not be less than 0.059 in. (1.5 mm).
- (c) The material shall be limited to headers not exposed to products of combustion.
- (d) All other requirements of Section IV shall apply.
- (e) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: December 30, 2006

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2576**  
**Use of ASTM A672-06 and A691-98(R2002) Electric-Fusion-Welded Pipe**  
**Section I**

*Inquiry:* May electric fusion welded (EFW) pipe made to ASTM A672-06 and ASTM A691-98(R2002) be used in Section I construction?

*Reply:* It is the opinion of the Committee that electric fusion welded pipe may be used in Section I construction under the following conditions:

(a) The electric fusion welded pipe shall be limited to those specifications, grades, and classes given in Table 1.

(b) Allowable stresses to be used shall be those given in Table 1A of Section II Part D for Section I use for the equivalent ASME materials (as shown in Table 1), and design temperatures shall be limited to those given in Table 1.

(c) Material Test Reports (MTRs) shall be provided for the plate used in making the pipe and for all tests required to be performed in manufacturing the pipe.

(d) The welding filler metal used shall have the same nominal composition as the base metal.

(e) The P and/or S numbers to be used in welding these materials shall be the same as the P numbers of the equivalent ASME plate material specifications given in Table 1.

(f) This Case number shall be identified in the MTR.

(g) This Case number shall be included in the Manufacturer's Data Report.

**Table 1**  
**Pipe Specifications**

ASTM Specification	Plate Material Specification	Maximum Use Temperature, °F (°C)
A672-C60 Cl. 22	SA-516 Gr. 60	700 (371)
A672-C65 Cl. 22	SA-516 Gr. 65	700 (371)
A672-C70 Cl. 22	SA-516 Gr. 70	700 (371)
A672-N75 Cl. 22	SA-299	700 (371)
A672-H80 Cl. 22	SA-302 Gr. C	800 (427)
A691-1Cr Cl. 22	SA-387 Gr. 12 Cl. 1	850 (454)
A691-1Cr Cl. 22	SA-387 Gr. 12 Cl. 2	850 (454)
A691-1 $\frac{1}{4}$ Cr Cl. 22	SA-387 Gr. 11 Cl. 1	850 (454)
A691-1 $\frac{1}{4}$ Cr Cl. 22	SA-387 Gr. 11 Cl. 2	850 (454)
A691-2 $\frac{1}{4}$ Cr Cl. 22	SA-387 Gr. 22 Cl. 1	850 (454)
A691-2 $\frac{1}{4}$ Cr Cl. 22	SA-387 Gr. 22 Cl. 2	850 (454)
A691-91 Cl. 42	SA-387 Gr. 91 Cl. 2	1,000 (538)

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: October 2, 2008

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2577**  
**Use of 316L Stainless Steel at Elevated Temperatures**  
**Section VIII, Division 1**

*Inquiry:* May Type 316L (UNS S31603) material conforming to material specifications SA-182, SA-213/SA-213M, SA-240, SA-249, SA-312, SA-336, SA-403, or SA-479 be used in the construction of welded vessels designed to Section VIII, Division 1, at 850°F to 1200°F (454°C to 649°C)?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used for welded construction under the rules of Section VIII, Division 1 within the limits listed in the Inquiry, provided the following requirements are met:

(a) The allowable stresses shall be obtained from Tables 1 and 1M.

(b) The material shall have an ASTM grain size of 7 or coarser for use at 1000°F (550°C) and above.

(c) This Case number shall be identified on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1  
Maximum Allowable Stress Values**

For Metal		
Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi [Note (1)] and [Note (2)]	
900	9.2	12.4 [Note (3)]
950	9.0	12.1 [Note (3)]
1000	8.8	11.9 [Note (3)]
1050	8.6	11.6 [Note (3)]
1100	8.4	11.4 [Note (3)]
1150	8.3	8.8 [Note (3)]
1200	6.4	6.4

GENERAL NOTE: Material sensitized by exposure to long-time high-temperature operation may have reduced low-temperature notch toughness.

NOTES:

- (1) Stress values for welded pipe and tube shall be the listed values multiplied by a factor of 0.85.
- (2) Allowable stresses for temperatures of 1200°F and above are values obtained from time-dependent properties.
- (3) Due to the relatively low yield strength of these materials, these high stress values were established at temperatures where the short-time tensile properties govern to permit use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed 66<sup>2</sup>/<sub>3</sub>% but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.

**Table 1M  
Maximum Allowable Stress Values**

For Metal		
Temperature Not Exceeding, °C	Maximum Allowable Stress Values, MPa [Note (1)] and [Note (2)]	
525	61.2	82.6 [Note (3)]
550	59.9	80.9 [Note (3)]
575	58.8	79.4 [Note (3)]
600	57.8	76.5 [Note (3)]
625	57.0	58.5 [Note (3)]
650	43.4	43.4 [Note (4)]

GENERAL NOTE: Material sensitized by exposure to long-time high-temperature operation may have reduced low-temperature notch toughness.

NOTES:

- (1) Stress values for welded pipe and tube shall be the listed values multiplied by a factor of 0.85.
- (2) Allowable stresses for temperatures of 650°C and above are values obtained from time-dependent properties.
- (3) Due to the relatively low yield strength of these materials, these high stress values were established at temperatures where the short-time tensile properties govern to permit use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed 66<sup>2</sup>/<sub>3</sub>% but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.
- (4) Maximum design temperature is 649°C. Value at 650°C is provided for interpolation only.

Approval Date: April 26, 2007

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2581**  
**20Cr-25Ni-1.5Mo-Cb-N Seamless Austenitic Stainless**  
**Steel Tube**  
**Section I**

*Inquiry:* May solution-treated 20Cr-25Ni-1.5Mo-Cb-N seamless austenitic stainless steel tube with chemical analysis shown [Table 1](#), the mechanical properties shown in [Table 2](#), and that otherwise conform to applicable requirements in SA-213/SA-213M be used for steam service in Section I construction?

*Reply:* It is the opinion of the Committee that the material listed in the Inquiry may be used for steam service in Section I construction, provided that the following requirements are met:

(a) The material shall meet the chemical analysis and minimum tensile requirements specified in [Tables 1](#) and [2](#), and shall otherwise meet the requirements of SA-213/SA-213M as applicable, except as shown in (b) and (c).

(b) The minimum solution treating temperature for this material shall be 2100°F (1150°C).

(c) This material shall have a hardness not exceeding 256 HB/270 HV (100 HRB).

(d) The rules of PG-19 for TP347H shall apply for this material, except that solution treatment, when required, shall be at the minimum temperature of 2100°F (1150°C).

(e) The maximum allowable stress values for the material shall be as given in [Tables 3](#) and [3M](#). The maximum design temperature is 1500°F (815°C).

(f) Separate welding procedure and performance qualification shall be conducted for the material in accordance with Section IX. Filler metal shall be limited to either nickel-base fillers SFA-5.14 class ERNiCrMo-3 (Alloy 625) or to matching filler metal.

NOTE: When nickel-base fillers SFA-5.14 class ERNiCrMo-3 (Alloy 625) is used, the weld metal is subject to severe loss of impact strength at room temperature after exposure in the range of 1000°F to 1400°F (540°C to 760°C).

(g) This Case number shall be referenced in the documentation and marking of the material and recorded on the Manufacturer's Data Report.

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**Table 1  
 Chemical Requirements**

Element	Composition, %
Carbon, max.	0.10
Manganese, max	1.50
Phosphorus, max.	0.030
Sulfur, max.	0.030
Silicon, max.	1.00
Nickel	23.0–26.0
Chromium	19.5–23.0
Molybdenum	1.0–2.0
Nitrogen	0.10–0.25
Columbium	0.10–0.40
Titanium, max.	0.20
Boron	0.002–0.010

**Table 2  
 Mechanical Property Requirements**

Tensile strength, min. ksi (MPa)	93 (640)
Yield strength, min. ksi (MPa)	39 (270)
Elongation in 2 in. or 50 mm, min. %	30

**Table 3  
 Maximum Allowable Stresses**

For Metal Temperature		
Not Exceeding, °F	Allowable Stress Values, ksi	
–40 to 100	26.0	26.0
200	22.1	26.0 [Note (1)]
300	20.5	25.5 [Note (1)]
400	19.5	24.7 [Note (1)]
500	18.8	24.1 [Note (1)]
600	18.2	24.1 [Note (1)]
650	17.9	24.1 [Note (1)]
700	17.6	23.7 [Note (1)]
750	17.2	23.3 [Note (1)]
800	16.9	22.9 [Note (1)]
850	16.6	22.5 [Note (1)]
900	16.4	22.1 [Note (1)]
950	16.1	21.8 [Note (1)]
1000	15.9	21.5 [Note (1)]
1050	15.7	21.2 [Note (1)]
1100	15.6	19.0 [Note (1)]
1150	14.9	14.9
1200	11.9	11.9
1250	9.6	9.6
1300	7.8	7.8
1350	6.3	6.3
1400	5.1	5.1
1450	4.1	4.1
1500	3.2	3.2

GENERAL NOTE: The revised criterion of 3.5 on tensile strength was used in establishing these values.

NOTE:

- (1) Due to the relatively low yield strength of this material, these high stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed  $66\frac{2}{3}\%$ , but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.

**Table 3M**  
**Maximum Allowable Stresses**

For Metal Temperature		
Not Exceeding, °C	Allowable Stress Values, MPa	
-30 to 40	180	180
65	161	180 [Note (1)]
100	151	180 [Note (1)]
125	145	179 [Note (1)]
150	141	176 [Note (1)]
200	135	171 [Note (1)]
250	130	168 [Note (1)]
300	126	167 [Note (1)]
325	125	167 [Note (1)]
350	123	166 [Note (1)]
375	121	163 [Note (1)]
400	119	160 [Note (1)]
425	117	158 [Note (1)]
450	115	155 [Note (1)]
475	113	153 [Note (1)]
500	112	151 [Note (1)]
525	110	149 [Note (1)]
550	109	147 [Note (1)]
575	108	146 [Note (1)]
600	107	123 [Note (1)]
625	99.3	99.3
650	81.4	81.4
675	67.1	67.1
700	55.5	55.5
725	46.0	46.0
750	38.1	38.1
775	31.2	31.2
800	25.4	25.4
825	20.2	20.2 [Note (2)]

GENERAL NOTE: The revised criterion of 3.5 on tensile strength was used in establishing these values.

NOTES:

(1) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed  $66\frac{2}{3}\%$ , but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.

(2) These values are provided for interpolation purposes only.

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**Case 2582-3**  
**UNS S31803 Plate and Seamless and Welded Pipe and Tube**  
**Section IV**

*Inquiry:* Under what conditions may UNS S31803 ferritic-austenitic stainless steel in the material specifications SA-240/SA-240M, SA-789/SA-789M, and SA-790 be used in the construction of hot water heating boilers and water heaters?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used in the welded construction of hot water heating boilers and water heaters, provided the following requirements are met:

(a) The allowable stress values for plate in accordance with SA-240/SA-240M and seamless pipe and tube in accordance with SA-789/SA-789M and SA-790 shall be as listed in [Tables 1](#) and [1M](#).

(b) The allowable stress values for welded pipe and tube in accordance with SA-789/SA-789M, and SA-790 shall be as listed in [Tables 2](#) and [2M](#).

(c) Welding procedure and performance qualification shall be conducted in accordance with Section IX.

(d) For external pressure, Fig. HA-5 of Section II, Part D shall be used.

(e) The maximum design temperature shall be 500°F (260°C).

(f) All other requirements of Section IV shall be met.

(g) This Case number shall be shown on the Manufacturer's Data Report.

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**Table 1**  
**Maximum Allowable Stress Values for SA-240/SA-240M Plate and SA-789/SA-789M and SA-790 Seamless Pipe and Tube**

For Metal Temperatures Not Exceeding, °F	Maximum Allowable Stress Values, ksi
100	18.0
150	18.0
200	18.0
250	18.0
300	17.4
400	16.7
500	16.3

GENERAL NOTES:

- (a) This steel may be expected to develop embrittlement after service at moderately elevated temperature; see Section II, Part D, Nonmandatory Appendix A, A-207 and A-208.
- (b) This material may utilize the minimum thickness exemptions as shown in HF-301.1(c) at pressures up to 160 psi.
- (c) Tubing may utilize the thickness requirements of HF-204.3.

**Table 2**  
**Maximum Allowable Stress Values for SA-789/SA-789M and SA-790 Welded Pipe and Tube**

For Metal Temperatures Not Exceeding, °F	Maximum Allowable Stress Values, ksi [Note (1)]
100	15.3
150	15.3
200	15.3
250	15.3
300	14.8
400	14.2
500	13.9

GENERAL NOTE: Tubing may utilize the thickness requirements of HF-204.3.

NOTE:

- (1) For SA-789/SA-789M and SA-790 welded pipe and tube, the allowable stress values have been decreased by a factor of 0.85.

**Table 1M**  
**Maximum Allowable Stress Values for SA-240/SA-240M Plate and SA-789/SA-789M and SA-790 Seamless Pipe and Tube**

For Metal Temperatures Not Exceeding, °C	Maximum Allowable Stress Values, MPa
40	124
65	124
125	122
150	120
200	116
250	113
300 [Note (1)]	111

GENERAL NOTES:

- (a) This steel may be expected to develop embrittlement after service at moderately elevated temperature; see Section II, Part D, Nonmandatory Appendix A, A-207 and A-208.
- (b) This material may utilize the minimum thickness exemptions as shown in HF-301.1(c) at pressures up to 1100 kPa.
- (c) Tubing may utilize the thickness requirements of HF-204.3.

NOTE:

- (1) The maximum use temperature shall be 260°C. Datum for 300°C temperature is provided for interpolation purposes.

**Table 2M**  
**Maximum Allowable Stress Values for SA-789/SA-789M and SA-790 Welded Pipe and Tube**

For Metal Temperatures Not Exceeding, °C	Maximum Allowable Stress Values, MPa [Note (1)]
40	105
65	105
125	104
150	102
200	98.0
250	95.9
300 [Note (2)]	94.5

GENERAL NOTE: Tubing may utilize the thickness requirements of HF-204.3.

NOTES:

- (1) For SA-789/SA-789M and SA-790 welded pipe and tube, the allowable stress values have been decreased by a factor of 0.85.
- (2) The maximum use temperature shall be 260°C. Datum for 300°C temperature is provided for interpolation purposes.

Approval Date: September 15, 2009

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2585-1**  
**23Cr-35Ni-7.5Mo-N, UNS N08354, Austenitic Alloy**  
**Section VIII, Division 1**

*Inquiry:* May 23Cr-35Ni-7.5Mo-N, UNS N08354, austenitic alloy sheet, strip, plate, pipe, tube, and bar, meeting the chemical composition and mechanical property requirements shown in Tables 1 and 2, and otherwise conforming to one of the specifications in Table 3, be used in welded construction under the rules of Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used in Section VIII, Division 1 construction, provided the following requirements are met:

(a) The rules in Section VIII, Division 1, Subsection C that shall apply are those given in Part UNF for nickel alloys.

(b) For external pressure, use Fig. HA-6 of Section II, Part D.

(c) The maximum allowable stress values for the material shall be those given in Tables 4 and 4M. For welded pipe and tube products, a joint efficiency of 0.85 shall be used.

(d) Maximum design temperature of the material shall be 800°F (427°C).

(e) Separate welding procedure and performance qualifications shall be conducted for the material in accordance with Section IX. When welding this material to itself, GTAW welding process welded with ERNiCrMo-4 (UNS N10276) or similar corrosion resistant weld filler metals shall be used.

(f) Heat treatment after forming or fabrication is neither required nor prohibited. However, if heat treatment is applied, the solution annealing treatment shall be as noted in (g).

(g) The material shall be furnished in the solution annealed condition at a temperature range from 1975°F to 2155°F (1080°C to 1180°C) followed by rapid cooling in air or water.

(h) This Case number shall be shown on the documentation, marking of the material, and on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1  
 Chemical Requirements**

Element	Composition, %
Carbon, max.	0.030
Manganese, max	1.00
Phosphorus, max.	0.030
Sulfur, max.	0.010
Silicon, max.	1.00
Nickel	34.00–36.00
Chromium	22.00–24.00
Molybdenum	7.0–8.0
Nitrogen	0.17–0.24

**Table 2  
 Mechanical Property Requirements**

Tensile strength, min. ksi (MPa)	93 (640)
Yield strength, min. ksi (MPa)	43 (295)
Elongation in 2 in. or 50 mm, min. %	40
Hardness HRB (HB), max.	96 (217)

**Table 3  
 Product Specifications**

Bar and wire	SB-649
Seamless pipe and tube	SB-677
Sheet, strip, and plate	SB-625
Welded pipe	SB-673

**Table 4  
 Maximum Allowable Stresses**

For Metal		
Temperature Not Exceeding, °F	Allowable Stress Values, Max., ksi	
100	26.5	26.5
200	24.3	26.5 [Note (1)]
300	22.1	25.0 [Note (1)]
400	20.5	23.8 [Note (1)]
500	19.6	23.0 [Note (1)]
600	18.9	22.5 [Note (1)]
650	18.6	22.3 [Note (1)]
700	18.3	22.1 [Note (1)]
750	18.0	21.9 [Note (1)]
800	17.7	21.7 [Note (1)]

GENERAL NOTE: The revised criterion of 3.5 on tensile strength was used in establishing these values.

NOTE:

- (1) Due to the relatively low yield strength of this material, these high stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed 66<sup>2</sup>/<sub>3</sub>%, but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.

**Table 4M  
 Maximum Allowable Stresses**

For Metal		
Temperature Not Exceeding, °C	Allowable Stress Values, Max., MPa	
40	183	183
65	178	183 [Note (1)]
100	166	182 [Note (1)]
125	158	177 [Note (1)]
150	152	172 [Note (1)]
200	142	165 [Note (1)]
250	136	160 [Note (1)]
300	132	156 [Note (1)]
325	130	155 [Note (1)]
350	128	154 [Note (1)]
375	126	152 [Note (1)]
400	124	151 [Note (1)]
425	122	150 [Note (1)]
450	121	148 [Note (1)], [Note (2)]

GENERAL NOTE: The revised criterion of 3.5 on tensile strength was used in establishing these values.

NOTES:

- (1) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed 66<sup>2</sup>/<sub>3</sub>%, but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.
- (2) These values are provided for interpolation purposes only. The maximum use temperature is 800°F (427°C).

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Approval Date: October 2, 2008

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2586-1**  
**25Cr-7.5Ni-4.5Mo-Co-N Austenitic-Ferritic Stainless**  
**Steel UNS S32707**  
**Section VIII, Division 1**

*Inquiry:* May solution annealed alloy UNS S32707 seamless pipe and tube with the chemical composition conforming to Table 1, mechanical properties conforming to Table 2, and otherwise conforming to the respective requirements of the specifications given in Table 3 be used for welded construction under the rules of Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that solution annealed alloy UNS S32707 seamless pipe and tube as described in the Inquiry may be used in welded construction under the rules of Section VIII, Division 1, provided the following requirements are met:

(a) The material shall be heat treated at a temperature of 1,975°F to 2,050°F (1 080°C to 1 120°C) followed by rapid cooling in air or water.

(b) The rules in Section VIII, Division 1, Subsection C that shall apply are those given in Part UHA for austenitic-ferritic duplex stainless steels.

(c) The maximum allowable stress values for the material shall be those given in Table 4 and Table 4M. The design temperature shall not exceed 500°F (260°C).

(d) Separate welding procedure qualifications and performance qualifications, conducted in accordance with Section IX, shall be required for this material.

(e) Heat treatment after welding or fabrication is neither required nor prohibited. If heat treated, the requirements of (a) shall apply.

(f) For external pressure design, see Fig. HA-5 in Section II, Part D shall apply.

(g) This Case number shall be shown on the documentation and marking of the material and recorded on the Manufacturer's Data Report.

**Table 1**  
**Chemical Requirements**

Element	Composition, %
Carbon, max.	0.030
Manganese, max.	1.50
Phosphorus, max.	0.035
Sulfur, max.	0.010
Silicon, max.	0.50
Chromium	26.00–29.00
Nickel	5.5–9.5
Molybdenum	4.0–5.0
Copper, max.	1.0
Nitrogen	0.3–0.5
Cobalt	0.50–2.00
Iron	balance

**Table 2**  
**Mechanical Test Requirements (Room Temperature)**

Tensile Strength, min. ksi (MPa)	133 (920)
Yield Strength, 0.2% offset, min., ksi (MPa)	101 (700)
Elongation in 2 in., min., %	25

**Table 3**  
**Product Specifications**

Seamless pipe	SA-790
Seamless tube	SA-789

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 4**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Allowable Stress Values, Max., ksi
100	38.0
200	38.0
300	37.6
400	36.2
500	35.5

GENERAL NOTE: Based on a factor of 3.5 tensile strength, where applicable.

**Table 4M**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Allowable Stress Values, Max., MPa
40	262
65	262
100	262
125	262
150	259
175	254
200	250
225	247
250	245
275	244 [Note (1)]

GENERAL NOTES:

- (a) This material may embrittle by exposure to moderately elevated temperatures. See paras. A-340 and A-360 in Appendix A of Section II, Part D.
- (b) Based on a factor of 3.5 tensile strength, where applicable.

NOTE:

- (1) These values are provided for interpolation purposes only. The maximum use temperature is 260°C.

Approval Date: August 6, 2007

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2587**  
**Alternative Rules for Designing U-Shaped Bellows**  
**Section VIII, Division 1**

*Inquiry:* May the rules of Section VIII, Division 1, Appendix 26 be used to design bellows expansion joints with U-shaped convolutions having a torus radius,  $r_i$ , less than three times the bellows thickness,  $t$ ?

*Reply:* It is the opinion of the Committee that the rules of Section VIII, Division 1, Appendix 26 may be used to design bellows expansion joints with U-shaped convolutions having a torus radius,  $r_i$ , less than three times the bellows thickness,  $t$ , provided the following:

- (a) The rules of 26-4.2(b) are followed.
- (b) The increasing bending stress due to curvature is accounted for in the correlation testing.
- (c) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: October 19, 2007

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2588**  
**Ni-Cr-Mo Bolting Material UNS N06059, ASTM F468-06**  
**Section VIII, Division 1**

*Inquiry:* May cold-worked/strain-hardened or annealed alloy UNS N06059 bars up to 4.00 in. diameter conforming to ASTM F468-06 be employed for bolting materials up to 700°F (371°C) for code applications?

*Reply:* It is the opinion of the Committee that cold-worked/strain-hardened bars as described in the Inquiry may be employed for bolting applications.

(a) The maximum allowable stresses for the four different grades of alloy UNS N06059 per ASTM F468-06 shall be as shown in [Table 1](#) and [Table 1M](#).

(b) No welding, weld repair, or any thermal treatment shall be permitted on the cold-reduced/strain-hardened bars.

(c) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values, ksi**

Grade / Condition	Metal Temperature Not Exceeding, °F						
	100	200	300	400	500	600	700
Ni 59 Grade 1 (cold worked)	25.0	25.0	25.0	23.8	22.6	21.4	21.3
Ni 59 Grade 2 (cold worked)	27.0	27.0	27.0	27.0	27.0	27.0	27.0
Ni 59 Grade 3 (cold worked)	32.0	32.0	32.0	32.0	32.0	32.0	32.0
Ni 59 Grade 4 (annealed)	25.0	25.0	25.0	23.8	22.6	21.4	20.2

**Table 1M**  
**Maximum Allowable Stress Values, MPa**

Grade / Condition	Metal Temperature Not Exceeding, °C										
	40	65	100	125	150	200	250	300	325	350	375 [Note (1)]
Ni 59 Grade 1 (cold worked)	172	172	172	172	172	165	157	150	147	146	146
Ni 59 Grade 2 (cold worked)	186	186	186	186	186	186	186	186	186	186	186
Ni 59 Grade 3 (cold worked)	221	221	221	221	221	221	221	221	221	221	221
Ni 59 Grade 4 (annealed)	172	172	172	172	172	169	164	150	146	143	139

NOTE:

(1) This value is provided for interpolation purposes only.

Approval Date: October 2, 2008

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2591**  
**25Cr-20Ni Austenitic Stainless Steel UNS S31002**  
**Section VIII, Division 1**

*Inquiry:* May solution annealed alloy UNS S31002 seamless pipe and tube with the chemical composition conforming to [Table 1](#), mechanical properties conforming to [Table 2](#), and otherwise conforming to the respective requirements of the specifications given in [Table 3](#) be used for welded construction under the rules of Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that solution annealed alloy UNS S31002 seamless pipe and tube as described in the Inquiry may be used in welded construction under the rules of Section VIII, Division 1, provided the following requirements are met:

(a) The material shall be heat treated at a temperature of 1900°F (1040°C) minimum followed by rapid cooling in air or water.

(b) The rules in Section VIII, Division 1, Subsection C that shall apply are those given in Part UHA for austenitic stainless steels.

(c) For Section VIII, Division 1, the maximum allowable stress values for the material shall be those given in [Tables 4](#) and [4M](#). The maximum design temperature shall be 600°F (316°C).

(d) Separate welding procedure qualifications and performance qualifications, conducted in accordance with Section IX, shall be required for this material.

(e) Heat treatment after welding or fabrication is neither required nor prohibited. If heat treated, the requirements of (a) shall apply.

(f) For external pressure design, Fig. HA-2 in Section II, Part D shall apply.

(g) This Case number shall be shown on the documentation and marking of the material, and recorded on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1  
Chemical Requirements**

Element	Composition Limits, %
Carbon, max.	0.015
Manganese, max.	2.00
Phosphorous, max.	0.020
Sulfur, max.	0.015
Silicon, max.	0.15
Chromium	24.0-26.0
Nickel	19.0-22.0
Molybdenum, max.	0.10
Nitrogen, max.	0.10

**Table 2  
Mechanical Test Requirements (Room Temperature)**

Tensile Strength, min. ksi (MPa)	73 (500)
Yield Strength, 0.2% offset, min., ksi (MPa)	30 (205)
Elongation, in 2 in., min., %	35

**Table 3  
Product Specifications**

Seamless pipe	SA-312
Seamless tube	SA-213/SA-213M

**Table 4  
Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Allowable Stress Values, Max., ksi
100	20.0
200	17.0, 20.0 [Note (1)]
300	16.3, 20.0 [Note (1)]
400	15.2, 19.2 [Note (1)]
500	14.1, 18.5 [Note (1)]
600	13.6, 18.2 [Note (1)]

NOTE:  
 (1) Due to the relatively low yield strength of these materials, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. The stress values in this range exceed 66<sup>2</sup>/<sub>3</sub>%, but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction. For Section III applications, Table Y-2 lists multiplying factors that, when applied to the yield strength values shown in Table Y-1, will give allowable stress values that will result in lower levels of permanent strain.

**Table 4M  
Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Allowable Stress Values, Max., MPa
40	138
65	121, 138 [Note (1)]
100	117, 138 [Note (1)]
150	112, 138 [Note (1)]
200	106, 133 [Note (1)]
250	98.5, 128 [Note (1)]
300	94.5, 126 [Note (1)]
325 [Note (2)]	93.8, 125 [Note (1)]

NOTES:  
 (1) Due to the relatively low yield strength of these materials, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. The stress values in this range exceed 66<sup>2</sup>/<sub>3</sub>%, but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction. For Section III applications, Table Y-2 lists multiplying factors that, when applied to the yield strength values shown in Table Y-1, will give allowable stress values that will result in lower levels of permanent strain.  
 (2) Value at 325°C is for interpolation only. Maximum use temperature shall be 316°C.

Approval Date: September 30, 2018

(19)

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2594-2**  
**Use of SA/EN 10028-3 , Grade P460NL1, Fine Grain**  
**Normalized Steel Plates for Class 2**  
**Section VIII, Division 2**

*Inquiry:* Under what conditions may steel plates, manufactured in accordance with SA/EN 10028-3, Grade P460NL1 be used in Section VIII, Division 2, Class 2 construction?

*Reply:* It is the opinion of the Committee that steel plates, manufactured in accordance with SA/EN 10028-3, Grade P460NL1, may be used in Section VIII, Division 2, Class 2 construction, provided the following additional requirements are met:

(a) The thickness of the plates shall not exceed 0.79 in. (20 mm).

(b) The chemical composition shall conform to the values listed in SA/EN 10028-3 for Grade P460NL1, except that:

(1) The copper content shall not exceed 0.20% by heat analysis.

(2) The vanadium content shall be within the range of 0.10% to 0.20% by heat analysis.

(c) The design temperature shall not exceed 150°F (65°C).

(d) The specified minimum tensile strength shall be 91.5 ksi (630 MPa).

(e) The yield strength values shall be those listed in Table 1.

(f) The design stress intensity,  $S_m$ , shall be 38.14 ksi (263 MPa).

(g) For external pressure design, the requirements of Fig. CS-5 of Section II, Part D shall apply.

(h) The provisions for impact test exemption in paras. 3-11.2.3 through 3-11.2.5 shall not apply.

(i) For the purpose of postweld heat treatment, the material shall be considered as P-No. 10A, Gr. 1, except that:

(1) Postweld heat treatment shall be in the temperature range of 985°F to 1040°F (530°C to 560°C) with a minimum holding time of  $\frac{1}{2}$  hr at temperature.

(2) Consideration should be given for possible embrittlement when postweld heat treating the material and welded joints.

(j) Separate welding procedure and performance qualifications shall be conducted in accordance with Section IX.

(k) Welding by electroslag or electrogas process is not permitted.

(l) This Case number shall be marked on the material, documented on the material test report, and shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Values of Yield Strength**

Thickness, $t$ , in. (mm)	Yield Strength, ksi (MPa) For Metal Temperature Not Exceeding, °F (°C)	
	100 (40)	150 (65)
$t \leq \frac{5}{8}$ in. (16 mm)	66.5 (460)	64.5 (445)
$\frac{5}{8}$ in. (16 mm) < $t \leq 0.79$ in. (20 mm)	64.5 (445)	62.5 (430)

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Approval Date: January 4, 2008

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2595**  
**Use of Materials in a Current Code Edition for a Boiler**  
**Constructed to an Earlier Code Edition**  
**Section I**

*Inquiry:* May materials in the current Code Edition and Addenda of Section I be used in a boiler to be constructed to an earlier Code Edition and Addenda of Section I that did not include those materials?

*Reply:* It is the opinion of the Committee that that materials in the current Code Edition and Addenda of Section I may be used in a boiler to be constructed to an earlier Code Edition and Addenda of Section I that did not include those materials, provided the following additional requirements are met:

(a) The maximum allowable stress values in the current Code Edition and Addenda are the unit stresses to be used in the formulas of the current Code Edition and

Addenda to calculate the minimum required thickness or the maximum allowable working pressure of the pressure part.

(b) Miscellaneous pressure parts shall comply with the requirements of PG-11 of the current Code Edition and Addenda.

(c) The applicable welding requirements in the current Code Edition and Addenda shall be applied for the material and welding processes.

(d) The base material, post-weld, and post-forming heat treatment requirements in the current Code Edition and Addenda shall be applied for the material.

(e) All other Code requirements of the earlier Code Edition and Addenda to be used for final certification of the completed boiler shall be met.

(f) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: April 6, 2011

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2596-1**  
**Cold-Stretching of Austenitic Stainless Steel Pressure Vessels**  
**Section VIII, Division 1**

*Inquiry:* May cold-stretched austenitic stainless steel pressure vessels be constructed under the rules of Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that cold-stretched austenitic stainless steel vessels may be constructed under the rules of Section VIII, Division 1, provided the following additional requirements are met.

**1 SCOPE**

(a) Vessel wall thickness shall not exceed 1.2 in. (30 mm).

(b) Minimum metal design temperature (MDMT) shall not be colder than  $-320^{\circ}\text{F}$  ( $-196^{\circ}\text{C}$ ).

(c) Maximum design temperature shall not exceed  $120^{\circ}\text{F}$  ( $50^{\circ}\text{C}$ ).

(d) Pressure vessels designed using the rules specified in this Case are limited to single diameter cylindrical shells with dished heads, spherical shells, and nozzles without reinforcing pad.

(e) The minimum specified ultimate tensile strength (UTS) of the weld filler metal used in construction shall not be less than the minimum specified UTS for the base metals of the weld joint.

(f) Nozzles and opening reinforcement components shall be designed using Section VIII, Division 1 rules, and applying the allowable stress values specified in Section II, Part D.

(g) The rules specified in this Case are applicable for vessels designed for internal pressure only, and shall not be used for vessels designed for external pressure.

(h) Nozzle size shall not exceed NPS 6 (DN 150) in shells and heads and NPS 8 (DN 200) at the center of the heads.

(i) All Category A weld joints shall be Type No. 1. All Category B weld joints shall be Type No. 1 or Type No. 2.

**2 NOMENCLATURE**

$P$  = design pressure  
 $P_c$  = coldstretch pressure  
 $S$  = allowable design stress in tension  
 $Y_c$  = yield strength in the coldstretched condition

**3 MATERIALS AND ALLOWABLE DESIGN STRESS**

The stainless steel materials listed in Table 1 are allowed in the vessel construction. The value of allowable design stress  $S$  in tension shall not exceed the value listed in Table 1.

**4 DESIGN**

(a) Wall thicknesses shall be calculated according to the applicable rules of Section VIII, Division 1 before cold-stretching. The maximum design stress value shall be as shown in Table 1.

(b) Nominal diameters may be used in the design calculations. No allowance is necessary for the possible increase in diameter due to cold-stretching.

(c) The cold-stretching pressure  $P_c$  shall not be less than 1.5 times the design pressure  $P$  and shall not be greater than 1.6 times the design pressure.

(d) Inside knuckle radius of formed torispherical heads shall not be less than 10% of the inside crown radius of the head.

(e) Butt welded joints shall be fully radiographed per UW-51 or examined by ultrasonic examination using Code Case 2235.

(f) All nozzles shall be attached with full penetration welds.

(g) The thickness of a support pad shall not exceed the thickness of the shell at the attachment location.

(h) Full thickness fillet welds shall be provided at support pad attachment locations.

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**Table 1**  
**Allowable Materials and Design Stress**

Material	Allowable Design Stress <i>S</i> in	
	Tension, ksi	Tension, MPa
SA-240, Type 304 Stainless steel	39.3	270
SA-240, Type 304L Stainless steel	36.0	247
SA-240, Type 304N Stainless steel	42.7	293
SA-240, Type 316 Stainless steel	39.3	270
SA-240, Type 316L Stainless steel	36.0	247
SA-240, Type 316N Stainless steel	42.7	293
SA-240, Type 316LN Stainless steel	39.3	270

## 5 FABRICATION PROCESS

### 5.1 WELDING AND EXAMINATION

(a) For all Category A joints, the reinforcement shall not exceed 10% of the plate thickness or  $\frac{1}{8}$  in. (3 mm), whichever is less. The edge of the weld deposits shall merge smoothly into the base metal without undercut or abrupt transition. All attachment welds shall be continuous and have a smooth contour with no undercut permitted.

(b) Welder and welding operator identification shall be marked with a paint pen or maintained by weld maps. Direct stamping of the vessel is not permitted. In lieu of stamping of the material marking on the plates, other methods acceptable to the Authorized Inspector shall be used. Stamping of the ASME Certification Mark shall be on a nameplate attached to a stand-off plate or by other means.

(c) Butt joints shall comply with Section VIII, Division 1, UW-51. Radiographic examinations shall be performed prior to coldstretching. As an alternative to the radiographic examination, ultrasonic examination may be used in accordance with Code Case 2235.

(d) In areas such as nozzle-to-shell attachment locations, abrupt changes in thickness or contour, and other similar structural discontinuities, high local stress and strain concentrations are anticipated during the cold-stretching process. To check for potential crack formation in these areas, after depressurization of the vessel following cold-stretching, all Category A weld joints and all attachment welds shall be examined externally for their entire lengths using the liquid penetrant method in accordance with Section VIII, Division 1, Appendix 8.

(e) Renewed cold-stretching shall be performed if cold-stretched parts of the vessel have been welded after cold-stretching, except for attachment or tack welds less than 0.25 in. (6 mm) in length. Such welds shall be examined as described in (d).

(f) Except when renewed cold-stretching is to be performed, the pressure test required by UG-99 or UG-100 shall be applied after all welding on the pressure retaining parts.

### (g) Impact Test Requirements

(1) The cold-stretched base materials listed in Table 1 need not be impact tested when used in vessels constructed in accordance with this Code Case.

(2) The Welding Procedure Qualification shall include impact tests of welds and heat affected zones (HAZ) made in accordance with UG-84(h) and with requirements of UHA-51(a) at MDMT. The specimens shall be tested from the welded cold-stretched plate. The welded plate shall be cold-stretched by applying tensile stress across the welded joint equal to or greater than 1.5 times the allowable design stress listed in Table 1 of this Code Case. The Welding Procedure Qualification impact tests need not be conducted for MDMT of  $-55^{\circ}\text{F}$  ( $-48^{\circ}\text{C}$ ) and warmer.

(3) The vessel (production) impact tests in accordance with UHA-51(h) are not required for vessels constructed in accordance with this Code Case.

### 5.2 COLD-STRETCHING OPERATION

(a) The cold-stretching operation shall be performed using the following rules. These rules shall include the steps described in (b) through (f).

(b) Fill the vessel with water with adequate high point venting to ensure complete filling. Allow the vessel to sit with the vents open for at least 15 min to allow any air dissolved in the water to escape. After venting, finish filling the vessel completely and close the vents, top off, and seal the vessel.

(c) Prior to applying the cold-stretching pressure, the circumference of all shell courses shall be measured where the largest increase in cross-section is expected. All measurements shall be made with instruments that have been calibrated to an accuracy of  $\pm 0.05\%$ . This shall be used to establish a baseline dimensional value. Additional measurements of the vessel while under cold-stretching pressure shall be taken as necessary to calculate the strain rate. The strain rate during the cold-stretching operation shall be calculated over the full circumference. As an alternative to this, the strain rate may also be determined by recording time, pressure, and elongation of the circumference.

(d) The cold-stretching operation shall be carried out as follows:

(1) The pressure shall be increased until the cold-stretching pressure  $P_c$  is reached. The cold-stretching pressure shall be maintained until the calculated strain rate has dropped to less than 0.1%/hr.

(2) The minimum holding time under coldstretching pressure shall be not less than one hour, except as described in (e).

(3) The calculated strain rate shall be determined by repeated and/or continuous measurements of the circumference while the vessel is under cold-stretching pressure as described in (c). The required maximum strain rate of 0.1%/hr shall be met during the last half hour.

**CAUTION: Pressurized equipment contains stored energy capable of sudden release in the event of a catastrophic failure. The potential hazard is greater as the pressure is increased. It is recommended a "safety zone" be established and maintained around the vessel while cold-stretching pressure is applied. Special care shall be given to minimize the time personnel remain within the "safety zone" while taking the required measurements.**

NOTE: The total time under cold-stretching pressure required to achieve the desired strain may be substantial. The amount of time the vessel is subjected to cold-stretching pressure may be reduced somewhat if a 5% higher cold-stretching pressure is applied during the first 30 min to 1 hr to accelerate strain formation.

(e) For pressure vessels having a diameter not more than 79 in. (2 000 mm) the time under pressure may be reduced to 30 min, provided the strain rate of 0.1%/hr is met during the last 15 min.

(f) The strengthening operation replaces the final pressure testing of the vessel. Should later pressure testing be required, the requirements of UG-99 or UG-100 shall be applied.

(g) The cold-stretching process shall be witnessed by the Authorized Inspector (AI).

(h) If the vessel requires welded repair, renewed cold-stretching shall be carried out in accordance with the rules of 5.2.

### 5.3 COLD-STRETCHING PROCEDURE RECORD

A written record shall be prepared, containing at least the following information:

(a) pressurizing sequence specifying pressure readings and time

(b) results of the circumference measurements before, during and after pressurization, and of the time, pressure, and elongation as an alternative

(c) results of strain rate calculations

(d) notes of any significant changes of shape and size relevant to the functioning of the vessel

(e) information for renewed cold-stretching [according to 5.1(e) and 5.2(h)]

### 6 STAMPING AND CERTIFICATION

(a) The Certification Mark stamping on the nameplate shall include marking with "CS" under the Certification Mark, indicating the vessel was constructed using cold-stretching methods.

(b) This Case number shall be shown on the Manufacturer's Data Report. Additionally, the Manufacturer shall indicate in the Remarks section of the Manufacturer's Data Report: "This vessel has been constructed using cold-stretch processes."

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Approval Date: May 21, 2008

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2597**  
**Permit Testing a Single Forging to Represent Several Thicknesses**  
**Section VIII, Division 3**

*Inquiry:* Under what conditions may the separate test forging permitted by Section VIII, Division 3, KM-211.2(d) be used to represent forgings of several thicknesses in lieu of the requirements in KM-211.2(d) (3)?

*Reply:* It is the opinion of the Committee that the separate test forging permitted by Section VIII, Division 3, KM-211.2(d) may be used to represent forgings of several

thicknesses in lieu of the requirements in KM-211.2(d) (3), provided the following additional requirements are met:

(a) The separate test forging shall have a weight equal to or greater than the weight of the heaviest forging in the batch to be represented.

(b) The separate test forging shall have a thickness equal to or greater than the thickness of the thickest forging in the batch to be represented.

(c) This Case number shall be shown on the marking and certification of the material and on the Manufacturer's Data Report.

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Approval Date: January 29, 2008

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**Case 2598**  
**22Cr-15Ni-Cb-N Austenitic Stainless Steel Seamless**  
**Tubing**  
**Section I**

*Inquiry:* May solution-treated 22Cr-15Ni-Cb-N austenitic stainless steel seamless tubing with chemical analysis shown in [Table 1](#), the mechanical properties shown in [Table 2](#), and that otherwise conform to applicable requirements in SA-213/SA-213M be used for steam service in Section I construction?

*Reply:* It is the opinion of the Committee that the material listed in the Inquiry may be used for steam service in Section I construction, provided that the following requirements are met:

(a) The material shall meet the chemical analysis and minimum tensile requirements described in the Inquiry, and shall otherwise meet the requirements of SA-213/SA-213M as applicable, except as shown in (b) and (c).

(b) The minimum solution-treating temperature for this material shall be 2120°F (1160°C).

(c) This material shall have a hardness not exceeding 219 HBW/230 HV (95 HRB).

(d) The rules of PG-19 for TP347H shall apply for this material, except that solution treatment, when required, shall be at the minimum temperature of 2120°F (1160°C).

(e) The maximum allowable stress values for the material shall be as given in [Tables 3](#) and [3M](#). The maximum design temperature is 1382°F (750°C).

(f) Separate welding procedure and performance qualification shall be conducted for the material in accordance with Section IX.

(g) This Case number shall be referenced in the documentation and marking of the material and recorded on the Manufacturer's Data Report.

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**Table 1**  
**Chemical Requirements**

Element	Composition, %
Carbon	0.03–0.10
Manganese, max.	2.00
Phosphorus, max.	0.040
Sulfur, max.	0.030
Silicon, max.	1.00
Nickel	14.5–16.5
Chromium	21.0–23.0
Columbium	0.50–0.80
Nitrogen	0.10–0.20
Boron	0.001–0.005

**Table 2**  
**Mechanical Property Requirements**

Tensile strength, min., ksi (MPa)	86 (590)
Yield strength, min., ksi (MPa)	34 (235)
Elongation in 2 in. or 50 mm, min., %	35

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**Table 3**  
**Maximum Allowable Stresses**

For Metal Temperature Not Exceeding, °F		
Exceeding, °F	Allowable Stress Values, ksi	Allowable Stress Values, ksi
-40 to 100	22.7	22.7
200	20.9	22.7 [Note (1)]
300	19.5	22.7 [Note (1)]
400	18.2	22.7 [Note (1)]
500	17.0	22.5 [Note (1)]
600	16.1	21.7 [Note (1)]
650	15.7	21.2 [Note (1)]
700	15.4	20.7 [Note (1)]
750	15.1	20.4 [Note (1)]
800	14.9	20.1 [Note (1)]
850	14.7	19.8 [Note (1)]
900	14.6	19.7 [Note (1)]
950	14.5	19.5 [Note (1)]
1000	14.4	19.5 [Note (1)]
1050	14.4	19.4 [Note (1)]
1100	14.3	16.1 [Note (2)]
1150	12.1	12.1
1200	9.0	9.0
1250	6.9	6.9
1300	5.4	5.4
1350	4.4	4.4
1400	3.7 [Note (3)]	3.7 [Note (3)]

GENERAL NOTE: The revised criterion of 3.5 on tensile strength was used in establishing these values.

NOTES:

- (1) Due to the relatively low yield strength of this material, these high stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed 66<sup>2</sup>/<sub>3</sub>%, but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.
- (2) This allowable stress value for a temperature of 1100°F is obtained from time-dependent properties. Similarly, all the allowable stress values shown at temperatures of 1150°F and above are obtained from time-dependent properties.
- (3) These values are provided for interpolation purposes only.

**Table 3M**  
**Maximum Allowable Stresses**

For Metal Temperature Not		
Exceeding, °C	Allowable Stress Values, MPa	Allowable Stress Values, MPa
-30 to 40	156	156
65	149	156 [Note (1)]
100	143	156 [Note (1)]
125	139	156 [Note (1)]
150	134	156 [Note (1)]
175	130	156 [Note (1)]
200	126	156 [Note (1)]
225	122	156 [Note (1)]
250	119	155 [Note (1)]
275	116	154 [Note (1)]
300	113	152 [Note (1)]
325	110	148 [Note (1)]
350	108	145 [Note (1)]
375	106	143 [Note (1)]
400	104	140 [Note (1)]
425	103	139 [Note (1)]
450	101	137 [Note (1)]
475	101	136 [Note (1)]
500	100	135 [Note (1)]
525	99.5	134 [Note (1)]
550	99.2	134 [Note (1)]
575	99.0	133 [Note (1)]
600	98.9	104 [Note (2)]
625	79.7	79.7
650	61.2	61.2
675	48.0	48.0
700	38.7	38.7
725	32.0	32.0
750	27.1	27.1

GENERAL NOTE: The revised criterion of 3.5 on tensile strength was used in establishing these values.

NOTES:

- (1) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed  $66\frac{2}{3}\%$ , but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.
- (2) This allowable stress value for a temperature 600°C is obtained from time-dependent properties. Similarly, all the allowable stress values shown at temperatures of 625°C and above are obtained from time-dependent properties.

(19)

**Case 2602-1  
Dry Film Storage of Digital Radiographic  
Images  
Section V**

**ANNULLED**

Annulment Date: December 30, 2018

Reason: No longer needed.

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Approval Date: April 15, 2017

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**Case 2603-2**  
**Use of UNS S32101 Ferritic/Austenitic Stainless Steel**  
**Plate, Sheet, Strip, Pipe, and Tube**  
**Section IV**

*Inquiry:* Under what conditions may UNS S32101 ferritic/austenitic stainless steel in SA-240 plate, sheet, and strip, SA-790 pipe, and SA-789 tube specifications be used in the construction of Section IV hot water heating boilers?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used in the welded construction of Section IV hot water heating boilers, provided the following requirements are met:

(a) The allowable stress for plate, sheet, strip, seamless pipe and seamless tube in accordance with SA-240, SA-790, and SA-789 shall be as listed in [Tables 1](#) and [1M](#).

(b) The allowable stress for welded pipe and tube in accordance with SA-790 and SA-789 shall be as listed in [Tables 2](#) and [2M](#).

(c) Welding procedure and performance qualification shall be conducted in accordance with Section IX.

(d) For external pressure Fig. HA-5 of Section II, Part D shall be used.

(e) The maximum design temperature shall be 500°F (260°C).

(f) All other requirements of Section IV shall be met.

(g) This Case number shall be shown on the Manufacturer's Data Report.

NOTES:

- (1) This steel may be expected to develop embrittlement after service at moderately elevated temperatures; see Appendix A, A-340 and A-360 Section II, Part D.
- (2) This material may utilize the minimum thickness exceptions of HF-301.1(c) at pressures up to 160 psi (1 100 kPa).

<b>Table 1</b>	
<b>Maximum Allowable Stress Values for SA-240 Plate, Sheet, and Strip, Seamless SA-790 Pipe, and Seamless SA-789 Tube</b>	
For Metal Temperatures Not Exceeding, °F	Maximum Allowable Stress Values, ksi
100	20.7
200	19.1
300	17.9
400	17.3
500	17.3

<b>Table 1M</b>	
<b>Maximum Allowable Stress Values for SA-240 Plate, Sheet, and Strip, Seamless SA-790 Pipe, and Seamless SA-789 Tube</b>	
For Metal Temperatures Not Exceeding, °C	Maximum Allowable Stress Values, MPa
40	143
65	137
90	132
150	124
200	120
250	119
300	119 <a href="#">[Note (1)]</a>

NOTE:  
(1) The maximum use temperature shall be 260°C. Datum for 300°C temperature is provided for interpolation purposes.

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**Table 2**  
**Maximum Allowable Stress Values for**  
**Welded SA-790 Pipe and Welded SA-789**  
**Tube**

For Metal Temperatures Not Exceeding, °F	Maximum Allowable Stress Values, ksi [Note (1)]
100	17.6
200	16.2
300	15.2
400	14.7
500	14.7

NOTE:

(1) For welded pipe and tube, the allowable stress values have been decreased by a factor of 0.85.

**Table 2M**  
**Maximum Allowable Stress Values for**  
**Welded SA-790 Pipe and Welded SA-789**  
**Tube**

For Metal Temperatures Not Exceeding, °C	Maximum Allowable Stress Values, MPa [Note (1)]
40	122
65	116
90	113
150	105
200	102
250	101
300	101 [Note (2)]

NOTES:

(1) The maximum use temperature shall be 260°C. Datum for 300°C temperature is provided for interpolation purposes.

(2) For welded pipe and tube, the allowable stress values have been decreased by a factor of 0.85.

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Approval Date: October 2, 2008

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**Case 2604**  
**Use of Pneumatic Testing on Individual Cast Aluminum**  
**Sections**  
**Section IV**

*Inquiry:* Under what conditions may cast aluminum boiler sections, manufactured by a manufacturer who is in possession of an H Code Symbol Stamp and a valid Certificate of Authorization, be pneumatically tested in lieu of the hydrostatic requirements of HA-406?

*Reply:* It is the opinion of the Committee that, in lieu of the hydrostatic test provisions as stated in HA-406, the manufacturer of the cast aluminum boiler sections may pneumatically test those sections, provided the following requirements are met:

(a) The maximum allowable working pressure of the casting cannot exceed 60 psi.

(b) The pneumatic test pressure shall be at least  $2\frac{1}{2}$  times the maximum allowable working pressure to be stamped on the individual boiler section. In no case shall the pneumatic test pressure exceed  $2\frac{1}{2}$  times maximum allowable working pressure by more than 10 psi.

(c) The pressure in the casting shall be gradually increased to no more than one-half of the required test pressure. Thereafter the pressure shall be increased in steps of approximately one-tenth of the required test pressure until the required test pressure has been

reached. Once the required test pressure has been reached, the pneumatic testing shall be considered completed. However, the  $1\frac{1}{2}$  times hydrostatic test of the assembled boiler as required by HA-406.1 must still be performed by the assembler.

(d) The Manufacturer is responsible for performing the pneumatic test in a test facility or with test equipment that is capable of containing, including the pressure wave and projectiles, a catastrophic failure of the vessel under the maximum pneumatic test pressure permitted in (b). The Manufacturer shall attest to the adequacy of such a facility or testing equipment by one of the following signed certifications:

(1) for test facilities or test equipment installed in the United States or Canada, certification by a Professional Engineer experienced in design of blast resistant enclosures and registered in either one or more states of the United States or provinces of Canada

(2) for test facilities or test equipment installed outside of the United States and Canada, certification by an Engineer experienced in the design of blast resistant enclosures with qualifications acceptable to the concerned legal jurisdiction

(e) The signed certification shall be identified in the written description of the Quality Control System.

(f) The Manufacturer shall ensure that the test facility or test equipment is designed, constructed, and operated as certified above.

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Approval Date: December 11, 2017

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**Case 2605-3**  
**Fatigue Evaluation for Class 2 Parts Constructed With SA-182 F22V; SA-336 F22V; SA-541 22V; SA-542 Type D, Class 4a; and SA-832 Grade 22V at Temperatures Greater Than 371°C (700°F) and Less Than or Equal to 482°C (900°F)**  
**Section VIII, Division 2**

*Inquiry:* Under what requirements may Section VIII, Division 2, Class 2 pressure parts constructed with SA-182 F22V; SA-336 F22V; SA-541 Grade 22V; SA-542 Type D, Class 4a; and SA-832 Grade 22V be evaluated for fatigue for operating temperatures greater than 371°C (700°F) and less than or equal to 482°C (900°F)?

*Reply:* It is the opinion of the Committee that Section VIII, Division 2, Class 2 pressure parts constructed with SA-182 F22V; SA-336 F22V; SA-541 22V; SA-542 Type D, Class 4a; and SA-832 22V may be evaluated for fatigue for operating temperatures greater than 371°C (700°F) and less than or equal to 482°C (900°F); provided the following requirements are satisfied.

(a) The time, temperature, and load history shall be provided in the User's Design Specification. The load history shall include both design and operating conditions. The design conditions shall be used for analyses defined in (b) and (c). The operating conditions are used for analyses defined in (d) and (e). The maximum permissible temperature for the analyses defined in (d) and (e) is 482°C (900°F).

(b) The design of pressure parts or nonpressure parts, i.e., skirt and skirt attachment, may be in accordance with the design-by-rule requirements of Part 4 or the design-by-analysis requirements of Part 5. In either case, the allowable stress,  $S$ , to be used for design shall be in accordance with Table 5A of ASME Section II, Part D. If design-by-analysis is used to qualify the design of a pressure part or nonpressure part, the design-by-analysis shall be based on the elastic stress analysis methods in Part 5.

(c) Restrictions on the design of pressure parts shall be as follows:

(1) The diameter ratio of the shell shall satisfy  $D_o/D_i \leq 1.2$ .

(2) Standard pressure parts that comply with an ASME product listed in Part 1, Table 1.1, and para. 4.1.11 may be used for closure components or piping connections at the pressure-temperature rating listed in the ASME standard.

(3) The skirt attachment detail shall be in accordance with para. 4.2, Fig. 4.2.4, illustration (e). Figure 4.2.4, illustration (f) may be used if the requirements of (d)(5) are satisfied.

(4) Integral reinforcement shall be used for nozzles and conical transitions.

(5) Flange designed in accordance with Part 4, para. 4.16 may be used for closure components or piping connections, except that the allowable stress,  $S$ , shall be in accordance with Table 1A of Section II, Part D.

(6) The rules for external pressure and compressive stress design in Part 4, para. 4.4 may be used if the strain rate computed using eq. (d)(3)(3) based on the membrane stress for the most severe combination of applied loads that results in compressive stress satisfy eq. (1)

$$\dot{\epsilon} \leq \frac{3(10)^{-8}}{\text{hr}} \quad (1)$$

(d) An inelastic analysis including the effect of creep shall be performed for pressure parts based on the following requirements. This analysis is not required for standard pressure parts and bolted flanges specified in (c)(2) and (c)(5).

(1) The inelastic analysis shall be based on the histogram defined in (-a) using one of the following options. Either option may be used for different components in the vessel.

(-a) *Option 1.* An approximate ratcheting analysis may be performed, based on establishing elastic shake-down at all points in the structure. If this option is chosen, a conservative load histogram shall be used based on the most extreme conditions of stress and temperature. A minimum of two complete cycles shall be computed, including a hold time of a minimum of one year, for the purpose of establishing the effects of creep relaxation. During the last computed cycle, a state of linear elasticity must be demonstrated throughout the cycle. If this criterion is not

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

achieved, a full inelastic analysis using the actual time-dependent thermal and mechanical loading histograms shall be performed as per Option 2.

(-b) *Option 2.* If it is elected not to perform a simplified analysis as per Option 1, or if such an analysis is carried out and fails to demonstrate elastic shakedown according to the criterion stated in Option 1, then a full inelastic analysis shall be performed using the actual time-dependent thermal and mechanical loading histograms, including all operating cycles and their associated hold times. This analysis shall be continued for all cycles defined in the load histogram including their associated hold times, or until the analysis demonstrates shakedown to a stable state or a steady ratchet deformation. In either case, the strain limits in (6)(-a) shall be satisfied.

Protection against ratcheting may be demonstrated using an elastic analysis in lieu of inelastic analysis. To evaluate protection against ratcheting, the following limit shall be satisfied:

$$P_L + P_b + Q + F \leq (S_h + S_{yc}) \quad (2)$$

(2) Elastic, perfectly plastic stress-strain curves based on the yield strengths consistent with the operating temperature envelope and the following creep rate shall be used in the analysis.

(3) The strain rate to be used in the inelastic analysis (i.e., creep model) shall be determined using eqs. (3) through (14). The coefficients for these equations are provided in Tables 1 and 1M.

$$\dot{\epsilon}_c = \frac{\dot{\epsilon}_{oc}}{1 - D_c} \quad (3)$$

$$\log_{10} \dot{\epsilon}_{oc} = - \left\{ A_0 + \left( \frac{A_1 + A_2 S_l + A_3 S_l^2 + A_4 S_l^3}{T} \right) \right\} \quad (4)$$

$$S_l = \log_{10}(\sigma_e) \quad (5)$$

$$\sigma_e = \frac{1}{\sqrt{2}} [(\sigma_1 - \sigma_2)^2 + (\sigma_1 - \sigma_3)^2 + (\sigma_2 - \sigma_3)^2]^{0.5} \quad (6)$$

$$D_c = \int_0^t \dot{D}_c dt \leq 1.0 \quad (7)$$

$$\dot{D}_c = \Omega_m \dot{\epsilon}_{oc} \quad (8)$$

$$\Omega_m = \Omega_n^{\delta + 1} \quad (9)$$

$$\Omega_n = \max. [(\Omega - n), 3.0] \quad (10)$$

$$\log_{10} \Omega = B_0 + \left( \frac{B_1 + B_2 S_l + B_3 S_l^2 + B_4 S_l^3}{T} \right) \quad (11)$$

$$n = \left( \frac{A_2 + 2A_3 S_l + 3A_4 S_l^2}{T} \right) \quad (12)$$

$$\delta = \beta \left( \frac{3p}{\sigma_e} - 1.0 \right) \quad (13)$$

$$p = \frac{\sigma_1 + \sigma_2 + \sigma_3}{3} \quad (14)$$

(4) The inelastic analysis shall be performed for selected locations experiencing the most extreme conditions of stress and temperature to determine the creep life absent fatigue,  $L_{caf}$ . Sufficient locations shall be selected to ensure that the most critical conditions have been considered. The creep life absent fatigue is defined as the time in which the inelastic analysis produces an accumulated creep damage such that  $0.95 \leq D_c < 1.0$  or 1,000,000 hours, whichever is reached first. A range is given for  $D_c$  to account for numerical accuracy in the inelastic analysis. For design purposes and to account for

**Table 1**  
**MPC Project Omega Creep Data**

Material	Strain Rate Parameter, $\dot{\epsilon}_0$ [Note (1)]		Omega Parameter, $\Omega$ [Note (1)]	
2.25Cr-1Mo-V	$A_0$	-25.0	$B_0$	-2.53
	$A_1$	50,315.0	$B_1$	9,000.0
	$A_2$	5,358.06	$B_2$	-3,500.0
	$A_3$	-7,580.0	$B_3$	225.0
	$A_4$	450.0	$B_4$	450.0

GENERAL NOTE: The coefficients in this table represent minimum material behavior.

NOTE:

(1) The units of measure for computing the strain rate parameter,  $\dot{\epsilon}_0$ , and the Omega parameter,  $\Omega$ , using the coefficients in this table are ksi and °R.

**Table 1M**  
**MPC Project Omega Creep Data**

Material	Strain Rate Parameter, $\dot{\epsilon}_0$ [Note (1)]		Omega Parameter, $\Omega$ [Note (1)]	
2.25Cr-1Mo-V	$A_0$	-25	$B_0$	-2.53
	$A_1$	22348.5	$B_1$	6570.9
	$A_2$	10566.2	$B_2$	-1626.7
	$A_3$	-4840	$B_3$	-503.9
	$A_4$	250	$B_4$	250

GENERAL NOTE: The coefficients in this table represent minimum material behavior.

NOTE:

(1) The units of measure for computing the strain rate parameter,  $\dot{\epsilon}_0$ , and the Omega parameter,  $\Omega$ , using the coefficients in this table are MPa and °K.

uncertainties in the analysis, a lower value of  $D_c$  may be used, at the discretion of the designer, to establish a conservative value for  $L_{caf}$ .

(5) The creep damage at all locations shall be such that  $D_c < 1.0$ . In addition, the weldment and adjacent base material of all weld joints shall be located a minimum distance of 25 mm (1 in.), measured from the weld bevel, from regions where the creep damage,  $D_c$ , exceeds 0.50.

(6) Based on the results of the inelastic analysis, the following criteria shall be satisfied:

(-a) The equivalent total accumulated inelastic strain shall not exceed the values in Table 2.

(-b) If the design of the component is based on Part 5, see para. (b), then the protection against local failure shall be determined in accordance with Part 5, para. 5.3.3. This analysis shall not consider the effects of creep.

(e) The permissible number of cycles,  $N$ , and the creep life with fatigue,  $L_{cwf}$ , at each point in the component shall be determined in accordance with one of the following methods. The permissible number of cycles and the creep life with fatigue shall satisfy the specified design requirements in the User's Design Specification.

(1) If Option 1 is used in (d)(1), the fatigue screening analysis in accordance with Part 5, para. 5.5.2.4 may be used except that the fatigue curves in Figures 1 and 1M and Tables 3 and 3M shall be used in the screening assessment, and the value of  $S_{as}$  shall be based on  $(10)^4$  cycles. In addition, in Steps 3 and 4 of para. 5.5.2.4, the alternating equivalent stress amplitude based on the primary plus

secondary plus peak stress determined from shakedown analysis in (d)(1) may be used instead of  $C_1S$ . The permissible number of cycles,  $N$ , in eq. (15) is determined in Step 3 of para. 5.5.2.4. The creep life with fatigue,  $L_{cwf}$ , is determined using eq. (15) or (16), as applicable. The equivalent plastic strain amplitude,  $\Delta\epsilon_{peq}$ , in eqs. (15) and (16) may be determined from Table 4 as a function of the alternating equivalent stress amplitude.

$$L_{cwf} = L_{caf} \cdot \left( \frac{\beta_{cf} \cdot \Delta\epsilon_{peq} \cdot N}{\exp[\beta_{cf} \cdot \Delta\epsilon_{peq} \cdot N] - 1} \right), \quad \Delta\epsilon_{peq} > 0 \quad (15)$$

$$L_{cwf} = L_{caf}, \quad \Delta\epsilon_{peq} = 0 \quad (16)$$

(2) If Option 2 is used in (d)(1), then the fatigue analysis shall be performed in accordance with Part 5, para. 5.5.4, except that the fatigue curves in Figures 1 and 1M and Tables 3 and 3M shall be used to determine the accumulated fatigue damage. The accumulated fatigue damage shall satisfy the requirements of Part 5, para. 5.5.4. The creep life with fatigue,  $L_{cwf}$ , is determined using eq. (1)(15) or (1)(16), as applicable. The equivalent plastic strain range for the  $k^{th}$  loading condition or cycle in eqs. (17) and (18) is determined directly from the strain-based fatigue analysis results.

$$L_{cwf} = L_{caf} \cdot \left[ \frac{\beta_{cf} \cdot \sum_{i=1}^k \Delta\epsilon_{peq,k}}{\exp\left[\beta_{cf} \cdot \sum_{i=1}^k \Delta\epsilon_{peq,k}\right] - 1} \right], \quad \Delta\epsilon_{peq} > 0 \quad (17)$$

$$L_{cwf} = L_{caf}, \quad \Delta\epsilon_{peq} = 0 \quad (18)$$

(f) Nondestructive examination of all welds shall be performed in accordance with Examination Group 1a, see Part 7, Tables 7.1 and 7.2. The supplemental examination for cyclic service in para. 7.4.7 shall be performed.

**Table 2**  
**Total Accumulated Inelastic Strain**

Type of Stress	Equivalent Total Accumulated Inelastic Strain	
	Weld and HAZ	Other Parts
Membrane	0.5%	1.0%
Membrane plus bending	1.25%	2.5%
Local (at any point)	2.5%	5.0%

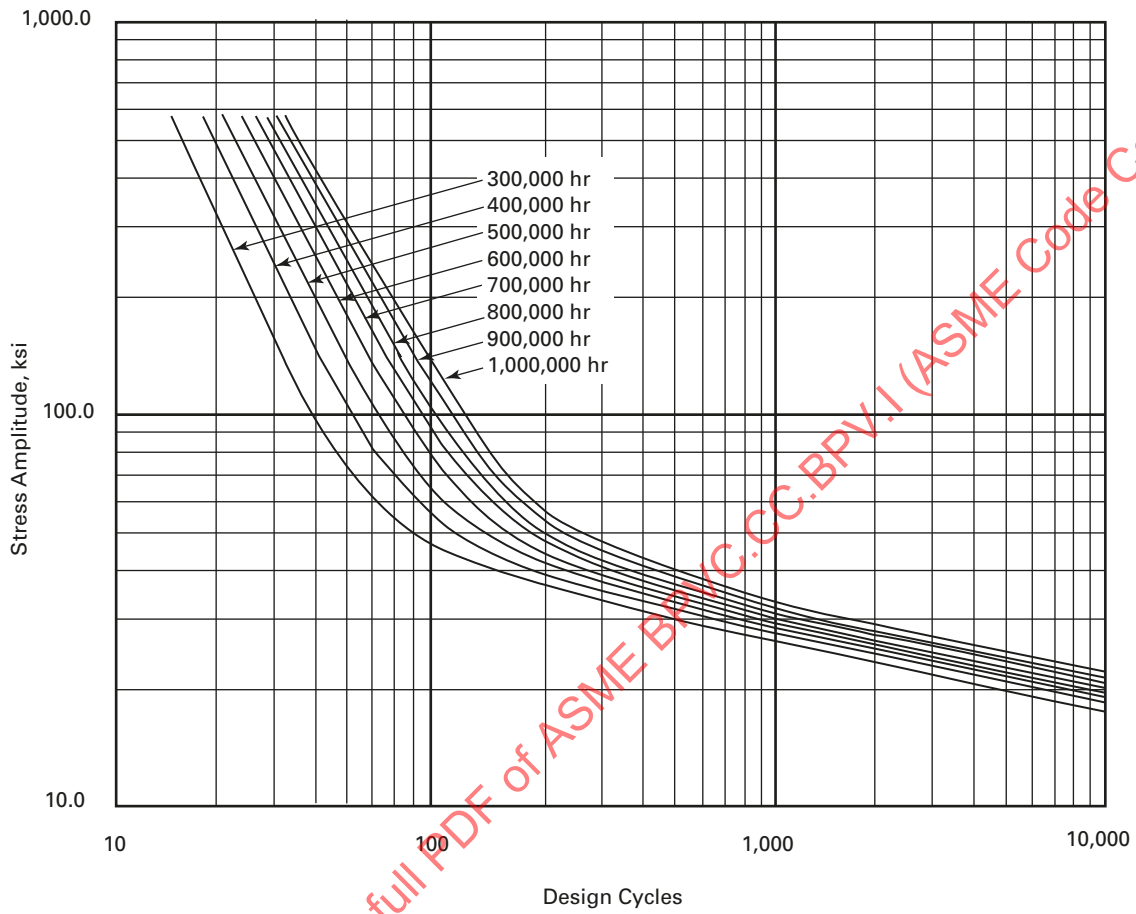
(g) This Case number shall be marked on the nameplate and shown in the Manufacturer's Data Report.

(h) Nomenclature

$A_0 \dots A_4$  = material coefficients for the MPC Project Omega strain-rate-parameter, see Tables 1 and 1M  
 $B_0 \dots B_4$  = material coefficients for the MPC Project Omega Omega-parameter, see Tables 1 and 1M  
 $\beta$  = MPC Project Omega parameter equal to  $1/3$   
 $\beta_{cf}$  = creep fatigue damage factor equal to 2.0  
 $D_c$  = creep damage  
 $\dot{D}_c$  = creep damage rate  
 $\Delta\epsilon_{peq}$  = equivalent plastic strain amplitude based on the alternating equivalent stress amplitude determined in the fatigue screening analysis  
 $\Delta\epsilon_{peq,k}$  = equivalent plastic strain amplitude for the  $k^{th}$  loading condition or cycle  
 $\delta$  = MPC Project Omega parameter  
 $\dot{\epsilon}_c$  = creep strain rate  
 $\dot{\epsilon}_{c0}$  = initial creep strain rate at the start of the time period being evaluated based on the stress state and temperature  
 $F$  = additional stress produced by the stress concentration over and above the nominal stress

$L_{caf}$  = creep life absent fatigue  
 $L_{cwf}$  = creep life with fatigue  
 $n$  = MPC Project Omega parameter  
 $N$  = permissible number of cycles  
 $p$  = hydrostatic stress  
 $P_b$  = primary bending equivalent stress  
 $P_L$  = local primary membrane equivalent stress  
 $Q$  = secondary equivalent stress resulting from operating loadings  
 $\sigma_e$  = effective stress  
 $\sigma_1$  = principal stress in the 1-direction  
 $\sigma_2$  = principal stress in the 2-direction  
 $\sigma_3$  = principal stress in the 3-direction  
 $S_h$  = allowable stress at the maximum temperature for the cycle under consideration  
 $S_{yc}$  = yield strength at the minimum temperature for the cycle under consideration  
 $t$  = time, hr  
 $T$  = temperature  
 $\Omega$  = uniaxial Omega damage parameter  
 $\Omega_m$  = multiaxial Omega damage parameter  
 $\Omega_n$  = adjusted uniaxial Omega damage parameter

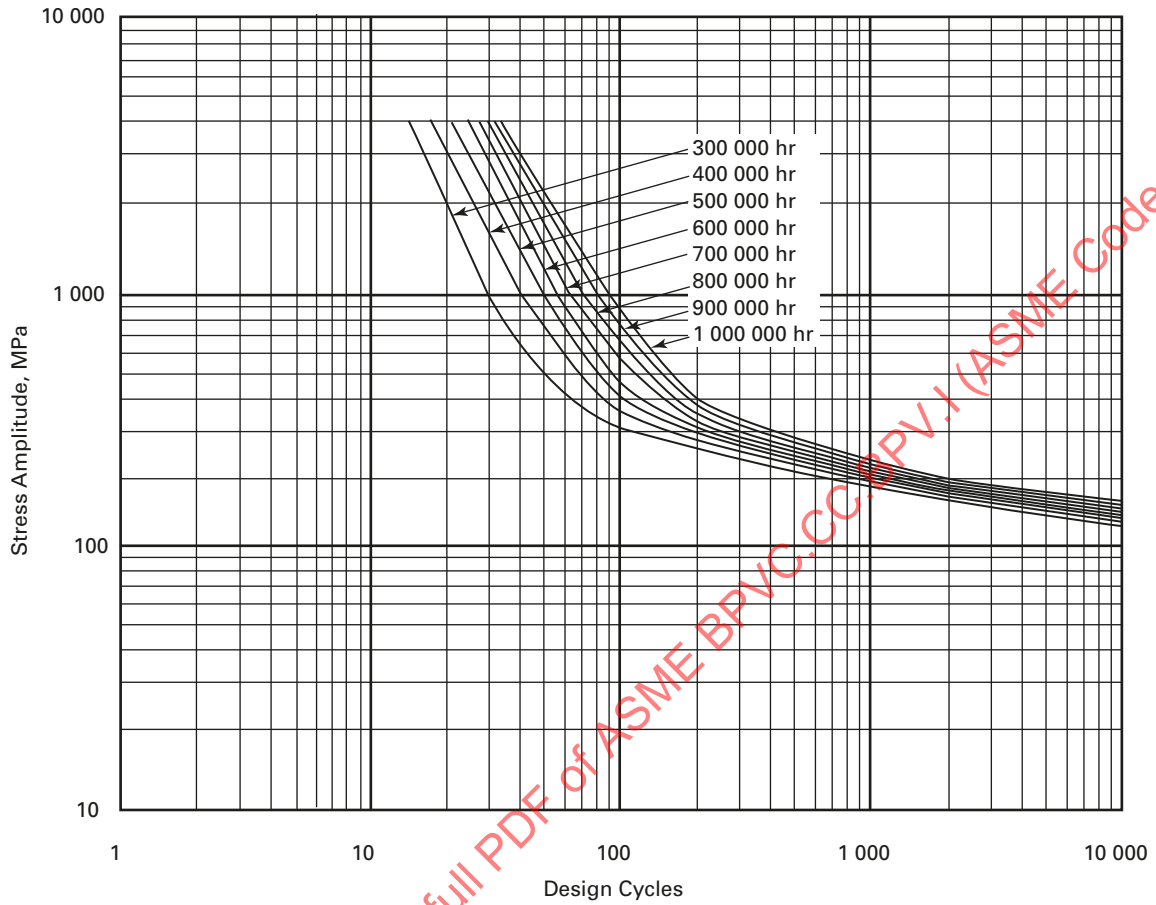
**Figure 1**  
**Design Fatigue Curve for 2.25Cr-1Mo-V Steel for Temperatures Not Exceeding 900°F, Design Cycles as a Function of Stress Amplitude and Creep Life Absent Fatigue**



GENERAL NOTES:

- (a) Interpolation of design cycles as a function of design life is permitted.
- (b) Extrapolation of design cycles as a function of stress amplitude is not permitted.
- (c) The reference temperature and Young's Modulus for these fatigue curves are 900°F and 26,106 ksi, respectively.

**Figure 1M**  
**Design Fatigue Curve for 2.25Cr-1Mo-V Steel for Temperatures Not Exceeding 482°C, Design Cycles as a Function of Stress Amplitude and Creep Life Absent Fatigue**



GENERAL NOTES:

- (a) Interpolation of design cycles as a function of design life is permitted.
- (b) Extrapolation of design cycles as a function of stress amplitude is not permitted.
- (c) The reference temperature and Young's Modulus for these fatigue curves are 482°C and 180 000 MPa, respectively.

**Table 3**  
**Design Fatigue Curve for 2.25Cr-1Mo-V Steel for Temperatures Not Exceeding 900°F, Design Cycles**  
**as a Function of Stress Amplitude and Creep Life Absent Fatigue**

Stress Amplitude, ksi	Creep Life Absent Fatigue, hr							
	300,000	400,000	500,000	600,000	700,000	800,000	900,000	1,000,000
577.3	15	18	21	24	26	29	31	32
440.6	17	21	25	28	31	34	37	39
339.2	20	25	29	33	37	40	44	47
263.9	22	28	34	39	43	48	52	56
207.9	26	33	39	45	51	56	61	66
166.2	29	37	45	52	59	65	71	77
135.2	33	42	51	60	68	75	83	89
112.0	37	48	58	68	78	87	95	104
94.6	41	54	66	77	88	99	109	119
81.5	46	61	74	88	100	113	125	136
71.6	52	68	84	99	114	128	142	155
64.1	58	76	94	111	128	145	161	176
58.3	64	85	105	125	144	163	181	199
53.9	72	95	117	139	161	183	204	224
50.3	80	105	131	156	180	205	228	252
47.6	88	117	145	174	201	229	256	282
45.3	98	130	162	193	224	255	285	315
43.4	109	144	180	215	249	284	318	352
41.9	121	160	199	238	277	316	354	392
40.6	133	177	221	265	308	351	394	436
39.4	148	197	245	294	342	390	437	485
38.4	164	218	272	325	379	432	485	538
37.4	181	241	301	360	420	479	538	597
36.6	200	267	333	399	465	531	596	662
35.8	222	295	369	442	515	588	661	734
35.0	245	327	408	489	570	651	732	813
34.3	271	361	451	541	631	721	810	900
33.6	300	400	499	599	698	798	897	996
33.0	332	442	553	663	773	883	993	1,102
32.3	367	489	611	733	855	977	1,098	1,220
31.7	406	541	676	811	946	1,080	1,215	1,350
31.1	449	598	747	897	1,046	1,195	1,344	1,493
30.5	496	661	827	992	1,157	1,322	1,487	1,651
30.0	549	731	914	1,097	1,279	1,462	1,644	1,826
29.4	607	809	1,011	1,213	1,415	1,616	1,818	2,020
28.9	671	894	1,118	1,341	1,564	1,787	2,011	2,234
28.3	742	989	1,236	1,483	1,730	1,976	2,223	2,470
27.8	820	1,093	1,366	1,639	1,912	2,185	2,458	2,731
27.3	906	1,209	1,511	1,813	2,115	2,416	2,718	3,020
26.8	1,002	1,336	1,670	2,004	2,338	2,672	3,006	3,339
26.3	1,108	1,477	1,847	2,216	2,585	2,954	3,323	3,692
25.8	1,225	1,633	2,042	2,450	2,858	3,266	3,674	4,082
25.3	1,354	1,806	2,257	2,709	3,160	3,611	4,063	4,514
24.8	1,497	1,997	2,496	2,995	3,494	3,993	4,492	4,991
24.4	1,656	2,207	2,759	3,311	3,863	4,414	4,966	5,518
23.9	1,830	2,440	3,050	3,661	4,271	4,881	5,491	6,100
23.5	2,024	2,698	3,373	4,047	4,722	5,396	6,070	6,745
23.1	2,237	2,983	3,729	4,474	5,220	5,966	6,711	7,457
22.6	2,473	3,298	4,122	4,947	5,771	6,596	7,420	8,244
22.2	2,735	3,646	4,558	5,469	6,381	7,292	8,204	9,115
21.8	3,023	4,031	5,039	6,047	7,054	8,062	9,070	10,078
21.4	3,343	4,457	5,571	6,685	7,799	8,913	10,028	11,142
21.0	3,696	4,927	6,159	7,391	8,623	9,855	11,086	12,318
20.6	4,086	5,448	6,809	8,171	9,533	10,895	12,257	13,619
20.2	4,517	6,023	7,528	9,034	10,540	12,045	13,551	15,057
19.9	4,994	6,659	8,323	9,988	11,652	13,317	14,982	16,646
19.5	5,521	7,362	9,202	11,042	12,883	14,723	16,564	18,404
19.1	6,104	8,139	10,174	12,208	14,243	16,278	18,312	20,347

**Table 3**  
**Design Fatigue Curve for 2.25Cr-1Mo-V Steel for Temperatures Not Exceeding 900°F, Design Cycles as a Function of Stress Amplitude and Creep Life Absent Fatigue (Cont'd)**

Stress Amplitude, ksi	Creep Life Absent Fatigue, hr							
	300,000	400,000	500,000	600,000	700,000	800,000	900,000	1,000,000
18.8	6,749	8,998	11,248	13,497	15,747	17,996	20,246	22,495
18.4	7,461	9,948	12,435	14,922	17,409	19,896	22,383	24,870
18.1	8,249	10,998	13,748	16,498	19,247	21,997	24,747	27,496
17.8	9,120	12,160	15,200	18,240	21,279	24,319	27,359	30,399
17.4	10,083	13,443	16,804	20,165	23,526	26,887	30,248	33,609
17.1	11,147	14,863	18,579	22,294	26,010	29,726	33,441	37,157
16.8	12,324	16,432	20,540	24,648	28,756	32,864	36,972	41,080
16.5	13,625	18,167	22,709	27,250	31,792	36,334	40,875	45,417
16.2	15,064	20,085	25,106	30,127	35,149	40,170	45,191	50,212
15.9	16,654	22,205	27,757	33,308	38,860	44,411	49,962	55,514
15.6	18,412	24,550	30,687	36,825	42,962	49,100	55,237	61,375
15.3	20,356	27,142	33,927	40,713	47,498	54,284	61,069	67,854

## GENERAL NOTES:

- (a) Interpolation of design cycles as a function of design life is permitted.  
 (b) Extrapolation of design cycles as a function of stress amplitude is not permitted.  
 (c) The reference temperature and Young's Modulus for these fatigue curves are 900°F and 26,106 ksi, respectively.

**Table 3M**  
**Design Fatigue Curve for 2.25Cr-1Mo-V Steel for Temperatures Not Exceeding 482°C, Design Cycles**  
**as a Function of Stress Amplitude and Creep Life Absent Fatigue**

Stress Amplitude, MPa	Creep Life Absent Fatigue, h							
	300 000	400 000	500 000	600 000	700 000	800 000	900 000	1 000 000
3 982	15	18	21	24	26	29	31	32
3 039	17	21	25	28	31	34	37	39
2 339	20	25	29	33	37	40	44	47
1 820	22	28	34	39	43	48	52	56
1 434	26	33	39	45	51	56	61	66
1 147	29	37	45	52	59	65	71	77
932	33	42	51	60	68	75	83	89
772	37	48	58	68	78	87	95	104
652	41	54	66	77	88	99	109	119
562	46	61	74	88	100	113	125	136
494	52	68	84	99	114	128	142	155
442	58	76	94	111	128	145	161	176
402	64	85	105	125	144	163	181	199
371	72	95	117	139	161	183	204	224
347	80	105	131	156	180	205	228	252
328	88	117	145	174	201	229	256	282
312	98	130	162	193	224	255	285	315
300	109	144	180	215	249	284	318	352
289	121	160	199	238	277	316	354	392
280	133	177	221	265	308	351	394	436
272	148	197	245	294	342	390	437	485
265	164	218	272	325	379	432	485	538
258	181	241	301	360	420	479	538	597
252	200	267	333	399	465	531	596	662
247	222	295	369	442	515	588	661	734
242	245	327	408	489	570	651	732	813
237	271	361	451	541	631	721	810	900
232	300	400	499	599	698	798	897	996
227	332	442	553	663	773	883	993	1 102
223	367	489	611	733	855	977	1 098	1 220
219	406	541	676	811	946	1 080	1 215	1 350
215	449	598	747	897	1 046	1 195	1 344	1 493
211	496	661	827	992	1 157	1 322	1 487	1 651
207	549	731	914	1 097	1 279	1 462	1 644	1 826
203	607	809	1 011	1 213	1 415	1 616	1 818	2 020
199	671	894	1 118	1 341	1 564	1 787	2 011	2 234
195	742	989	1 236	1 483	1 730	1 976	2 223	2 470
192	820	1 093	1 366	1 639	1 912	2 185	2 458	2 731
188	906	1 209	1 511	1 813	2 115	2 416	2 718	3 020
185	1 002	1 336	1 670	2 004	2 338	2 672	3 006	3 339
181	1 108	1 477	1 847	2 216	2 585	2 954	3 323	3 692
178	1 225	1 633	2 042	2 450	2 858	3 266	3 674	4 082
175	1 354	1 806	2 257	2 709	3 160	3 611	4 063	4 514
171	1 497	1 997	2 496	2 995	3 494	3 993	4 492	4 991
168	1 656	2 207	2 759	3 311	3 863	4 414	4 966	5 518
165	1 830	2 440	3 050	3 661	4 271	4 881	5 491	6 100
162	2 024	2 698	3 373	4 047	4 722	5 396	6 070	6 745
159	2 237	2 983	3 729	4 474	5 220	5 966	6 711	7 457
156	2 473	3 298	4 122	4 947	5 771	6 596	7 420	8 244
153	2 735	3 646	4 558	5 469	6 381	7 292	8 204	9 115
150	3 023	4 031	5 039	6 047	7 054	8 062	9 070	10 078
148	3 343	4 457	5 571	6 685	7 799	8 913	10 028	11 142
145	3 696	4 927	6 159	7 391	8 623	9 855	11 086	12 318
142	4 086	5 448	6 809	8 171	9 533	10 895	12 257	13 619
140	4 517	6 023	7 528	9 034	10 540	12 045	13 551	15 057
137	4 994	6 659	8 323	9 988	11 652	13 317	14 982	16 646
135	5 521	7 362	9 202	11 042	12 883	14 723	16 564	18 404

**Table 3M**  
**Design Fatigue Curve for 2.25Cr-1Mo-V Steel for Temperatures Not Exceeding 482°C, Design Cycles as a Function of Stress Amplitude and Creep Life Absent Fatigue (Cont'd)**

Stress Amplitude, MPa	Creep Life Absent Fatigue, h							
	300 000	400 000	500 000	600 000	700 000	800 000	900 000	1 000 000
132	6 104	8 139	10 174	12 208	14 243	16 278	18 312	20 347
130	6 749	8 998	11 248	13 497	15 747	17 996	20 246	22 495
127	7 461	9 948	12 435	14 922	17 409	19 896	22 383	24 870
125	8 249	10 998	13 748	16 498	19 247	21 997	24 747	27 496
123	9 120	12 160	15 200	18 240	21 279	24 319	27 359	30 399
120	10 083	13 443	16 804	20 165	23 526	26 887	30 248	33 609
118	11 147	14 863	18 579	22 294	26 010	29 726	33 441	37 157
116	12 324	16 432	20 540	24 648	28 756	32 864	36 972	41 080
114	13 625	18 167	22 709	27 250	31 792	36 334	40 875	45 417
112	15 064	20 085	25 106	30 127	35 149	40 170	45 191	50 212
110	16 654	22 205	27 757	33 308	38 860	44 411	49 962	55 514
108	18 412	24 550	30 687	36 825	42 962	49 100	55 237	61 375
106	20 356	27 142	33 927	40 713	47 498	54 284	61 069	67 854

## GENERAL NOTES:

- (a) Interpolation of design cycles as a function of design life is permitted.  
 (b) Extrapolation of design cycles as a function of stress amplitude is not permitted.  
 (c) The reference temperature and Young's Modulus for these fatigue curves are 482°C and 180 000 MPa, respectively.

**Table 4**  
**Stress Amplitude Versus Plastic Strain**

Alternating Equivalent Stress Amplitude		Equivalent Plastic Strain Amplitude
ksi	MPa	
577.5	3 982	0.02000000
440.7	3 039	0.01480000
339.2	2 339	0.01095200
263.9	1 820	0.00810400
207.9	1 434	0.00599700
166.3	1 147	0.00443800
135.2	932	0.00328400
112.0	772	0.00243000
94.6	652	0.00179800
81.5	562	0.00133100
71.7	494	0.00098500
64.1	442	0.00072900
58.3	402	0.00053900
53.9	371	0.00039900
50.4	347	0.00029500
47.6	328	0.00021900
45.3	312	0.00016200
43.5	300	0.00012000
41.9	289	0.00008860
40.6	280	0.00006550
39.4	272	0.00004850
38.4	265	0.00003590
37.4	258	0.00002660
36.6	252	0.00001960
35.8	247	0.00001450
35.0	242	0.00001080
34.3	237	0.00000796
33.6	232	0.00000589
33.0	227	0.00000436
32.3	223	0.00000323
31.7	219	0.00000239
31.1	215	0.00000177
30.5	211	0.00000131
30.0	207	0.00000097

GENERAL NOTES:

- (a) The plastic strain below 207 MPa (30 ksi) shall be taken as 0.0.
- (b) Interpolation of data values is permitted.
- (c) Extrapolation of data values is not permitted.

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Approval Date: January 26, 2009

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2606**  
**Use of SA-350, Grade LF2, Class 1 Steel Forgings**  
**Section I**

*Inquiry:* May steel forgings conforming to SA-350, Grade LF2, Class 1 be used in Section I construction?

*Reply:* It is the opinion of the Committee that steel forgings conforming to SA-350, Grade LF2, Class 1 may be used in Section I construction, provided the following requirements are met:

(a) The maximum allowable stress values for the material shall be those given in Tables 1 and 1M.

(b) The maximum design temperature shall be 850°F (454°C).

(c) Welding procedure and performance qualifications shall be performed in accordance with Section IX.

(d) The final postweld heat treatment shall be that shown in Table PW-39 for P-No.1 material.

(e) For external pressure applications, use Chart No. CS-2 of Section II, Part D.

(f) This Case number shall be identified in the Manufacturer's Data Report.

For Metal Temperatures Not Exceeding, °F	Maximum Allowable Stress, ksi
-20 to 400	20.0
500	19.6
600	18.4
650	17.8
700	17.2
750	14.8 [Note (1)]
800 [Note (2)]	12.0 [Note (1)]
850 [Note (2)]	9.3 [Note (1)]

NOTES:  
 (1) The stress values at 750°F and higher are based on time-dependent properties.  
 (2) Upon prolonged exposure to temperatures at or above 800°F, the carbide phase of carbon steel may be converted to graphite.

For Metal Temperatures Not Exceeding, °C	Maximum Allowable Stress, MPa
-30 to 200	138
250	136
300	129
325	125
350	122
375	117
400	101 [Note (1)]
425 [Note (2)]	83.9 [Note (1)]
450 [Note (2)]	67.0 [Note (1)]
475 [Note (2)] and [Note (3)]	51.1 [Note (1)]

NOTES:  
 (1) The stress values at 400°C and higher are based on time-dependent properties.  
 (2) Upon prolonged exposure to temperatures at or above 425°C, the carbide phase of carbon steel may be converted to graphite.  
 (3) The stress value at 475°C is provided for interpolation only. The maximum design temperature is stated in (b) of the Reply.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2607**  
**Use of SA-420, Grade WPL6 and Welded Steel Fittings**  
**Section I**

*Inquiry:* May seamless and welded steel fittings conforming to SA-420, Grade WPL6 be used in Section I construction?

*Reply:* It is the opinion of the Committee that seamless and welded steel fittings conforming to SA-420, Grade WPL6 may be used in Section I construction, provided the following requirements are met:

- (a) The maximum allowable stress values for the material shall be those given in Tables 1 and 1M.
- (b) The maximum design temperature shall be 850°F (454°C).
- (c) Welding procedure and performance qualifications shall be performed in accordance with Section IX.
- (d) The final postweld heat treatment shall be that shown in Table PW-39 for P-No. 1 material.
- (e) For external pressure applications, use Chart No. CS-2 of Section II, Part D.
- (f) This Case number shall be identified on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values**

For Metal Temperatures Not Exceeding, °F	Max. Allowable Stress, Seamless Pipe Fittings, ksi	Max. Allowable Stress, Welded Pipe Fittings, ksi
-20 to 650	17.1	14.6
700	15.6 [Note (1)]	13.3 [Note (1)]
750	13.0 [Note (1)]	11.1 [Note (1)]
800 [Note (2)]	10.8 [Note (1)]	9.2 [Note (1)]
850 [Note (2)]	8.7 [Note (1)]	7.4 [Note (1)]

NOTES:

- (1) The stress values at 700°F and higher are based on time-dependent properties.
- (2) Upon prolonged exposure to temperatures at or above 800°F, the carbide phase of carbon steel may be converted to graphite.

**Table 1M**  
**Maximum Allowable Stress Values**

For Metal Temperatures Not Exceeding, °C	Max. Allowable Stress, Seamless Pipe Fittings, MPa	Max. Allowable Stress, Welded Pipe Fittings, MPa
-30 to 325	118	101
350	117	99.7
375	105 [Note (1)]	89.7 [Note (1)]
400	88.9 [Note (1)]	75.9 [Note (1)]
425 [Note (2)]	75.3 [Note (1)]	64.1 [Note (1)]
450 [Note (2)]	62.7 [Note (1)]	53.3 [Note (1)]
475 [Note (2)] and [Note (3)]	45.5 [Note (1)]	38.6 [Note (1)]

NOTES:

- (1) The stress values at 375°C and higher are based on time-dependent properties.
- (2) Upon prolonged exposure to temperatures at or above 425°C, the carbide phase of carbon steel may be converted to graphite.
- (3) The stress value at 475°C is provided for interpolation only. The maximum design temperature is stated in (b) of the Reply.

Approval Date: January 26, 2009

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2608**  
**Testing of Vessels Containing an Internal Piston**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions may a single chamber pressure vessel that includes an internal piston be tested under the rules of Section VIII, Division 1, with one side to be hydrostatically tested per UG-99, and the other to be pneumatically tested per UG-100?

*Reply:* It is the opinion of the Committee that a single chamber pressure vessel that includes an internal piston that separates the chamber into two sections may be tested using subsequent hydrostatic and pneumatic tests in lieu of the requirements of UG-99 or UG-100, provided the following requirements are met:

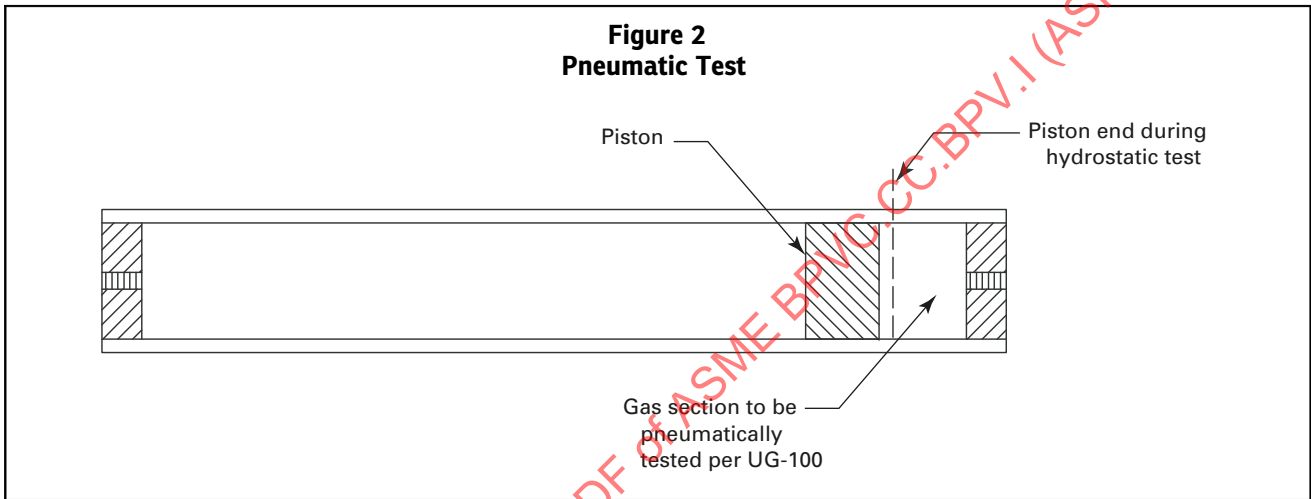
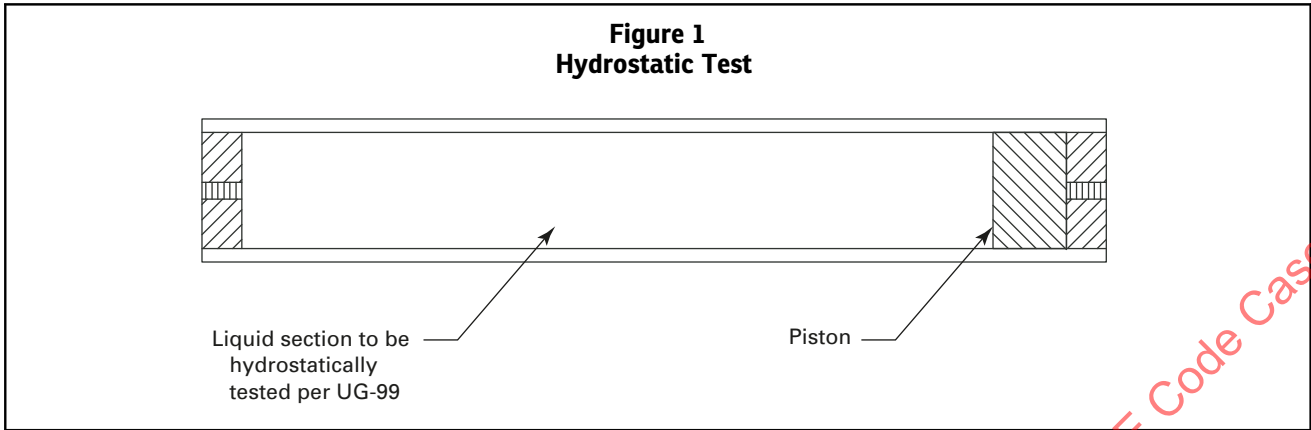
(a) The liquid section shall be hydrostatically tested per UG-99. During this test, the internal piston shall be positioned against the vessel head on the gas side (see Figure 1).

(b) The gas section shall be pneumatically tested per UG-100. During this test, the internal piston shall be positioned such that, as a minimum, the vessel area previously covered by the piston during the hydrostatic test is now exposed to the pneumatic test (see Figure 2).

(c) The vessel section to be pneumatically tested shall be nondestructively examined in accordance with the rules of UW-50.

(d) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.



Approval Date: January 26, 2009

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2609**  
**Use of Chromium-Silicon Alloy Steel Wire ASTM A401/  
A401M-03 UNS G92540**  
**Section VIII, Division 3**

*Inquiry:* Under what conditions may ASTM A401/A401M-03, UNS G92540 be used for manufacture of special closure parts designed in accordance with Article KD-6 of Section VIII, Division 3?

*Reply:* It is the opinion of the Committee that the material, UNS G92540 and otherwise conforming to ASTM A401/A401M-03, described in the Inquiry may be used in the construction of closure parts conforming to the rules of Article KD-6 of Section VIII, Division 3, provided the following additional requirements are met:

(a) The maximum design temperature shall be 100°F (38°C).

(b) The material shall be manufactured with the minimum and maximum tensile strength values listed in [Table 1](#) and [Table 1M](#).

(c) Tensile strength values used in design shall be the minimum tensile strength values of [Table 1](#) and [Table 1M](#). Tensile strength values for intermediate diameters

may be linearly interpolated. The tensile strength used for design shall be determined using (d) for material that is not of a round cross section.

(d) The mechanical testing of the material shall be performed once it is in the final cross sectional shape and heat treated in accordance with the specification prior to coiling into a helical spring. The material shall be certified to the mechanical properties for a diameter of wire that has a cross sectional area equivalent to that of the cross sectional area of the wire in the final shape.

(e) Welding is not permitted.

(f) The material shall not be used for fabrication of other pressure retaining components, such as bolting, wire wound vessels, or wire wound frames.

(g) Certification of the material in accordance with ASTM A401/A401M-03, para. 13.1 to the requirements of this Case and the balance of ASTM A401/A401M-03 shall be mandatory, including comparison of results of physical testing performed to specification requirements.

(h) This Case number shall be shown on the material certification, marking on the material, and on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Tensile Strength Values,  $S_u$**

Diameter, in.	$S_u$ min., ksi	$S_u$ max., ksi
0.032	290	315
0.041	280	305
0.054	270	295
0.062	265	290
0.08	255	275
0.105	245	265
0.135	235	255
0.162	225	245
0.192	220	240
0.244	210	230
0.283	205	225
0.312	203	223
0.375	200	220
0.438	195	215
0.5	190	210

**Table 1M**  
**Tensile Strength Values,  $S_u$**

Diameter, mm	$S_u$ min., MPa	$S_u$ max., MPa
0.8	1 980	2 140
0.9	1 960	2 120
1	1 940	2 100
1.1	1 920	2 080
1.2	1 900	2 060
1.4	1 860	2 020
1.6	1 820	1 980
1.8	1 800	1 960
2	1 780	1 930
2.2	1 750	1 900
2.5	1 720	1 860
2.8	1 680	1 830
3	1 660	1 800
3.5	1 620	1 760
4	1 580	1 720
4.5	1 560	1 680
5	1 520	1 640
5.5	1 480	1 620
6	1 460	1 600
6.5	1 440	1 580
7	1 420	1 560
8	1 400	1 540
9	1 380	1 520
10	1 360	1 500
11	1 340	1 480
12	1 320	1 460

Approval Date: January 26, 2009

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2610**

**SA-453, Grade 660, Class C, High Temperature Bolting  
Materials With Expansion Coefficients Comparable to  
Austenitic Steels  
Section VIII, Division 1; Section VIII, Division 2**

*Inquiry:* May bolts manufactured of material in accordance with SA-453, Grade 660, Class C be used in Section VIII, Division 1 or Section VIII, Division 2 (2007 edition and later) construction?

*Reply:* It is the opinion of the Committee that bolts manufactured of material in accordance with SA-453, Grade 660, Class C may be used in the Section VIII, Division 1 or Section VIII, Division 2 construction, provided the following additional requirements are met:

- (a) The maximum allowable stress values of the material shall be those given in [Table 1](#) and [Table 1M](#).
- (b) The maximum temperature for Section VIII, Division 1 shall be 1000°F (538°C).
- (c) The maximum temperature for Section VIII, Division 2 shall be 800°F (427°C).
- (d) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Div. 1 Allowable Stress Value, or Div. 2 Design Stress Intensity Value for Flanges Designed to	Div. 2 Design Stress Intensity Value; for Flanges Designed to
	Part 4; Max., ksi	Part 5; Max., ksi
100	21.3	28.3
200	21.3	27.8
300	21.3	27.3
400	21.3	26.9
500	21.3	26.4
600	21.3	26.0
650	21.3	25.7
700	21.3	25.5
750	21.3	25.2
800	21.3	25.0
850	21.3	...
900	21.3	...
950	21.3	...
1000	21.3	...

**Table 1M**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Div. 1 Allowable Stress Value, or Div. 2 Design Stress Intensity Value for Flanges Designed to	Div. 2 Design Stress Intensity Value; for Flanges Designed to
	Part 4; Max., MPa	Part 5; Max., MPa
40	147	195
100	147	191
150	147	188
200	147	186
250	147	183
300	147	180
325	147	179
350	147	177
375	147	176
400	147	174
425	147	172
450	147	170 [Note (1)]
500	147	...
525	147	...
550	147 [Note (1)]	...

NOTE:

(1) Value for interpolation only.

Approval Date: January 26, 2009

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2611**  
**Use of SA/EN 10028-3, Grade P355N,<sup>1</sup> Fine Grain**  
**Normalized Steel Plates**  
**Section VIII, Division 2**

*Inquiry:* Under what conditions may steel plate, manufactured in accordance with SA/EN 10028-3, Grade P355N, be used in Division 2, 2004 Edition (including 2006 Addenda) construction?

*Reply:* It is the opinion of the Committee that steel plate manufactured in accordance with SA/EN 10028-3, Grade P355N, may be used in Section VIII, Division 2, 2004 Edition (including 2006 Addenda) construction, provided the following additional requirements are met:

- (a) The thickness of the plates shall not exceed  $\frac{5}{8}$  in. (16 mm).
- (b) The design temperature shall not exceed 120°F (49°C).

(c) The design stress intensity,  $S_m$ , shall be 23.7 ksi (163 MPa).

(d) For external pressure design, the requirements of Fig. CS-3 of Section II, Part D, shall apply.

(e) The provisions for impact test exemption in AM-218 shall not apply.

(f) For the purpose of postweld heat treatment, the material shall be considered as P-No. 1, Gr. 2.

(g) Separate welding procedure and performance qualifications shall be conducted in accordance with Section IX.

(h) Welding by electroslag or electrogas process is not permitted.

(i) The permitted types of welds and the required examination shall be in accordance with Table AF-241.1, Column 1.

(j) This Case number shall be shown on the Manufacturer's Data Report.

<sup>1</sup> See Section II, Part A, Nonmandatory Appendix A for ordering information for Specification EN10028-3 and its references.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: January 30, 2009

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2613**  
**Phenolic Lining Material in HLW-200 Application**  
**Section IV**

*Inquiry:* Under what conditions may baked phenolic coatings be used to line water heaters and storage tanks construction in accordance with Part HLW, Section IV?

*Reply:* It is the opinion of the Committee that baked phenolic linings may be used to satisfy the requirements of HLW-200, provided the following conditions are met:

(a) Baked phenolic linings shall be of an analysis intended for use in potable hot water service, and the minimum thickness shall be 0.004 in. (0.1 mm).

(b) If multiple coats are used, each intermediate coat shall be cured at a minimum metal temperature of 250°F (120°C) for a length of time suitable to sufficiently harden the coat for further processing.

(c) For final coated surfaces the lining shall be cured at a metal temperature of 400°F to 425°F (205°C to 218°C) for 60 to 90 minutes. The manufacturer shall inspect the lining to verify proper cure and minimum thickness and to verify that it is free of discontinuities. Documentation of the basis of the temperature/time used and records of the inspection shall be available to the Inspector.

(d) The absorption rate of the cured lining shall be less than 2% by the method specified in SD-570 shown in Appendix I.

(e) Surfaces to be phenolic-lined must be cleaned to remove all scale, oxidation, oil, etc., prior to application of the lining.

(f) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: September 23, 2013

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2616-1**  
**2014-T6 Aluminum Hand Forgings for Nonwelded**  
**Construction**  
**Section VIII, Division 1**

*Inquiry:* May 2014-T6 (UNS A92014) aluminum hand forgings produced in compliance with ASTM B247-02a be used in Section VIII, Division 1 nonwelded construction?

*Reply:* It is the opinion of the Committee that 2014-T6 (UNS A92014) aluminum hand forgings produced in compliance with ASTM B247-02a may be used in Section VIII, Division 1 nonwelded construction, provided the following requirements are met:

(a) The forging thickness shall be thicker than 3.0 in. (75 mm) and no thicker than 4.0 in. (100 mm).

(b) The maximum allowable stress values shall be those given in [Table 1](#) or [1M](#).

(c) The maximum design temperature shall be 250°F (121°C).

(d) This Case number shall be recorded on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1  
Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress, ksi [Note (1)]
100	17.4
150	17.4
200	17.4
250	14.4

NOTE:

(1) The allowable stress values were determined by comparing the mechanical properties for SB-247 for 2014-T6 die forgings (2.02 in. to 4.0 in. thick) to ASTM B247-02a for 2014-T6 hand forgings (3.0 in. to 4.0 in. thick):

(a) Specified Minimum Yield Strength is 90% of ultimate tensile strength (UTS) for both die and hand forging product forms, indicating allowable stresses in Section II-D for SB-247 die forgings are UTS based.

(b) UTS for 2014-T6 hand forgings in Table 5 of ASTM B247-02a is 97% of the UTS for 2014-T6 die forgings in Table 2 of SB-247.

(c) The allowable stress values for SB-247 2014-T6 die forgings in Section II, Part D, Table 1B were multiplied by a factor of 0.97.

**Table 1M  
Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress, MPa [Note (1)], [Note (2)]
40	120
65	120
100	117
125	95.7

NOTES:

(1) The allowable stress values were determined by comparing the mechanical properties for SB-247 for 2014-T6 die forgings (2.02 in. to 4.0 in. thick) to ASTM B247-02a for 2014-T6 hand forgings (3.0 in. to 4.0 in. thick):

(a) Specified Minimum Yield Strength is 90% of ultimate tensile strength (UTS) for both die and hand forging product forms, indicating allowable stresses in Section II-D for SB-247 die forgings are UTS based.

(b) UTS for 2014-T6 hand forgings in Table 5 of ASTM B247-02a is 97% of the UTS for 2014-T6 die forgings in Table 2 of SB-247.

(c) The allowable stress values for SB-247 2014-T6 die forgings in Section II, Part D, Table 1B were multiplied by a factor of 0.97.

(2) The allowable stress value given for 125°C is not intended to indicate acceptability for use at temperatures warmer than 121°C, but are provided for interpolating allowable stress values for temperatures warmer than 100°C and no warmer than 121°C.

Approval Date: May 9, 2009

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2617**  
**18Cr-15Ni-4Mo-3Cu-N, UNS S31727, Austenitic**  
**Stainless Steel**  
**Section VIII, Division 1**

*Inquiry:* May 18Cr-15Ni-4Mo-3Cu-N, UNS S31727, austenitic stainless steel sheet, strip, plate, pipe, tube, and bar, meeting the chemical composition and mechanical property requirements shown in Tables 1 and 2, and otherwise conforming to one of the specifications given in Table 3, be used in welded construction under the rules of Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used in Section VIII, Division 1 construction, provided the following additional requirements are met:

(a) The rules in Section VIII, Division 1, Subsection C that shall apply are those given in Part UHA for austenitic stainless steels.

(b) For external pressure, use Fig. HA-4 of Section II, Part D.

(c) The maximum allowable stress values for the material shall be those given in Tables 4 and 4M. For welded pipe and tube products, a joint efficiency factor of 0.85 shall be used.

(d) Maximum design temperature of the material shall be 800°F (427°C).

(e) Separate welding procedure and performance qualifications shall be conducted for the material in accordance with Section IX. When welding this material to itself, GTAW welding process welded with ERNiCrMo-4 (UNS N10276) or similar corrosion resistant weld filler metals shall be used.

(f) Heat treatment after forming or fabrication is neither required nor prohibited. However, if heat treatment is applied, the solution annealing treatment shall be as noted in (g).

(g) The material shall be furnished in the solution annealed condition at a temperature range from 1975°F to 2155°F (1080°C to 1180°C) followed by rapid cooling in air or water.

(h) This Case number shall be shown on the documentation and marking of the material and on the Manufacturer's Data Report.

**Table 1**  
**Chemical Requirements**

Element	Composition, %
Carbon, max.	0.030
Manganese, max.	1.00
Phosphorus, max.	0.030
Sulfur, max.	0.030
Silicon, max.	1.00
Nickel	14.50–16.50
Chromium	17.50–19.00
Molybdenum	3.80–4.50
Copper	2.80–4.00
Nitrogen	0.15–0.21

**Table 2**  
**Mechanical Property Requirements**

Tensile strength, min., ksi (MPa)	80 (550)
Yield strength, min., ksi (MPa)	36 (245)
Elongation in 2 in. or 50 mm, min., %	35
Hardness HRB (HB), max.	96 (217)

**Table 3**  
**Product Specifications**

Bars and shapes	SA-479
Flanges, fittings, and valves	SA-182
Piping fittings	SA-403
Seamless and welded pipes	SA-312
Sheet, strip, and plate	SA-240
Welded pipes	SA-358, SA-409, SA-813, SA-814
Welded tubes	SA-249

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**Table 4  
Maximum Allowable Stresses**

For Metal Temperature Not Exceeding, °F	Allowable Stress Values, Max., ksi	
	100	22.9
200	20.8	22.8 [Note (1)]
300	18.9	21.4 [Note (1)]
400	17.7	20.5 [Note (1)]
500	17.0	19.9 [Note (1)]
600	16.6	19.6 [Note (1)]
650	16.3	19.5 [Note (1)]
700	16.1	19.5 [Note (1)]
750	15.7	19.4 [Note (1)]
800	15.4	19.3 [Note (1)]

GENERAL NOTE: The revised criterion of 3.5 on tensile strength was used in establishing these values.

NOTE:

- (1) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed 66<sup>2</sup>/<sub>3</sub>%, but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.

**Table 4M  
Maximum Allowable Stresses**

For Metal Temperature Not Exceeding, °C	Allowable Stress Values, Max., MPa	
	40	158
65	157	157
100	140	155 [Note (1)]
125	134	151 [Note (1)]
150	128	147 [Note (1)]
200	121	141 [Note (1)]
250	116	138 [Note (1)]
300	114	135 [Note (1)]
325	112	135 [Note (1)]
350	111	134 [Note (1)]
375	109	134 [Note (1)]
400	107	132 [Note (1)]
425	105	132 [Note (1)]
450	103	131 [Note (1)], [Note (2)]

GENERAL NOTE: The revised criterion of 3.5 on tensile strength was used in establishing these values.

NOTES:

- (1) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed 66<sup>2</sup>/<sub>3</sub>%, but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.
- (2) These values are provided for interpolation purpose only. The maximum use temperature is 800°F (427°C).

Approval Date: July 5, 2009

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2618**  
**Use of SB-148 C95500, As-Cast Temper, in the**  
**Manufacture of Heating Boilers, Part HF and**  
**Potable-Water Heaters, Part HLW**  
**Section IV**

*Inquiry:* Under what conditions may SB-148 C95500, as-cast temper, be used in the construction of Section IV heating boilers, Part HF and potable-water heaters, Part HLW?

*Reply:* It is the opinion of the Committee that SB-148 C95500 in the as-cast temper may be used in the construction of Section IV heating boilers, Part HF and potable-water heaters, Part HLW, provided the following requirements are met:

(a) The minimum allowable thickness shall be as shown in HF-301.2.

(b) The maximum allowable stresses are as shown in Tables 1 and 1M.

(c) The material shall not be brazed nor welded.

(d) The material shall not be heat treated.

(e) The maximum use temperature for hot water heating boilers and hot water supply boilers shall be as stated in HG-101.

(f) The maximum use temperature for water heaters shall be as stated in HLW-101.

(g) This Case number shall be shown on the Manufacturer's Data Report.

**Table 1**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Allowable Stress Values, Max., ksi
100	18.0
150	18.0
200	18.0
250	18.0
300	18.0
350	18.0 [Note (1)]

GENERAL NOTE: The (maximum allowable) stress value includes a casting quality factor of 0.80. Increased casting quality factors as a result of material examination beyond the requirement of the material specification shall not be permitted.

NOTE:

(1) Values for 350°F and 175°C are provided for interpolation purposes only.

**Table 1M**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Max. Allowable Stress Values, MPa
40	124
65	124
100	124
125	124
150	124
175	124 [Note (1)]

GENERAL NOTE: The (maximum allowable) stress value includes a casting quality factor of 0.80. Increased casting quality factors as a result of material examination beyond the requirement of the material specification shall not be permitted.

NOTE:

(1) Values for 350°F and 175°C are provided for interpolation purposes only.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: June 24, 2009

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2619**  
**Use of ASTM A414/A414M-07**  
**Section VIII, Division 1**

*Inquiry:* May hot-rolled carbon steel sheet conforming to ASTM A414/A414M-07 be used in Section VIII, Division 1 construction?

*Reply:* It is the opinion of the Committee that hot-rolled carbon steel sheet conforming to ASTM A414/A414M-07 may be used in Section VIII, Division 1 construction, provided the following requirements are met:

(a) The allowable stress shall be per SA-414/SA-414M in Section II, Part D, Table 1A.

(b) All other requirements for Section VIII, Division 1 for SA-414/SA-414M shall be met.

(c) This Case number shall appear on the Manufacturer's Data Report Form.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: October 29, 2013

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2620-2**  
**Use of UNS S32101 Ferritic/Austenitic Stainless Steel**  
**Plate, Sheet, Strip, Pipe, and Tube in the Manufacture of**  
**Part HLW Water Heaters and Storage Tanks**  
**Section IV**

*Inquiry:* Under what conditions may UNS S32101 ferritic/austenitic stainless steel in SA-240 plate, SA-790 pipe, and SA-789 tube specifications be used in the construction of unlined Section IV, Part HLW water heaters and storage tanks?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used in the welded construction of Section IV, Part HLW water heaters and storage tanks, provided the following requirements are met:

(a) The allowable stress values for plate, sheet, and strip, seamless pipe, and seamless tube in accordance with SA-240, SA-789, and SA-790 shall be as listed in Tables 1 and 1M.

(b) Welding procedure and performance qualification shall be conducted in accordance with Section IX.

(c) As an alternative to calculation using the listed stress values, the allowable working pressure of the water or storage tank may be established in accordance with the proof test provision of HLW-500.

(d) The maximum design temperature shall be 500°F (260°C).

(e) All other requirements of Section IV shall be met.

(f) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values for**  
**SA-240 Plate, Sheet, and Strip, Seamless**  
**SA-790 Pipe, and Seamless SA-789 Tube**

For Metal Temperatures Not Exceeding, °F	Maximum Allowable Stress Values, ksi	
	$t \leq 0.187$ in.	$t > 0.187$ in.
100	25.3	23.5
200	25.3	23.5
300	24.1	22.4
400	23.2	21.6
500	23.2	21.6

GENERAL NOTES:

- (a) This steel may be expected to develop embrittlement after service at moderately elevated temperatures; see Nonmandatory Appendix A, A-207 and A-208 of Section II, Part D.
- (b) This material may utilize the minimum thickness exceptions of HF-301.1(d).
- (c) Values for welded pipe to SA-790 and tube to SA-789 are found by multiplying the above values by 0.85.

**Table 1M**  
**Maximum Allowable Stress Values for**  
**SA-240 Plate, Sheet, and Strip, Seamless**  
**SA-790 Pipe, and Seamless SA-789 Tube**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Values, MPa	
	$t \leq 5$ mm	$t > 5$ mm
40	175	163
65	175	163
100	175	163
150	167	155
175	161	152
200	160	150
225	160	149
250	160	149
275	160 [Note (1)]	149 [Note (1)]

GENERAL NOTES:

- (a) This steel may be expected to develop embrittlement after service at moderately elevated temperatures; see Nonmandatory Appendix A, A-207 and A-208 of Section II, Part D.
- (b) This material may utilize the minimum thickness exceptions of HF-301.1(d).
- (c) Values for welded pipe to SA-790 and tube to SA-789 are found by multiplying the above values by 0.85.

NOTE:

- (1) The maximum use temperature shall be 260°C. The value at 275°C temperature is provided for interpolation purposes.

Approval Date: December 14, 2009

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2621-1**  
**Diffusion Bonding**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions may diffusion bonding be used for the construction of microchannel heat exchangers to Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that diffusion bonding may be used for the construction of microchannel heat exchangers to Section VIII, Division 1, provided the following requirements are met:

(a) Sheet materials shall be limited to the following grades as listed in Section VIII, Division 1, Table UHA-23 and Section II, Part D.

NOTE: When a material has an associated T-Note in Section II, Part D, Table 1A, the maximum design temperature for such materials shall be limited to 50°F (28° C) below the T-Note temperature.

(1) SA-240 304L (UNS S30403)

(2) SA-240 316L (UNS S31603)

(3) SA-240 2205 Duplex (UNS S31803)

(b) This Code Case is not applicable for the construction of vessels designated for lethal service per UW-2(a), unfired steam boilers per UW-2(c), or direct fired vessels per UW-2(d).

(c) This Code Case is not applicable for use in diffusion bonding of dissimilar metals, nor the use of filler metals.

(d) The production diffusion bonded block may be larger than the bond procedure qualification block and produced on larger scale equipment provided that the essential variables of Table 1 for the production block match those of the bond procedure qualification block.

(e) The procedure and performance qualifications shall be performed by the Certificate Holder applying this Code Case.

(f) Controls and machine settings shall be as defined in the Bonding Procedure Specification.

(g) Any changes to essential variables listed in Table 1, outside the values qualified, will require requalification.

(h) The Bonding Procedure Specification and Bonding Performance Qualification shall be qualified by mechanical testing of a test block. The bond procedure qualification test block shall be a minimum of a 200 mm × 200 mm × 200 mm (8 in. × 8 in. × 8 in.) to suit production of

full size mechanical specimens. The mechanical properties in the through bond and parent directions shall comply with those specified for the sheet material.

(1) Three test samples shall be taken for through bond tensile testing, and three test samples shall be taken perpendicular to the through bond samples for the parent metal direction.

(2) Mechanical testing shall be conducted as per the requirements of the original material specification.

(-a) tensile testing per SA-370

(-b) impact testing per SA-370 with acceptance criteria to UHA-51

(3) Microstructure evaluation shall be performed per ASTM E3.

(-a) Sample shall be polished and etched. The etched macro section shall show complete fusion along the bond line and complete freedom from cracks in the bond or parent metal.

(i) Production bond examination is carried out by all of the following, in the sequence shown:

(1) Helium leak testing side to side and both sides to external, in accordance with Section V, Article 10 (Appendix IX). Acceptance criteria — maximum leak per Section V, Article 10 (Appendix IX).

(2) Ultrasonic examination of areas within  $T/2$  of external attachment welds on the endplate in accordance with Section V, Article 5, T-571.1 and SA-435/SA-435M including supplementary requirement S1.  $T$  is the thickness of the attachment. Acceptance criteria — no indications.

(3) Liquid penetrant examination in accordance with Section V, Article 6 after machining. Acceptance criteria — no indications.

(4) Visual examination in accordance with Section V, Article 9. Acceptance criteria — no unbonded areas.

(5) Hydrostatic testing in accordance with UG-99 or pneumatic testing in accordance with UG-100.

(j) Design calculations are conducted in accordance with Appendix 13, section 13-9, using a joint factor of 0.7 in the through bond direction equivalent to that for Types A and B welded joints with no radiographic examination from UW-12.

(k) This Case number shall be referenced on the Manufacturers' Data Report.

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**Table 1**  
**Essential Variables**

Variable	Essential	Nonessential
Material grade	X	...
Material sheet finish per SA-480	X	...
Method of preparing base material surface prior to diffusion bonding	X	...
Bonding minimum temperature/minimum time parameters	X	...
Bonding atmosphere	X	...
Post bond heat treatment	X	...
Post bond heat treatment time, temperature, and minimum cooling rate	X	...
Minimum block compression (original stack height compared to bonded height)	X	...
Test block dimensions	...	X
Sample location	...	X

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Approval Date: July 8, 2009

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2624**  
**Intermodal Transport Tanks (UN T50 Portable Tanks)**  
**Section VIII, Division 2**

*Inquiry:* Under what conditions may UN T50 portable tanks mounted in ISO frames, fitted with pressure relief devices in accordance with DOT Regulation 49 CFR, Part 178.276 set in the range 100% – 110% of the design pressure and used for intermodal transport (i.e., by motor vehicle, rail freight, and/or cargo vessel) be constructed and stamped under the rules of para. 1.2.1.2(b) of Section VIII, Division 2?

*Reply:* It is the opinion of the Committee that UN T50 portable tanks mounted in ISO frames, fitted with pressure relief devices in accordance with DOT Regulation 49 CFR, Part 178.276 set in the range 100% – 110% of the design pressure and used for intermodal transport (i.e., by motor vehicle, rail freight, and/or cargo vessel) may be constructed and stamped under the rules of para. 1.2.1.2(b) of Section VIII, Division 2, provided the requirements of paras. 1.2.1.2(b) and 1.2.1.2(b)(1) and (2), and the following additional requirements are met for all applicable modes of transport:

(a) The maximum design temperature shall not exceed 66°C (150°F).

(b) In Table 4.1.1, Design Loads, and Table 5.2, Load Descriptions, add the following condition:

Design Load Parameter	Description
V	Motor vehicle, rail, or water-borne transport loads

(c) In Table 4.1.2, Design Load Combinations, and Table 5.3, Load Case Combinations and Allowable Membrane Stresses for an Elastic Analysis, add the following condition:

Design Load Combination [Note (1)]	General Primary Membrane Allowable Stress [Note (2)]
$P + 0.9P_s + 0.9D + 0.9V$ [Note (3)] [Note (4)]	S [Note (5)]

Table continued

NOTES:

- (1) (For Note 1, see Table 4.1.2. Notes 2 through 5 below replace Notes 2 through 4 in Table 4.1.2.)
- (2) The materials permitted and the respective maximum allowable stress values shall be those given in Tables 1 and 1M.
- (3) The design pressure shall be taken to act simultaneously with the loads from motor vehicle, rail, or water-borne transport. However, loads from various modes of transport need not be assumed to act simultaneously.
- (4) When the rules of this Division are used in the design of pressure vessels transported by motor vehicle, rail, and/or water, loads from abnormal pressure vessel orientation and dynamic loads produced by shock, vibration, or impact loading, for evaluation under parameter V, shall be specified by the regulatory (jurisdictional) authority or authorities.
- (5) Based on corroded thickness at design metal temperature of 66°C (150°F) and colder.

(d) In Table 4.1.1, the operating load conditions that are the basis of fatigue evaluation shall include loads and load spectra caused by abnormal pressure vessel orientation, impact, shock, vibration, fluid sloshing, and temperature and pressure fluctuations.

(e) The loads referred to in paras. (a), (b), and (c) shall be defined in the User's Design Specification.

(f) The minimum thickness of shell, heads, nozzles, closures, or sumps shall not be less than the required thicknesses in accordance with the rules of Part 4 of Section VIII, Division 2.

(g) A means for retaining records of original construction, inspection, repair, accidents, and unusual loadings shall be established by the regulatory (jurisdictional) authority and implemented by the user. Any additional record retention requirements shall be specified in the User's Design Specification.

(h) All other applicable requirements of Section VIII, Division 2 shall be met.

(i) This Case number shall be shown in the Manufacturer's Data Report and marked on the nameplate.

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**Table 1**  
**Materials Permitted and Maximum**  
**Allowable Stresses, ksi**

Material Specification	Temperature, -20°F to 150°F
SA-105	22.6
SA-106 Gr. B	20.0
SA-350 LF2	22.6
SA-516 Gr. 70	23.3
SA-612 [Note (1)]	27.7
SA-612 [Note (2)]	27.0
SA-299/SA-299M	25.0
SA/EN 10028-3, Grade P460NL1 [Note (3)]	30.5

## NOTES:

- (1)  $t \leq 0.5$  in.  
(2)  $0.5$  in.  $< t \leq 1$  in.  
(3) Per Code Case 2594.

**Table 1M**  
**Materials Permitted and Maximum**  
**Allowable Stresses, MPa**

Material Specification	Temperature, -29°C to 65°C
SA-105	156
SA-106 Gr. B	138
SA-350 LF2	156
SA-516 Gr. 70	161
SA-612 [Note (1)]	190
SA-612 [Note (2)]	186
SA-299/SA-299M	172
SA/EN 10028-3, Grade P460NL1 [Note (3)]	210

## NOTES:

- (1)  $t \leq 13$  mm  
(2)  $13$  mm  $< t \leq 25$  mm  
(3) Per Code Case 2594.

Approval Date: September 30, 2009

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2627**  
**Use of Aluminum Alloy EN AW-6060 T1 Extruded**  
**(Integrally) Finned Tube in the Manufacture of Hot**  
**Water Heating Boilers**  
**Section IV**

*Inquiry:* May aluminum alloy EN AW-6060 T1 extruded finned and coiled tube meeting the chemical composition listed in [Table 1](#), the mechanical properties listed in [Table 2](#), and heat treatment “temper designation T1” according to EN 515 August 1993, be used in construction for hot water heating boilers under the rules of Section IV?

*Reply:* It is the opinion of the Committee that aluminum alloy EN AW-6060 T1 extruded finned and coiled tube meeting the requirements described in the Inquiry may be used in Section IV, construction of hot water heating boilers, under the following conditions:

(a) Maximum allowable working pressure shall not exceed 50 psi (350 kPa).

(b) The maximum water temperature shall be 220°F (105°C).

(c) The maximum allowable stress values shall be as shown in [Table 3](#) and [Table 3M](#).

(d) The material shall otherwise conform to the specifications listed in [Table 4](#).

(e) The minimum allowable thickness shall be 0.079 in. (2 mm), except as noted in [\(g\)](#).

(f) Separate welding procedure qualifications conducted in accordance with Section IX shall be required for this material.

(g) Minimum thickness, at the point where the tube is bent at the water inlet/outlet terminals, is 0.039 in. (1.0 mm), provided the tubes are enclosed by a shell, casing, or ducting, where such pipes or tubes are NPS 6 (DN 150) and less, and a proof test of the tubing is performed.

(h) All other applicable parts of Section IV shall apply.

(i) In case of conflict with any of the referenced specifications, this Code Case shall govern.

(j) This Case number shall be referenced in the documentation and marking of the material and shown on the Manufacturer’s Data Report.

**Table 1**  
**Chemical Composition of EN AW-6060 Alloy (AlMgSi)**

Silicon	0.30–0.6
Iron	0.10–0.30
Copper	0.10 max.
Manganese	0.10 max.
Magnesium	0.35–0.6
Chromium	0.05 max.
Zinc	0.15 max.
Titanium	0.10 max.
Others, total	0.15 max.
Aluminum	Balance

GENERAL NOTE: Ref. EN 573-3:2007; Table 6, Aluminium alloys  
 — 6 000 series — AlMgSi; page 16.

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**Table 2**  
**Minimum Mechanical Properties**

Temperature, °F	$R_{p0.2}$ , ksi	$R_m$ , ksi	Temperature, °C	$R_{p0.2}$ , MPa	$R_m$ , MPa	A50, %
68	7.3	17.4	20	50	120	14

GENERAL NOTE: Ref. UNI 9006-1:1988, para. 5.1, page 2.

**Table 3**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress, ksi
Up to 100	3.5
150	3.5
200	3.5
250	3.4
300	3.2

GENERAL NOTE: The maximum metal use temperature is 266°F (130°C). Data for 300°F and 150°C is provided for interpolation purposes.

**Table 3M**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress, MPa
Up to 40	24.0
65	24.0
100	24.0
125	23.3
150	22.3

GENERAL NOTE: The maximum metal use temperature is 266°F (130°C). Data for 300°F and 150°C is provided for interpolation purposes.

**Table 4**  
**Applicable Specifications**

UNI 9006-1, September 1988	Wrought primary aluminum and aluminum alloys. Aluminum-magnesium-silicon alloys. Al Mg 0.5 Si 0.4 Fe 0.2 (6060) alloy.
EN 515, August 1993	Aluminum and aluminum alloys. Wrought products. Temper designation.
EN 573-3, August 2007	Aluminum and aluminum alloys. Chemical composition and form of wrought products — Part 3: Chemical composition and form of products.
EN 755-1, March 2008	Aluminum and aluminum alloys. Extruded rod/bar, tube, and profiles. Part 1: Technical conditions for inspection and delivery.
EN 10002-1, July 2001	Metallic materials. Tensile testing. Part 1: Method of test at ambient temperature.

GENERAL NOTES:

- (a) See Section II, Part B, Appendix A for ordering information to obtain English copies.
- (b) Copy of the Italian Standard UNI 9006 can be obtained from: UNI, via Sannio 2, 20137 Milano, Italy.

Approval Date: September 30, 2009

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2628**  
**Use of SB-241/SB-241M Grade 6063 T1 (UNS A96063)**  
**Aluminum Alloy Extruded (Integrally) Finned and**  
**Coiled Tube in the Manufacture of Hot Water Heating**  
**Boilers**  
**Section IV**

*Inquiry:* Under what conditions may SB-241/SB-241M Grade 6063 T1 (UNS A96063) aluminum alloy extruded finned and coiled tube meeting the chemical composition and mechanical properties of SB-241/SB-241M be used in construction for hot water heating boilers under the rules of Section IV?

*Reply:* It is the opinion of the Committee that SB-241/SB-241M Grade 6063 T1 (UNS A96063) aluminum alloy extruded finned and coiled tube meeting the chemical composition and mechanical properties in SB-241/SB-241M may be used in Section IV construction of hot water heating boilers under the following conditions:

- (a) Maximum allowable working pressure shall not exceed 60 psi (413 kPa).
- (b) The maximum water temperature shall be 250°F (120°C).
- (c) The maximum allowable stresses are those given in Tables 1 and 1M.
- (d) The specified minimum tensile strength at room temperature shall be 17.0 ksi (115 MPa), the specified minimum yield strength shall be 9.0 ksi (60 MPa).
- (e) Minimum thickness shall be 0.079 in. (2 mm), except as noted in (f).
- (f) Minimum thickness, at the point where the tube is bent at the water inlet/outlet terminals, is 0.039 in. (1.0 mm), provided the tubes are enclosed by a shell, casing, or ducting where such pipes or tubes are NPS 6 (DN 150) and less, and a proof test of the tubing is performed.
- (g) All other applicable parts of Section IV shall apply.
- (h) This Case number shall be shown on the Manufacturer's Data report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values**

For Temperature Not Exceeding,	
°F	Maximum Allowable Stress, ksi
Up to 100	3.0
150	3.0
200	3.0
250	2.9
300	2.7

## GENERAL NOTES:

- (a) The allowable stress values are conservative annealed values to allow welding of the fins during construction.
- (b) The maximum metal use temperature is 266°F. Data for 300°F is provided for interpolation purposes.

**Table 1M**  
**Maximum Allowable Stress Values**

For Temperature Not Exceeding,	
°C	Maximum Allowable Stress, MPa
Up to 40	20.7
65	20.7
100	20.7
125	20.2
150	18.7

## GENERAL NOTES:

- (a) The allowable stress values are conservative annealed values to allow welding of the fins during construction.
- (b) The maximum metal use temperature is 130°C. Data for 150°C is provided for interpolation purposes.

Approval Date: January 13, 2010

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2629**  
**Alloy UNS N06690 Up To 1200°F (649°C)**  
**Section VIII, Division 1**

*Inquiry:* May solution annealed Ni-Cr-Fe Alloy (UNS N06690) seamless pipe and tube in sizes 5 in. O.D. and under that meet the requirements of SB-167 be used in Section VIII, Division 1, welded construction at temperatures above 850°F (454°C) up to and including 1200°F (649°C)?

*Reply:* It is the opinion of the Committee that solution annealed Ni-Cr-Fe alloy (UNS N06690) seamless pipe and tube in sizes 5 in. O.D. and under as described in the Inquiry may be used for Section VIII, Division 1

construction at temperatures above 850°F (454°C) up to and including 1200°F (649°C), provided the following additional requirements are met:

(a) The tubes shall be manufactured to SB-167 UNS N06690, cold worked, and annealed at 1900°F (1040°C) minimum.

(b) The maximum allowable stress values shall be those given in Section II, Part D, Table 1B for metal temperatures not exceeding 850°F (454°C) and Tables 1 and 1M for metal temperatures from 850°F (454°C) up to 1200°F (649°C).

(c) All material that is cold strained more than 5% during forming or fabrication shall be reannealed at a temperature of 1900°F (1040°C) minimum.

(d) This Case number shall be identified on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1  
Maximum Allowable Stress Values**

For Metal		
Temperatures Not Exceeding, °F	Maximum Allowable Stress, ksi [Note (1)]	
850	18.4	22.5
900	18.3	22.2
950	16.5 [Note (2)]	16.5 [Note (2)]
1000	11.6 [Note (2)]	11.6 [Note (2)]
1050	9.0 [Note (2)]	9.0 [Note (2)]
1100	6.5 [Note (2)]	6.5 [Note (2)]
1150	4.5 [Note (2)]	4.5 [Note (2)]
1200	3.0 [Note (2)]	3.0 [Note (2)]

NOTES:

- (1) Due to the relatively low yield strength of these materials, these higher stress values were established at temperatures where the short time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed 66<sup>2</sup>/<sub>3</sub>%, but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints, or other applications where slight amounts of distortion can cause leakage or malfunction.
- (2) Allowable stresses for temperatures of 950°F and above are values obtained from time-dependent properties.

**Table 1M  
Maximum Allowable Stress Values**

For Metal		
Temperatures Not Exceeding, °C	Maximum Allowable Stress, MPa [Note (1)]	
475	127	154
500	126	127 [Note (2)]
525	95.0 [Note (2)]	95.0 [Note (2)]
550	71.4 [Note (2)]	71.4 [Note (2)]
575	54.3 [Note (2)]	54.3 [Note (2)]
600	41.4 [Note (2)]	41.4 [Note (2)]
625	30.6 [Note (2)]	30.6 [Note (2)]
650	19.7 [Note (2)], [Note (3)]	19.7 [Note (2)], [Note (3)]

NOTES:

- (1) Due to the relatively low yield strength of these materials, these higher stress values were established at temperatures where the short time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed 66<sup>2</sup>/<sub>3</sub>%, but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints, or other applications where slight amounts of distortion can cause leakage or malfunction.
- (2) Allowable stresses for temperatures of 500°C and above are values obtained from time-dependent properties.
- (3) The stress value at 650°C is provided for interpolation only. The maximum design temperature is stated in (b) of the Reply.

Approval Date: January 13, 2010

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2630**  
**Use of Fatigue Analysis Screening, Method A For**  
**Vessels Made of 1.25Cr-0.5Mo-Si and 2.25Cr-1Mo Steels**  
**Section VIII, Division 2**

*Inquiry:* May the fatigue screening Method A in para. 5.5.2.3 be used for the vessels made of 1.25Cr-0.5Mo-Si and 2.25Cr-1Mo steels for Section VIII, Division 2 construction when the design allowable stress is governed by time-dependent properties?

*Reply:* It is the opinion of the Committee that the fatigue screening Method A in para. 5.5.2.3 may be used for the vessels made of 1.25Cr-0.5Mo-Si and 2.25Cr-1Mo steels for Section VIII, Division 2 construction when the design allowable stress is governed by time-dependent properties, provided that the following conditions are met:

- (a) The applicable materials are in [Table 1](#).
- (b) The allowable stress taken at operating conditions is governed by time-independent properties.
- (c) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1  
Applicable Materials**

Nominal Composition	Product Form	Spec. No.	Type/Grade	Class/Condition/ Temper	Minimum Tensile Strength, MPa (ksi)
1.25Cr-0.5Mo-Si	Forgings	SA-182	F11	1	415 (60)
	Fittings	SA-234	WP11	1	415 (60)
	Seamless pipe	SA-335	P11	...	415 (60)
	Plate	SA-387	11	1	415 (60)
	Forgings	SA-182	F11	2	485 (70)
	Forgings	SA-336	F11	2	485 (70)
	Plate	SA-387	11	2	515 (75)
	Forgings	SA-336	F11	3	515 (75)
2.25Cr-1Mo	Seamless tube	SA-213	T22	...	415 (60)
	Fittings	SA-234	WP22	1	415 (60)
	Forgings	SA-182	F22	1	415 (60)
	Forgings	SA-336	F22	1	415 (60)
	Plate	SA-387	22	1	415 (60)
	Seamless pipe	SA-335	P22	...	415 (60)
	Forgings	SA-182	F22	3	515 (75)
	Forgings	SA-336	F22	3	515 (75)
	Plate	SA-387	22	2	515 (75)
	Forgings	SA-508	22	3	586 (85)
	Forgings	SA-541	22	3	586 (85)
	Plate	SA-542	B	4	586 (85)

Approval Date: December 14, 2009

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2631**  
**Titanium Aluminum Alloy, ASTM B367-08b, Ti 3Al-2.5V**  
**or Ti 3Al-2.5V-0.05Pd Castings**  
**Section VIII, Division 1**

*Inquiry:* May titanium ASTM B367-08b, Gr. C-9 (Ti 3Al-2.5V) or C-18 (Ti 3Al-2.5V-0.05Pd) alloy castings be used in Section VIII, Division 1 construction?

*Reply:* It is the opinion of the Committee that titanium alloy castings conforming to ASTM B367-08b, Grade C-9 (UNS R56320) or C-18 (UNS R56322) may be used in Section VIII, Division 1 construction, provided the following additional requirements are met:

(a) Supplementary Requirement S5 requiring hot isostatic pressing is mandatory.

(b) Supplementary Requirement S6 requiring tensile test of representative cast test bars is mandatory.

(c) The maximum allowable stress values shall be as shown in Table 1 or 1M. These stress values are to be multiplied by casting quality factors of UG-24.

(d) The maximum design temperature shall be 600°F (316°C).

(e) Figure NFT-4 and corresponding Table NFT-4 shall be used for the materials.

(f) The base material shall be considered as P-No. 53 for purposes of welding procedure and performance qualifications conducted in accordance with Section IX.

(g) All other rules of Section VIII, Division 1, Part UNF applicable to titanium shall be met.

(h) This Case number shall be shown on the Manufacturer's Data Report.

**Table 1**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Allowable Stress Values, ksi Grade C-9 or C-18
100	25.7
150	25.7
200	24.2
250	22.8
300	21.5
350	20.2
400	19.1
450	18.1
500	17.2
550	16.4
600	15.7

**Table 1M**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Allowable Stress Values, MPa Grade C-9 or C-18
40	177
65	177
100	165
125	156
150	147
175	140
200	133
225	126
250	120
275	115
300	111
325	107

GENERAL NOTE: The value for 325°C temperature is provided for interpolation purposes.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: October 21, 2009

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2632**  
**Use of UNS N06625 Nickel Alloy (60Ni-22Cr-9Mo-3.5Cb) Annealed Grade 1 in Welded Tube, Plate, Sheet, and Strip**  
**Section I**

*Inquiry:* Under what conditions may UNS N06625 (60Ni-22Cr-9Mo-3.5Cb) conforming to SB-704 and SB-443 be used in Section I construction?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used in Section I, providing the following additional requirements are met:

(a) The material shall be furnished in the annealed Grade 1 condition as listed in the specifications. The flat rolled alloy used to produce the tubing shall be UNS N06625 Grade 1 from SB-443.

(b) The maximum allowable stress values for plate, sheet and strip, and welded tube shall be as listed in Section II Part D, Table 1B for Section I for temperatures up to 1100°F (593°C). For higher temperatures the maximum allowable stress values shall be as listed in Tables 1 and 1M for plate, sheet and strip, and Tables 2 and 2M for welded tube. The maximum temperature shall not exceed 1200°F (649°C).

(c) Welding procedure and performance qualifications shall be conducted as prescribed in Section IX.

(d) For parameter  $y$  (see PG-27.4), the  $y$  values shall be as follows:

1150°F (620°C) and below,  $y = 0.4$

1200°F (650°C),  $y = 0.5$

(e) This Case number shall be identified in the Manufacturer's Data Report.

NOTE: Alloy UNS N06625 is subject to severe loss of impact strength at room temperature after exposure in the range of 1000°F to 1400°F (538°C to 760°C).

**CAUTION: Austenitic alloys are subject to stress corrosion cracking, intergranular attack, pitting, and crevice corrosion when used in boiler applications in aqueous environments. Factors that affect the susceptibility of these materials are applied or residual stress, water chemistry and deposition of solids, and material condition. Susceptibility to attack is enhanced when the material is used in a sensitized condition, or with residual cold work. Concentration of corrosive agents (e.g., chlorides, caustic, or reduced sulfur species) can occur under deposits formed on the surface of these materials, and can result in severe underdeposit wastage or cracking. For successful operation in water environments, careful attention must be paid to continuous control of water chemistry.**

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values for SB-443 Plate, Sheet, and Strip 120/60 ksi (T.S./Y.S.)**

For Metal Temperatures Not Exceeding, °F	Maximum Allowable Stress Values, ksi
1150	21.0
1200	13.2

**Table 1M**  
**Maximum Allowable Stress Values for SB-443 Plate, Sheet, and Strip 825/415 MPa (T.S./Y.S.)**

For Metal Temperatures Not Exceeding, °C	Maximum Allowable Stress Values, MPa
600	192
625	136
650	89.0

GENERAL NOTE: The value for 650°C temperature is provided for interpolation purposes.

**Table 2**  
**Maximum Allowable Stress Values for Welded SB-704 Tube 120/60 ksi (T.S./Y.S.)**

For Metal Temperatures Not Exceeding, °F	Maximum Allowable Stress Values, ksi
1150	17.9
1200	11.2

**Table 2M**  
**Maximum Allowable Stress Values for Welded SB-704 Tube 825/415 MPa (T.S./Y.S.)**

For Metal Temperatures Not Exceeding, °C	Maximum Allowable Stress Values, MPa
600	164
625	116
650	75.5

GENERAL NOTE: The value at 650°C temperature is provided for interpolation purposes.

Approval Date: December 14, 2009

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2633**  
**Cast ASTM B752-06 Zirconium Alloy Grades 702C and 705C**  
**Section VIII, Division 1**

*Inquiry:* May ASTM B752-06 cast zirconium Grade 702C (UNS R60702) or Grade 705C (UNS R60705) alloy be used in Section VIII, Division 1 construction?

*Reply:* It is the opinion of the Committee that cast zirconium conforming to ASTM B752-06 Grade 702C or Grade 705C may be used in Section VIII, Division 1 construction, provided the following additional requirements are met:

(a) Supplementary Requirement S8 requiring hot isostatic pressing is mandatory.

(b) Supplementary Requirement S6 requiring tensile test of representative cast bars is mandatory.

(c) Supplementary Requirement S4 requiring certification and reporting is mandatory.

(d) The maximum allowable stress values shall be as shown in Table 1 or 1M. These stress values are to be multiplied by the casting quality factors of UG-24.

(e) The maximum design temperature shall be 600°F (316°C).

(f) Figure NFZ-1 and corresponding Table NFZ-1, Fig. NFZ-2 and corresponding Table NFZ-2 shall be used for Grades 702C and 705C materials, respectively.

(g) The base material shall be considered as P-No. 61 for Grade 702C and P-No. 62 for Grade 705C for purposes of welding procedures and welding performance qualification in accordance with Section IX.

(h) All other rules for Section VIII, Division 1, Part UNF applicable to wrought zirconium Grades 702 or 705 shall be met.

(i) This Case number shall be shown on the Manufacturer's Data Report.

**Table 1**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Allowable Stress Values, ksi	
	Grade 702C	Grade 705C
100	15.7	20.0
150	15.5	19.9
200	14.4	18.5
250	13.1	17.2
300	11.9	16.0
350	10.8	14.8
400	9.6	13.6
450	8.6	12.6
500	7.7	11.7
550	6.9	10.9
600	6.3	10.2

**Table 1M**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Allowable Stress Values, MPa [Note (1)]	
	Grade 702C	Grade 705C
40	108	138
65	107	137
100	97.0	126
125	89.5	118
150	82.0	110
175	74.7	102
200	67.6	95.1
225	61.1	88.6
250	55.1	82.6
275	49.9	77.3
300	45.7	72.8
325	42.4	69.2

NOTE:

(1) The value for 325°C temperature is provided for interpolation purposes.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: December 14, 2009

*Code Cases will remain available for use until annulled by the applicable Standards Committee.***Case 2634**  
**Inspection Openings in Small Pressure Vessels**  
**Section VIII, Division 1**

*Inquiry:* May the provisions of UG-46(d), regarding inspection openings in pressure vessels, be waived, provided that such vessels are contained within sealed inaccessible chambers?

*Reply:* It is the opinion of the Committee that for vessels contained within sealed inaccessible chambers, the provisions of UG-46(d) may be waived, provided the following:

(a) The vessels are constructed from the following materials:

- (1) SA-240 Gr. 304L
- (2) SA-312 Gr. TP304L
- (3) SA-403 Gr. 304L
- (4) SA-240 Gr. 316L
- (5) SA-312 Gr. TP316L
- (6) SA-403 Gr. 316L
- (7) SA-240 Gr. 310S
- (8) SA-312 Gr. TP310S
- (9) SA-403 Gr. 310S
- (10) SB-265 Gr. 2
- (11) SB-861 Gr. 2

(12) SB-363 Gr. WPT2

(13) SB-551 UNS R60702

(14) SB-658 UNS R60702

(b) The design pressure ranges from full vacuum to 320 psi (2.2 MPa).

(c) The minimum design metal temperature is not colder than 0°F (-18°C).

(d) The design temperature does not exceed 240°F (116°C).

(e) The vessels are not in cyclic service.

(f) "Leak before break" can be demonstrated by fracture mechanics analysis using  $6t$  long through wall crack at an applied pressure of MAWP at MDMT.

(g) This Code Case is not used for vessels constructed to the rules of U-1(j).

(h) The inside diameter of the vessels does not exceed 12 in. (300 mm).

(i) The volume of the vessels do not exceed 4.0 ft<sup>3</sup> (0.11 m<sup>3</sup>).

(j) A Professional Engineer shall provide a certification that such vessels will be enclosed within sealed inaccessible chambers.

(k) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: December 21, 2009

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2635**  
**Single Feedwater Source for Solar Fired Boiler**  
**Section I**

*Inquiry:* Under what conditions may a tower mounted, solar fired, natural circulation boiler constructed to the requirements of Section I and having more than 500 ft<sup>2</sup> of water heating surface be provided with a single means of feeding water?

*Reply:* It is the opinion of the Committee that a tower mounted, solar fired, natural circulation boiler constructed to the requirements of Section I and having more than 500 ft<sup>2</sup> of water heating surface may be provided with a single means of feeding water, provided all the following requirements are met:

(a) The heating control system shall automatically shut off the heat input to the boiler in the event of a loss in feedwater supply.

(b) The heating control system shall automatically shut off the heat input prior to the water level reaching the lowest permissible level established in PG-60.

(c) There shall be sufficient water in the drum at the water level that initiates the shutdown to prevent damage to the boiler during the duration of the shutdown process.

(d) The heating control system shall shut off the heat input to the boiler in the event of a failure in the main power supply to the heating control system.

(e) There shall be a backup means of automatically shutting off the heat input in the event of control system failures that could result in loss of control of any portion of the heating system sufficient to cause boiler part temperatures to exceed their design values.

(f) The amount of residual flux concentrated on the boiler surfaces after the shutdown shall not result in boiler part temperatures exceeding their design temperature limits as determined by the boiler manufacturer.

(g) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: January 13, 2010

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2636**  
**ASTM A240/A240M-09a UNS S30530 Solution Annealed Austenitic Stainless Steel Plate and Sheet**  
**Section VIII, Division 1**

*Inquiry:* May solution annealed ASTM A240/A240M-09a UNS S30530 austenitic stainless steel plate and sheet be used for welded construction under the rules of Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that solution annealed ASTM A240/A240M-09a UNS S30530 austenitic stainless steel plate and sheet may be used for welded construction under the rules of Section VIII, Division 1, provided the following additional requirements are met:

(a) The rules in Section VIII, Division 1, Subsection C that shall apply are those given in Part UHA for austenitic stainless steels.

(b) The maximum allowable stress values for the material shall be those given in Tables 1 and 1M. The maximum design temperature shall be 752°F (400°C).

(c) Separate welding procedure qualifications, conducted in accordance with Section IX, shall be required for this material. For the purposes of performance qualification, the material shall be considered P-No. 8, Group No. 1.

(d) Heat treatment after welding or fabrication is neither required nor prohibited. If heat treated, the requirements of ASTM A480/A480M-09, Table A1.2 shall apply.

(e) For external pressure design, Fig. HA-1 in Section II, Part D shall apply.

(f) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi	Maximum Allowable Stress Values, ksi
-20 to 100	20.0	20.0
200	16.8	19.8 [Note (1)]
300	15.3	19.0 [Note (1)]
400	14.3	18.6 [Note (1)]
500	13.6	18.4 [Note (1)]
600	13.0	17.6 [Note (1)]
650	12.6	17.1 [Note (1)]
700	12.2	16.5 [Note (1)]
750	11.7	15.8 [Note (1)]
800 [Note (2)]	11.1	14.9 [Note (1)]

## NOTES:

- (1) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of this alloy where slightly greater deformation is acceptable. The stress values in this range exceed  $66\frac{2}{3}\%$  but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.
- (2) This value is provided for interpolation only. The maximum design temperature is 752°F as shown in (b).

**Table 1M**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Values, MPa	Maximum Allowable Stress Values, MPa
-30 to 40	137	137
65	125	137 [Note (1)]
100	118	137 [Note (1)]
150	110	134 [Note (1)]
200	104	130 [Note (1)]
250	99.2	129 [Note (1)]
300	95.7	128 [Note (1)]
325	94.1	127 [Note (1)]
350	92.7	125 [Note (1)]
375	91.2	123 [Note (1)]
400	89.6	121 [Note (1)]

## NOTE:

- (1) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of this alloy where slightly greater deformation is acceptable. The stress values in this range exceed  $66\frac{2}{3}\%$  but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.

(19)

**Case 2638  
Alternative Piping Calibration Blocks  
Section V**

**ANNULLED**

Annulment Date: December 30, 2018

Reason: No longer needed.

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Approval Date: January 20, 2010

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2639**  
**25Cr-14Ni-Mo-Low C (UNS S30925) Seamless Austenitic Steel Tube**  
**Section I**

*Inquiry:* May solution treated 25Cr-14Ni-Mo-Low C (UNS S30925) seamless austenitic stainless steel tube that conforms to applicable requirements in ASTM A213 and SA-213/SA-213M be used for steam service in Section I construction?

*Reply:* It is the opinion of the Committee that the material listed in the Inquiry may be used for steam service in Section I construction, provided the following requirements are met:

(a) The material shall meet the chemical analysis and minimum tensile requirements specified in ASTM A213 (UNS S30925) as applicable, except as shown in (b) and (c).

(b) The minimum solution treating temperature for this material shall be 1,920°F (1 050°C).

(c) This material shall have a hardness not exceeding 256 HBW/270 HV (100 HRB).

(d) The rules of PG-19 for TP309S shall apply for this material, except that solution treatment, when required, shall be at the minimum temperature of 1,920°F (1 050°C).

(e) The maximum allowable stress values for the material shall be as given in Table 1 and 1M. The maximum design temperature is 1,200°F (649°C).

(f) Separate welding procedure and performance qualification shall be conducted for the material in accordance with Section IX.

(g) This Case number shall be referenced in the documentation and recorded on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stresses**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi	Maximum Allowable Stress Values, ksi
-20 to 100	25.3	25.3
200	21.3	25.3 [Note (1)]
300	19.5	24.9 [Note (1)]
400	18.3	23.9 [Note (1)]
500	17.5	23.2 [Note (1)]
600	16.8	22.6 [Note (1)]
650	16.5	22.3 [Note (1)]
700	16.2	21.9 [Note (1)]
750	15.9	21.5 [Note (1)]
800	15.6	21.1 [Note (1)]
850	15.4	20.8 [Note (1)]
900	15.1	20.4 [Note (1)]
950	14.9	20.1 [Note (1)]
1000	14.7	19.8 [Note (1)]
1050	14.5	19.2 [Note (1)]
1100	14.3	15.3 [Note (1)]
1150	9.7	9.7
1200	6.5	6.5

NOTE:

(1) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed 66<sup>2</sup>/<sub>3</sub>%, but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.

**Table 1M**  
**Maximum Allowable Stresses**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Values, MPa	Maximum Allowable Stress Values, MPa
-30 to 40	175	175
65	156	175 [Note (1)]
100	145	175 [Note (1)]
125	139	175 [Note (1)]
150	134	172 [Note (1)]
175	130	168 [Note (1)]
200	127	165 [Note (1)]
225	124	163 [Note (1)]
250	122	161 [Note (1)]
275	119	159 [Note (1)]
300	117	157 [Note (1)]
325	115	155 [Note (1)]
350	113	153 [Note (1)]
375	111	150 [Note (1)]
400	110	148 [Note (1)]
425	108	146 [Note (1)]
450	106	144 [Note (1)]
475	105	141 [Note (1)]
500	103	140 [Note (1)]
525	102	138 [Note (1)]
550	101	135 [Note (1)]
575	99.3	130 [Note (1)]
600	95.4	95.4
625	63.0	63.0
650	44.5	44.5 [Note (2)]

NOTES:

- (1) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed 66<sup>2</sup>/<sub>3</sub>%, but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.
- (2) These values are provided for interpolation purposes only.

**Approval Date: January 20, 2011**

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2640-1  
Postponement of Mandatory Date for Compliance  
Section I**

*Inquiry:* Is it permissible to postpone, until July 1, 2013, the date for mandatory compliance with the requirements of Section I, 2007 Edition, 2009 Addenda, PG-69.1.6 for direct spring loaded pressure relief valves?

*Reply:* It is the opinion of the Committee that the date for mandatory compliance with the requirements of PG-69.1.6 of the 2009 Addenda to the 2007 Edition of Section I for direct spring loaded pressure relief valves may be postponed until July 1, 2013. Until that date, the requirements pertaining to capacity certification of direct spring loaded pressure relief valves for economizer service as presented in the 2007 Edition, up to and including the 2008 Addenda, of Section I shall apply. This Case number shall be included in addition to the markings required by PG-110.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: December 14, 2009

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2641**  
**Titanium Nickel Molybdenum Alloy (Ti 0.8Ni-0.3Mo),**  
**Grade C-12 Castings**  
**Section VIII, Division 1**

*Inquiry:* May SB-367 titanium Grade C-12 (Ti 0.8Ni-0.3Mo, UNS R53400) alloy castings be used in Section VIII, Division 1 construction?

*Reply:* It is the opinion of the Committee that SB-367 titanium, Grade C-12 alloy castings may be used in Section VIII, Division 1 construction, provided the following additional requirements are met:

(a) Supplementary Requirement S5 requiring hot isostatic pressing is mandatory.

(b) Supplementary Requirement S6 requiring tensile test of representative cast test bars is mandatory.

(c) The maximum allowable stress values shall be shown in Table 1 or 1M. These stress values are to be multiplied by the casting quality factors of UG-24.

(d) The maximum design temperature shall be 600°F (316°C).

(e) Figure NFT-5 and the corresponding Table NFT-5 shall be used for the material.

(f) The base material shall be considered as P-No. 52 for purposes of welding procedure and performance specifications.

(g) All other rules for Section VIII, Division 1, Part UNF applicable to titanium shall be met.

(h) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values (Cast Product Forms)**

For Metal Temperature Not Exceeding, °F		Allowable Stress Values, ksi
100		20.0
150		19.5
200		17.9
250		16.4
300		14.9
350		13.4
400		12.1
450		11.0
500		9.9
550		9.1
600		8.4

**Table 1M**  
**Maximum Allowable Stress Values (Cast Product Forms)**

For Metal Temperature Not Exceeding, °C		Allowable Stress Values, MPa
40		138
65		135
100		121
125		111
150		102
175		93.8
200		85.1
225		77.5
250		70.8
275		65.1
300		60.5
325		57.1

GENERAL NOTE: The value for 325°C temperature is provided for interpolation purposes.

Approval Date: April 6, 2010

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2643**  
**Use of UNS S32003 Ferritic/Austenitic Stainless Steel**  
**Plate, Pipe, and Tube**  
**Section IV**

*Inquiry:* Under what conditions may UNS S32003 ferritic/austenitic stainless steel in SA-240 plate, SA-790 pipe, and SA-789 tube specifications be used in the construction of unlined Section IV, Part HLW water heaters and storage tanks?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used in the welded construction of Section IV, Part HLW water heaters and storage tanks, provided the following requirements are met:

(a) The material shall be furnished in the heat treated condition with the heat treatment as listed in the specification.

(b) The allowable stress for plate, seamless pipe, and seamless tube in accordance with SA-240, SA-790, and SA-789 shall be as listed in Tables 1, 1M, 2 and 2M.

(c) The allowable stress for welded pipe and tube in accordance with SA-790 and SA-789 shall be as listed in Tables 3, 3M, 4 and 4M.

(d) Welding procedure and performance qualification shall be conducted in accordance with Section IX.

(e) As an alternative to calculation using the listed stress values, the allowable working pressure of the water or storage tank may be established in accordance with the proof test provision of HLW-500.

(f) The maximum design temperature shall be 500°F (260°C).

(g) All other requirements of Section IV shall be met.

(h) This Case number shall be shown on the Manufacturer's Data Report.

NOTES:

- (1) This steel may be expected to develop embrittlement after service at moderately elevated temperatures; see Appendix A, A-340 and A-360, Section II, Part D.
- (2) This material may utilize the minimum thickness exceptions of HF-301.1(d).

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values for SA-789 Tube (100 ksi T.S./70 ksi Y.S.)**

For Metal Temperatures Not Exceeding, °F	Maximum Allowable Stress Values, ksi
100	25.0
200	24.3
300	22.8
400	22.6
500	22.6

**Table 1M**  
**Maximum Allowable Stress Values for Seamless SA-789 Tube**

For Metal Temperatures Not Exceeding, °C	Maximum Allowable Stress Values, MPa
40	172
65	172
100	165
125	160
150	157
175	156
200	155
225	155
250	155
275	155 [Note (1)]

NOTE:  
(1) The maximum use temperature shall be 260°C. The value at 275°C is provided for interpolation purposes.

**Table 2**  
**Maximum Allowable Stress Values for SA-240 Plate, Seamless SA-790 Pipe (90 ksi T.S./65 ksi Y.S.)**

For Metal Temperatures Not Exceeding, °F	Maximum Allowable Stress Values, ksi
100	22.5
200	21.8
300	20.5
400	20.3
500	20.3

**Table 2M**  
**Maximum Allowable Stress Values for SA-240 Plate and Seamless SA-790 Pipe (90 ksi T.S./65 ksi Y.S.)**

For Metal Temperatures Not Exceeding, °C	Maximum Allowable Stress Values, MPa
40	155
65	155
100	149
125	145
150	142
175	141
200	140
225	140
250	140
275	140 [Note (1)]

NOTE:  
(1) The maximum use temperature shall be 260°C. The value at 275°C is provided for interpolation purposes.

**Table 3**  
**Maximum Allowable Stress Values for Welded SA-789 Tube (100 ksi T.S./70 ksi Y.S.)**

For Metal Temperatures Not Exceeding, °F	Maximum Allowable Stress Values, ksi [Note (1)]
100	21.3
200	20.6
300	19.4
400	19.2
500	19.2

NOTE:  
(1) For welded pipe and tube, the allowable stress values have been decreased by a factor of 0.85.

**Table 3M**  
**Maximum Allowable Stress Values for**  
**Welded SA-789 Tube (100 ksi T.S./70 ksi Y.S.)**

For Metal Temperatures Not Exceeding, °C	Maximum Allowable Stress Values, MPa [Note (1)]
40	146
65	146
100	141
125	136
150	134
175	133
200	132
225	132
250	132
275	132 [Note (2)]

## NOTES:

- (1) For welded pipe and tube, the allowable stress values have been decreased by a factor of 0.85.  
 (2) The maximum use temperature shall be 260°C. The value at 275°C is provided for interpolation purposes.

**Table 4M**  
**Maximum Allowable Stress Values for**  
**Welded SA-790 Pipe (90 ksi T.S./65 ksi Y.S.)**

For Metal Temperatures Not Exceeding, °C	Maximum Allowable Stress Values, MPa [Note (1)]
40	132
65	132
100	127
125	123
150	120
175	120
200	119
225	119
250	119
275	119 [Note (2)]

## NOTES:

- (1) For welded pipe and tube, the allowable stress values have been decreased by a factor of 0.85.  
 (2) The maximum use temperature shall be 260°C. The value at 275°C is provided for interpolation purposes.

**Table 4**  
**Maximum Allowable Stress Values for**  
**Welded SA-790 Pipe (90 ksi T.S./65 ksi Y.S.)**

For Metal Temperatures Not Exceeding, °F	Maximum Allowable Stress Values, ksi [Note (1)]
100	19.1
200	19.1
300	18.6
400	17.4
500	17.3

## NOTE:

- (1) For welded pipe and tube, the allowable stress values have been decreased by a factor of 0.85.

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Approval Date: March 10, 2010

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2645**  
**Use of Carbon and Low Alloy Steel Plate, AS 1548-2008**  
**Grades PT430N/PT430NR, PT460N/PT460NR, and**  
**PT490N/PT490NR**  
**Section I; Section VIII, Division 1**

*Inquiry:* May the carbon and low alloy steel grades PT430N/PT430NR, PT460N/PT460NR, and PT490N/PT490NR, conforming to the Australian Standard AS 1548-2008<sup>1</sup> be used for the manufacture of power boilers to Section I and pressure vessels to Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that the grades of AS 1548-2008 described in the Inquiry may be used in Section I and Section VIII, Division 1 construction, provided the following requirements are met:

(a) The maximum allowable stress values shall be as given in Tables 1 and 1M. The maximum design temperature is 1000°F (538°C).

(b) When normalized rolled (NR) plates are supplied, the finishing temperature of the plates, after final rolling, shall be above the upper transformation temperature (Ac<sub>3</sub>) of the material.

(c) Grades PT430 and PT460 shall be considered as P-No. 1, Group 1; Grade PT490 shall be considered as P-No. 1, Group 2.

(d) For the purpose of impact test requirements for Section VIII, Division 1 use, PT430NR and PT460NR shall be considered Curve B; PT430N and PT460N shall be considered Curve D; PT490N and PT490NR shall be considered Curve A per UCS-66.

(e) For external pressure applications, use Chart No. CS-2 of Section II, Part D.

(f) This Case number shall be referenced in the documentation and marking of the material, and recorded on the Manufacturer's Data Report.

<sup>1</sup> See Section II, Part A, Nonmandatory Appendix A for ordering information to obtain a copy of AS 1548-2008.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values, ksi**

For Metal Temperatures Not Exceeding, °F	Maximum Allowable Stress Values, ksi		
	PT430N, PT430NR	PT460N, PT460NR	PT490N, PT490NR
-20 to 100	17.9	19.0	20.3
150	17.9	19.0	20.3
200	17.9	19.0	20.3
250	17.9	19.0	20.3
300	17.9	19.0	20.3
400	17.9	19.0	20.3
500	17.9	19.0	20.3
600	17.9	19.0	20.3
650	17.9	19.0	20.3
700	16.9	16.9	18.3
750	13.9	13.9	14.8
800	11.4	11.4	12.0
850	8.7	8.7	9.3
900	5.9	5.9	6.7
950	4.0	4.0	4.0
1000	2.5	2.5	2.5

**Table 1M**  
**Maximum Allowable Stress Values, MPa**

For Metal Temperatures Not Exceeding, °C	Maximum Allowable Stress Values, MPa		
	PT430N, PT430NR	PT460N, PT460NR	PT490N, PT490NR
-30 to 40	123	131	140
65	123	131	140
100	123	131	140
125	123	131	140
150	123	131	140
200	123	131	140
250	123	131	140
300	123	131	140
325	123	131	140
350	123	129	139
375	114	114	123
400	95.0	95.1	101
425	79.6	79.6	83.8
450	63.2	63.2	67.0
475	45.3	45.3	51.0
500	31.7	31.7	33.6
525	21.9	21.9	21.3
550 [Note (1)]	12.7	12.7	12.9

## NOTE:

(1) These values are provided for interpolation purposes only. The maximum use temperature is 538°C.

Approval Date: July 2, 2010

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2649**  
**Use of Capacitive Discharge Welding for Joining Non-Load-Bearing Attachments to P-No. 15E Group No. 1 Materials**  
**Section I**

*Inquiry:* Under what conditions may capacitive discharge welding be used to join non-load-bearing attachments to P-No. 15E Group No. 1 materials without requiring postweld heat treatment in accordance with PW-39?

*Reply:* It is the opinion of the Committee that capacitive discharge welding may be used to join non-load-bearing attachments to P-No. 15E Group No. 1 materials without postweld heat treatment in accordance with PW-39, provided the following requirements are met:

(a) The thickness of the non-load-bearing attachment shall not be thinner than 0.010 in. (0.25 mm).

(b) The energy input of the capacity discharge welding process shall not exceed 200 J.

(c) The maximum carbon content of the base metal is restricted to 0.15%.

(d) Prior to using the welding procedure, the Manufacturer shall verify that the heat-affected zone does not encroach upon the minimum wall thickness.

(e) This Case number shall be shown on the Manufacturer's Data Report or Manufacturer's Partial Data Report for the welded component.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: June 23, 2014

*Code Cases will remain available for use until annulled by the applicable Standards Committee.***Case 2652-1  
UNS N06696 Seamless Pipe, Tube, and Plate  
Section I; Section VIII, Division 1**

*Inquiry:* May UNS N06696 seamless pipe and tube meeting the requirements of ASTM B167-11 and UNS N06696 plate in thickness of  $\frac{3}{16}$  in. (4.76 mm) and over, and otherwise conforming to ASTM B168-11 be used for welded construction under the rules of Section I and Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that UNS N06696 seamless pipe and tube meeting the requirements of ASTM B167-11 and UNS N06696 plate in thickness of  $\frac{3}{16}$  in. (4.76 mm) and over, and otherwise conforming to ASTM B168-11 may be used for welded construction under the rules of Section I and Section VIII, Division 1, provided the following additional requirements are met:

(a) For plate, the minimum specified yield strength shall be 35 ksi (240 MPa); the minimum specified tensile strength shall be 85 ksi (586 MPa); and the minimum specified elongation in 2 in. (50 mm) shall be 30%.

(b) The material shall be solution annealed by heating to 2,100°F to 2,280°F (1 150°C to 1 250°C) followed by quenching in water or rapid cooling by other means.

(c) For Section I use, the  $y$  values [see Section I, PG-27.4, Note (6)] shall be as follows:

- (1) 1,050°F (565°C) and below: 0.4
- (2) 1,100°F (595°C): 0.5
- (3) 1,150°F (620°C) and above: 0.7

(d) For Section I use, the requirements for post-forming heat treatments after cold-working shall be the same as those for UNS N06600 in Table PG-19, except that heat treatment after cold-working shall be solution annealing according to the requirements of (b).

(e) The rules in Section VIII, Division 1, Subsection C that shall apply are those given in Part UNF for nickel alloys.

(f) For Section VIII, Division 1 use, the requirements for post-forming heat treatments after cold-working shall be the same as those for UNS N06600 in Table UNF-79, except that heat treatment after cold-working shall be solution annealing according to the requirements of (b).

(g) The maximum allowable stress values for the material shall be those given in Tables 1 and 1M. For Section I, the maximum design temperature shall be 1,562°F (850°C). For Section VIII, Division 1, the maximum design temperature shall be 1,832°F (1 000°C).

(h) Separate welding procedure and performance qualifications conducted in accordance with Section IX shall be required for this material.

(i) Heat treatment after welding is neither required nor prohibited, but if it is performed it shall be solution annealing, according to the requirements of (b).

(j) For external pressure design, Fig. NFN-9 of Section II, Part D shall apply for temperatures not exceeding 1,650°F (900°C). The external pressure charts do not account for reduction of buckling strength due to creep under long-term loads. The effect of creep on buckling shall be considered at temperatures above 930°F (500°C).

(k) This Case number shall be referenced in the documentation and marking of the material and shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi [Note (1)]
-20 to 100	23.3, 23.3
200	20.5, 23.3 [Note (2)]
300	18.6, 23.3 [Note (2)]
400	17.3, 23.3 [Note (2)]
500	16.3, 22.1 [Note (2)]
600	15.9, 21.5 [Note (2)]
650	15.8, 21.3 [Note (2)]
700	15.8, 21.3 [Note (2)]
750	15.8, 21.3 [Note (2)]
800	15.8, 21.3 [Note (2)]
850	15.8, 21.3 [Note (2)]
900	15.8, 21.3 [Note (2)]
950	15.8, 17.9 [Note (2)]
1,000	14.1, 14.1
1,050	11.0, 11.0
1,100	8.6, 8.6
1,150	6.7, 6.7
1,200	5.2, 5.2
1,250	4.1, 4.1
1,300	3.2, 3.2
1,350	2.4, 2.4
1,400	1.8, 1.8
1,450	1.4, 1.4
1,500	1.1, 1.1
1,550	0.76, 0.76
1,600 [Note (3)]	0.59, 0.59
1,650	0.47, 0.47
1,700	0.37, 0.37
1,750	0.29, 0.29
1,800	0.23, 0.23
1,850 [Note (4)]	0.19, 0.19

## NOTES:

- (1) Values shown in italics are obtained from time-dependent properties.
- (2) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of this alloy where slightly greater deformation is acceptable. The stress values in this range exceed 66<sup>2</sup>/<sub>3</sub>%, but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.
- (3) For Section I, this value is provided for interpolation only. The maximum design temperature for Section I is 1,562°F as shown in (g).
- (4) For Section VIII, Division 1, this value is provided for interpolation only. The maximum design temperature for Section VIII, Division 1 is 1,832°F as shown in (g).

**Table 1M**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Values, MPa [Note (1)]
-30 to 40	161, 161
65	148, 161 [Note (2)]
100	139, 161 [Note (2)]
125	134, 161 [Note (2)]
150	128, 161 [Note (2)]
175	124, 161 [Note (2)]
200	120, 160 [Note (2)]
225	116, 157 [Note (2)]
250	114, 153 [Note (2)]
275	112, 151 [Note (2)]
300	110, 149 [Note (2)]
325	109, 148 [Note (2)]
350	109, 147 [Note (2)]
375	109, 147 [Note (2)]
400	109, 147 [Note (2)]
425	109, 147 [Note (2)]
450	109, 147 [Note (2)]
475	109, 147 [Note (2)]
500	109, 135 [Note (2)]
525	109, 109
550	87.0, 87.0
575	69.6, 69.6
600	55.6, 55.6
625	44.5, 44.5
650	35.5, 35.5
675	28.4, 28.4
700	22.8, 22.8
725	17.3, 17.3
750	13.9, 13.9
775	11.2, 11.2
800	8.97, 8.97
825	6.12, 6.12
850	4.92, 4.92 [Note (3)]
875	3.96, 3.96
900	3.20, 3.20
925	2.59, 2.59
950	2.10, 2.10
975	1.71, 1.71
1 000	1.39, 1.39 [Note (4)]

## NOTES:

- (1) Values shown in italics are obtained from time-dependent properties.
- (2) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of this alloy where slightly greater deformation is acceptable. The stress values in this range exceed 66<sup>2</sup>/<sub>3</sub>%, but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.
- (3) For Section I, the maximum design temperature is 850°C.
- (4) For Section VIII, Division 1, the maximum design temperature is 1000°C.

Approval Date: March 5, 2018

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2653-1**  
**F-Number Grouping for 63Ni-22Mo-15Cr Alloy (UNS N10362) Filler Metal**  
**Section VIII, Division 1; Section VIII, Division 2; Section VIII, Division 3; Section IX**

*Inquiry:* What alternate rules may be applied to grouping UNS N10362 62Ni-22Mo-15Cr welding filler metal meeting the chemical requirements of [Table 1](#) but otherwise conforming to SFA-5.14 to reduce the number of welding procedures and performance qualifications?

*Reply:* It is the opinion of the Committee that UNS N10362 62Ni-22Mo-15Cr welding filler metal meeting the chemical requirements of [Table 1](#) but otherwise conforming to SFA-5.14 may be considered as F-No. 43 for both procedure and performance qualification purposes. Further, this material shall be identified as UNS N10362 in the welding procedure specification, procedure qualification record, and performance qualification records.

This Case number shall be shown on the Manufacturer's Data Report.

**Table 1**  
**Chemical Requirements (UNS N10362)**

Element	Weight, %
Mo	21.5–23.0
Cr	13.8–15.6
Fe	1.25 max.
C	0.010 max.
Si	0.08 max.
Mn	0.60 max.
P	0.025 max.
S	0.010 max.
Ni	Remainder
Al	0.50 max.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: September 8, 2010

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**Case 2655**  
**Elevated Temperature Design of Bolting**  
**Section VIII, Division 2**

*Inquiry:* Under what rules may Section VIII, Division 2 (2007 edition and later) bolting be used for temperatures exceeding the limiting temperatures in Section II, Part D, Table 3 for Division 2?

*Reply:* It is the opinion of the Committee that pending development of complete rules for the evaluation of cyclic operation, bolting otherwise complying with the rules of Section VIII, Division 2, may be used for temperatures exceeding those in Section II, Part D, Table 3 for Division 2 under the following provisions.

(a) The allowable stress values for Division 2 may be extended to higher temperatures by using the values contained within Section II, Part D, Table 3 for Division 1.

(b) For a material approved for Division 2 application by a Case, the stress values may be extended to higher temperatures by using the values contained within Section II, Part D, Table 3 for Division 1 or of a Case applicable to Division 1.

(c) The vessel or part is exempted from a fatigue analysis by the provisions of 5.5.2.2 of Division 2, and such exemption is made a part of the User's Design Specification.

NOTE: For metal temperatures exceeding those permitted in Section II, Part D, Table 3 for Division 2 applications, when both high membrane stress and high bending stress exist in the section, some inelastic straining due to creep in excess of the limits given in Appendix 1 of Section II, Part D, and Table P-1 of Appendix P of Section VIII, Division 1 may occur.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: August 24, 2010

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2656**  
**Use of Austenitic Stainless Steel on HLW Water Heaters**  
**for Potable Water Applications**  
**Section IV**

*Inquiry:* Under what conditions may a water heater fabricated of austenitic stainless steel listed in Table HLW-301 be used for potable water applications without the restriction imposed by Note (3)?

*Reply:* It is the opinion of the Committee that water heaters fabricated of austenitic stainless steel listed in Table HLW-301 may be used for potable water applications under the following conditions:

(a) For welded applications, only the low carbon grades of SA-240 (304L and 316L plate), SA-213 (TP304L and TP316L tube), SA-249 (TP304L and TP316L tube), SA-479 (304L and 316L bar), SA-312 (TP304L and TP316L pipe), and SA-182 (F304L and F316L forgings) shall be used.

(b) In the design and fabrication processes, residual tensile stresses resulting from cold-forming operations, welding processes, and surface finishing operations, such as grinding, shall be minimized.

(c) In the design of the water heater, stagnant fluid regions and crevices shall be avoided.

(d) Weld joints using backing rings or backing bars that are left in place are prohibited.

(e) In order to comply with paras. (b) and (c), the Designer shall refer to Section II, Part D, Appendix A, A-300, including applicable publications listed in A-330 for detailed guidance and recommendations.

(f) The Manufacturer shall clearly identify any product environmental limitations or application restrictions by way of product labeling and literature.

(g) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: July 28, 2010

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2657**  
**Tubes Attached by Welding**  
**Section IV**

*Inquiry:* Under what conditions may tubes exposed to primary furnace gases and attached to a tubesheet, which has tube holes that are not beveled or recessed, using laser beam welding (LBW), extend through the tubesheet less than as required by Table HW-713?

*Reply:* It is the opinion of the Committee that tubes exposed to primary furnace gases and attached to a tubesheet, which has tube holes that are not beveled or

recessed, using laser beam welding (LBW), may extend through the tubesheet less than as required by Table HW-713, provided the following requirements are met:

(a) The tube shall extend at least through the tubesheet.

(b) The tubes shall be attached by welds that fully penetrate the tubesheet.

(c) Welding procedure and performance qualification shall be conducted in accordance with Section IX.

(d) All other requirements of Section IV shall be met.

(e) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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**Case 2658**  
**Alternative Rules for Appendix 24 When Controlled**  
**Bolting Is Used**  
**Section VIII, Division 1**

*Inquiry:* In Appendix 24, when controlled bolting (e.g., torque control or bolt tensioning) is specified for the clamp connection design bolt load,  $W$ , for the assembly condition, and for the design of bolt retainers and bolt redundancy, may alternative rules be used?

*Reply:* It is the opinion of the Committee that when controlled bolting is specified, the following alternative rules to those in Appendix 24 for the clamp connection design bolt load,  $W$ , for the assembly condition, and for the design of bolt retainers and bolt redundancy are acceptable.

(a) *In place of the rules in para. 24-1(f) the design of bolt retainers and bolt redundancy shall be as follows:*

Clamps designed to the rules of this Appendix shall be provided with a bolt retainer. The retainer shall be designed to hold the clamps together independently in the operating condition in case of failure of the primary bolting. Clamp hub friction shall not be considered as a retainer method. Multiple bolting (two or more bolts per lug)

is an acceptable alternative for meeting this requirement. See UG-35.2(b)(2) for additional guidance regarding redundancy of bolt retainers and redundant bolting.

(b) In addition to the rules in Appendix 24, consideration shall be given to loads other than pressure, such as piping loads that may act upon the clamp connection (see UG-22).

(c) *Add the following below 24-4, eq. (5):*

Alternatively, if controlled bolting (e.g., torque-control or bolt tensioning) techniques are used to assemble the clamp, the assembly design bolt load shall be taken as

$$W = 2A_{mL}S_a$$

(d) When controlled bolting techniques (e.g., torque control or bolt tensioning) are used to assemble the clamp, the Manufacturer shall provide to the user a copy of the controlled bolting instructions that were used. It is recommended that the Manufacturer refer to ASME PCC-1, Guidelines for Pressure Boundary Bolted Flange Joint Assembly. Furthermore, it is cautioned that bolt loads in excess of those using  $W = 2A_{mL}S_a$  can overstress the clamp.

(e) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: September 8, 2010

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**Case 2659**  
**Alternative Rules for Para. 4.17 When Controlled**  
**Bolting Is Used**  
**Section VIII, Division 2**

*Inquiry:* In para. 4.17, when controlled bolting (e.g., torque control or bolt tensioning) is specified for the clamp connection design bolt load,  $W_o$ , for the assembly condition, and for the design of bolt retainers and bolt redundancy, may alternative rules be used?

*Reply:* It is the opinion of the Committee that under the conditions described in the Inquiry, the following clarifications and changes to the rules are acceptable.

(a) Add to para. 4.17.1 the following sentence:

Consideration shall be given to loads other than pressure, such as piping loads that may act upon the clamp connection (see 2.2.2.1).

(b) In place of 4.17.2.6, the following shall be used:

The design method used in this paragraph to calculate stresses, loads, and moments may also be used for designing clamp connections of shapes differing from those shown in Figs. 4.17.1 and 4.17.2, and for clamps consisting of more than two circumferential segments. The design equations in this paragraph may be modified when designing clamp connections of shapes differing from those in Figs. 4.17.1 and 4.17.2, provided that the basis for the modifications is in accordance with 1.1.1.2. The clamp connections designed in this manner shall be provided with a bolt retainer. The retainer shall be designed such that, in case of failure of the primary bolting, the retainer shall hold the clamps together independently for the operating condition. Multiple bolting (two or more bolts per lug) is an acceptable alternative for meeting the redundancy requirement. See 4.8.3.2 for additional requirements for bolt retainers and redundant bolting. No credit shall be taken for clamp hub friction toward satisfying this redundancy requirement.

(c) The following equation shall be used in lieu of eq. (4.17.9):

$$W_g = (A_m + A_b)S_{bg}$$

(d) After the equation for  $W_g$ , insert the following:

Alternatively, if controlled bolting (e.g., torque-control or bolt tensioning) techniques are used to assemble the clamp, the assembly design bolt load may be taken as  $W_g = 2 \times A_m \times S_{bg}$ .

In addition, the Manufacturer shall provide to the user a copy of the bolting instructions that were used. It is recommended that the Manufacturer refer to ASME PCC-1, Guidelines for Pressure Boundary Bolted Flange Joint Assembly. It is cautioned that bolt loads in excess of those calculated using  $W_g = 2 \times A_m \times S_{bg}$  can overstress the clamp.

(e) In 4.17.6, the definitions of  $A_b$  and  $A_m$  shall be as follows:

$A_b$  = total cross-sectional area of the bolts per clamp lug based on the root diameter or the least diameter of the unthreaded portion, if less

$A_m$  = total cross-sectional area of the bolts per clamp lug

The definitions of  $W_g$ ,  $W_{g1}$ ,  $W_{g2}$ , and  $W_o$  shall be as follows:

$W_g$  = total clamp connection design bolt load on both lugs for the gasket seating and assembly condition

$W_{g1}$  = total clamp connection design bolt load on both lugs for the gasket seating condition

$W_{g2}$  = total clamp connection design bolt load on both lugs for the assembly condition

$W_o$  = total clamp connection design bolt load on both lugs for the design condition

(f) This Case number shall be shown on the Manufacturer's Data Report.

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Approval Date: September 8, 2010

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2660**  
**F-Number Grouping for 57Ni-30Cr-9Fe-1.8Nb Filler**  
**Metal (UNS N06043)**  
**Section IX**

*Inquiry:* What alternate rules may be applied to grouping 57Ni-30Cr-9Fe-1.8 Nb (UNS N06043) welding filler metals meeting the chemical requirements of [Table 1](#), but otherwise conforming to SFA-5.14 to reduce the number of required welding procedures and performance qualifications?

*Reply:* It is the opinion of the Committee that 57Ni-30Cr-9Fe-1.8Nb (UNS N06043) welding filler metals meeting the chemical requirements of [Table 1](#), but otherwise conforming to SFA-5.14 may be considered as F-No. 43 for both procedure and performance qualification purposes, with these materials being identified as 57Ni-30Cr-9Fe-1.8Nb (UNS N06043) in the welding procedure specification, procedure qualification record, and performance qualification records. This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Chemical Requirements**

Element	Composition, %
C	0.04 max.
Mn	3.0 max.
Fe	7.0–12.0
P	0.020 max.
S	0.015 max.
Si	0.50 max.
Cu	0.30 max.
Ni	Remainder
Co	...
Al	0.50 max.
Ti	0.50 max.
Cr	28.0–31.5
Nb(Cb) Plus Ta	1.0 to 2.5 [Note (1)]
Mo	0.50 max.
V	...
W	...
Other Elements Total	0.50 max.

## NOTE:

(1) Nb(Cb) range is 1.0–2.5. Ta is 0.10 maximum.

**Approval Date: January 10, 2013**

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2661-1**  
**Use of SA-723/SA-723M Forgings, SA-705/SA-705M**  
**Forgings, and SA-564/SA-564M Bar for Bolting**  
**Material and Nuts**  
**Section VIII, Division 3**

*Inquiry:* May the materials listed below be used for fabrication of bolting material, including nuts, for Section VIII, Division 3 construction?

- (a) SA-723/SA-723M forgings, Grades 1, 2 and 3; Classes 1 and 2
- (b) SA-564/SA-564M bar, Type XM-13, Conditions H1150 and H1150M; Types XM-12 and 630, Conditions H1100 and H1150; Type XM-25, Conditions H1100 and H1150
- (c) SA-705/SA-705M forgings, Type XM-13, Conditions H1150 and H1150M; Types XM-12 and 630, Conditions H1100, H1150, and H1150M; Type XM-25, Conditions H1100 and H1150

*Reply:* It is the opinion of the Committee that the materials described in the Inquiry may be used for fabrication of bolting material, including nuts, for Section VIII, Division 3 construction, provided the following additional requirements are met:

(a) SA-723/SA-723M materials shall have a maximum measured yield strength not in excess of 25 ksi (170 MPa) above the specified minimum.

(b) Impact testing shall be in accordance with the requirements of KM-212.1 and KM-230, except that impact tests are also required for material to be used for the fabrication of nuts.

(c) The limits on stress intensity shall be in accordance with KD-621, except that the yield strength values,  $S_y$ , shall be obtained from Section II, Part D, Table Y-1 for the specified grade and class or condition of material that will be used for the bolting or nuts.

(d) All requirements in Tables KM-400-1, KM-400-1M, KM-400-2, and KM-400-2M for the material to be used for bolting, including the maximum design temperature and cautionary notes, shall apply.

(e) All heat treatment shall be conducted prior to cutting or rolling the threads.

(f) This Case number shall be shown on the certification of the material and on the Manufacturer's Data Report.

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Approval Date: December 7, 2010

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2663**

**Use of ASTM A106/A106M-08 as SA-106/SA-106M  
Section I; Section IV; Section VIII, Division 1; Section VIII,  
Division 2; Section VIII, Division 3; Section XII**

*Inquiry:* May ASTM A106/A106M-08 be used in Sections I; IV; VIII, Divisions 1, 2, and 3; and XII welded construction in lieu of SA-106/SA-106M?

*Reply:* It is the opinion of the Committee that ASTM A106/A106M-08 may be used in Sections I; IV; VIII, Divisions 1, 2, and 3; and XII welded construction in lieu of SA-106/SA-106M, provided the following additional requirements are met:

(a) The rules of the applicable construction code, division, and part for SA-106/SA-106M shall apply.

(b) The allowable stresses, external pressure chart, physical properties, P-Number, and Group number for SA-106/SA-106M applicable for the section, division, and part of the selected construction code, found in Section II, Part D shall apply.

(c) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: July 13, 2011

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**Case 2665-1**  
**57Ni-22Cr-14W-2Mo-La Alloy (UNS N06230)**  
**Section I**

*Inquiry:* May UNS N06230 wrought plate, sheet, and strip; forgings; welded pipe and tube; seamless pipe and tube, and wrought fittings be used in molten nitrate salt wetted Section I construction?

*Reply:* It is the opinion of the Committee that solution annealed alloy UNS N06230 wrought plate, sheet, and strip; forgings; welded pipe and tube; seamless pipe and

tube; and wrought fittings as listed in Table 1, but otherwise conforming to the rules of Section I may be used in molten nitrate salt wetted service, provided the following additional requirements are met:

(a) The maximum allowable stress values for the material that shall be used are those found in Section II, Part D, Table 1B for both U.S. Customary and SI Units.

(b) The maximum design temperature is 1,300°F (704°C).

(c) This Case number shall be recorded on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Product Specifications**

Forgings	SB-564
Plate, sheet, and strip	SB-435
Seamless pipe and tube	SB-622
Welded pipe	SB-619
Welded tube	SB-626
Wrought fittings	SB-366

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Approval Date: January 12, 2011

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2666**  
**Exemption From Postweld Heat Treatment for SA-268**  
**TP439 P-No. 7 Tube to SA-790 Alloy UNS S31803 P-No.**  
**10H Header Welds**  
**Section I**

*Inquiry:* Under what conditions may SA-268 TP439 P-No. 7 tube to SA-790 alloy UNS S31803 header welds be exempt from postweld heat treatment requirements of PW-39?

*Reply:* It is the opinion of the Committee that SA-268 TP439 P-No. 7 tube to SA-790 alloy UNS S31803 header welds may be exempted from postweld heat treatment requirements of PW-39 under the following conditions:

(a) The SA-268 TP439 tubes shall be limited in carbon content to 0.010% maximum.

(b) The SA-268 TP439 tubes shall be no larger than 1.500 in. (38.1 mm) outside diameter nor have a nominal wall thickness greater than 0.125 in. (3.2 mm).

(c) The header shall be SA-790 alloy UNS S31803 and shall be no larger than NPS 3½ (DN 90) nor have a nominal thickness greater than 0.318 in. (8.1 mm).

(d) The weld used to join the tube to the header shall be a combination groove and fillet weld with the combined nominal thickness not greater than 0.500 in. (13 mm) made using the GTAW process with SFA-5.9 ER2209 filler metal, with multiple stringer passes, and not exceeding 350°F (177°C) interpass temperature.

(e) The design pressure shall not exceed 100 psig (700 kPa), and the design temperature shall not exceed 400°F (204°C).

(f) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: January 31, 2017

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2668-1**  
**Use of SA-268 Grades UNS S43932 and UNS S43940**  
**Conforming to SA-268 in the Manufacture of Heating**  
**Boilers**  
**Section IV**

*Inquiry:* May SA-268 Grades UNS S43932 and UNS S43940 in the form of seamless and welded ferritic stainless steel tubing for general service, be used in the construction of Section IV hot water heating boilers?

*Reply:* It is the opinion of the Committee that SA-268 Grades UNS S43932 and UNS S43940 in the form of seamless and welded ferritic stainless steel tubing for general service may be used in the construction of heating boilers, under the following conditions:

(a) The maximum water temperature shall be 210°F (99°C).

(b) The maximum metal temperature shall be 300°F (150°C).

(c) The maximum allowable stresses are those given in Tables 1 and 1M, Tables 2 and 2M for Grade UNS S43932, and Tables 3, 3M, 4, and 4M for Grade UNS S43940.

(d) All other applicable parts of Section IV shall apply.

(e) For UNS S43932 and UNS S43940, use of P-No. 7 materials shall apply.

(f) This Case number shall be shown on the Manufacturer's Data Report.

Table 1 Maximum Allowable Stress for Grade UNS S43932, Seamless SA-268 Tube, Plate, and Strip	
For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi
Less than 100	12.0
150	11.8
200	11.4
250	11.3
300	11.2

Table 1M Maximum Allowable Stress for Grade UNS S43932, Seamless SA-268 Tube, Plate, and Strip	
For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Values, MPa
Less than 40	85.5
65	84.5
100	83.2
125	81.6
150	79.0

Table 2 Maximum Allowable Stress Values for Grade UNS S43932, SA-268 Welded Tube and Pipe	
For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi
Less than 100	10.2
150	10.0
200	9.7
250	9.6
300	9.5

Table 2M Maximum Allowable Stress Values for Grade UNS S43932, SA-268 Welded Tube and Pipe	
For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Values, MPa
Less than 40	72.6
65	71.8
100	70.7
125	69.3
150	67.1

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**Table 3**  
**Maximum Allowable Stress Values for**  
**Grade UNS S43940, SA-268 Seamless Tube,**  
**Plate, and Strip**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi
Less than 100	10.5
150	10.4
200	10.2
250	10.1
300	9.7

**Table 4**  
**Maximum Allowable Stress Values for**  
**Grade UNS S43940, SA-268 Welded Tube**  
**and Pipe**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi
Less than 100	10.2
150	10.0
200	9.7
250	9.6
300	9.5

**Table 3M**  
**Maximum Allowable Stress Values for**  
**Grade UNS S43940, SA-268 Seamless Tube,**  
**Plate, and Strip**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Values, MPa
Less than 40	82.7
65	81.3
100	78.6
125	77.8
150	77.2

**Table 4M**  
**Maximum Allowable Stress Values for**  
**Grade UNS S43940, SA-268 Welded Tube**  
**and Pipe**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Values, MPa
Less than 40	70.3
65	69.1
100	66.7
125	66.1
150	65.6

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(19)

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**Case 2671-2**  
**57Ni-22Cr-14W-2Mo-La Alloy (UNS N06230), Subpart 3,**  
**Fig. NFN-24 Up to 1,800°F (982°C)**  
**Section I; Section II, Part D; Section VIII, Division 1**

*Inquiry:* May solution annealed 57Ni-22Cr-14W-2Mo-La alloy (UNS N06230) wrought sheet, plate, strip, rod, welded pipe and tube, wrought fittings, seamless pipe and tube, and forgings conforming to the specifications listed in Section II, Part D, Subpart 1, Table 1B be used under external pressure represented in Fig. NFN-24 and as modified by this Case to 1,800°F (982°C) and conform to the rules of Section II, Part D, Subpart 1, Table 1B?

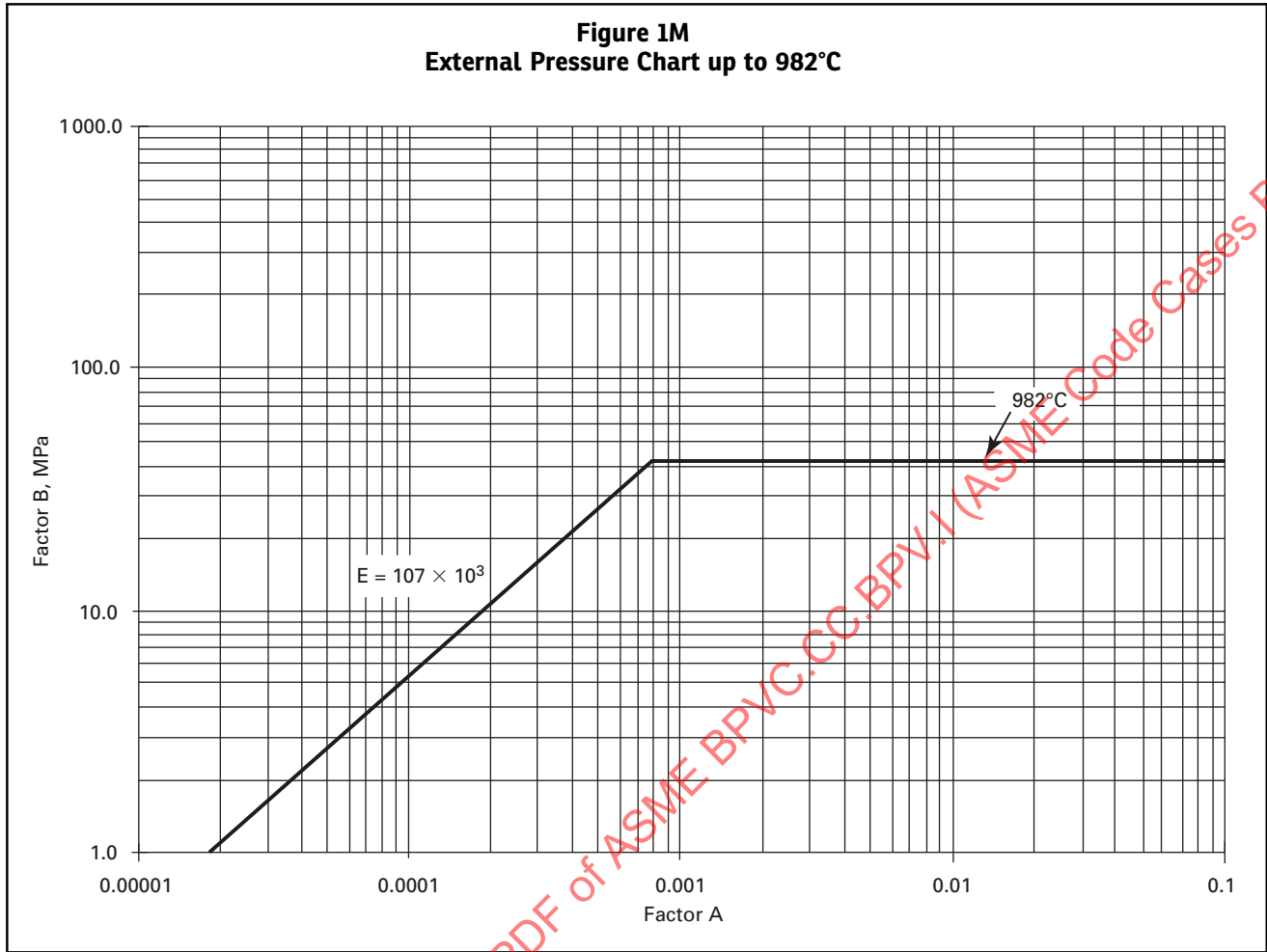
*Reply:* It is the opinion of the Committee that solution annealed 57Ni-22Cr-14W-2Mo-La alloy (UNS N06230) wrought sheet, plate, strip, rod, welded pipe and tube, wrought fittings, seamless pipe and tube, and forgings as described in the *Inquiry* may be used under external pressure in Fig. NFN-24 up to 1,800°F (982°F) curves (see Note) shown in [Figures 1](#) and [1M](#) and [Tables 1](#) and [1M](#) and conforming to the rules of assigned construction codes listed in Section II, Part D, Subpart 1, Table 1B.

This Case number shall be shown on the Manufacturer's Data Report.

NOTE: The external pressure charts do not account for reduction of buckling strength due to creep under long-term loads. The effect of creep under on buckling shall be considered at temperatures for which allowable stresses are shown italicized in Tables 1A, 2A, 2B, 5A, and 5B of Section II, Part D, Subpart 1.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.





**Table 1**  
**Tabular Values for Figure 1**

Temperature, °F	A	B, psi
1,800	1.00E-05	78
	1.29E-04	1,000
	7.87E-04	6,100
	1.00E-01	6,100

**Table 1M**  
**Tabular Values for Figure 1M**

Temperature, °C	A	B, MPa
982	1.00E-05	0.5
	1.87E-05	1
	1.29E-04	6.9
	7.87E-04	42.1
	1.00E-01	42.1

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Approval Date: June 16, 2011

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2672**  
**37Ni-33Fe-25Cr Alloy (UNS N08120) Welded**  
**Construction Above 1650°F to 1800°F**  
**Section VIII, Division 1**

*Inquiry:* May solution annealed 37Ni-33Fe-25Cr alloy (UNS N08120) wrought sheet, plate, strip, rod, welded pipe and tube, wrought and welded fittings, seamless pipe and tube, and forgings conforming to the requirements in the specifications listed in [Table 1](#) be used for Section VIII, Division 1 welded construction above 1650°F (899°C) up to and including 1800°F (982°C)?

*Reply:* It is the opinion of the Committee that solution annealed 37Ni-33Fe-25Cr alloy (UNS N08120) wrought sheet, plate, strip, rod, welded pipe and tube, wrought and welded fittings, seamless pipe and tube, and forgings as described in the *Inquiry* may be used in welded construction above 1650°F (899°C) up to and including 1800°F (982°C) complying with the rules of Section VIII, Division 1, provided the following additional requirements are met:

(a) The maximum allowable stress values shall be those given in [Tables 2](#) and [2M](#). For pipe, tube, and fitting products welded without filler, a joint efficiency factor of 0.85 shall be used.

(b) Welding procedure and performance qualifications shall be conducted in accordance with Section IX. Filler metals shall be limited to the following materials for welding to itself: UNS R30556, N06002, W86002, N06617, W86117, and N06231.

(c) Heat treatment after forming or fabrication is neither required nor prohibited except as required in (e).

(d) The rules in Subsection C that shall apply are those given in Part UNF for nickel alloys.

(e) The requirements for post-forming heat treatment after cold-working shall be the same as those for UNS N08800 in [Table UNF-79](#), except that heat treatment after cold-working shall be solution annealing at a minimum temperature of 2150°F (1177°C).

(f) The physical properties for UNS N08120 are given in [Table 3](#) and [Table 3M](#) for density, thermal diffusivity, thermal conductivity, dynamic modulus of elasticity, mean coefficient of thermal expansion, and Poisson's ratio.

(g) This Case number shall be recorded on the Manufacturer's Data Report.

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**Table 1  
Product Specifications**

Product	Specification
Fittings	SB-366
Forgings	SB-564
Plate, sheet, and strip	SB-409
Rod, bar	SB-408
Seamless pipe and tube	SB-407
Welded pipe	SB-514
Welded tube	SB-515

**Table 2  
Maximum Allowable Stress Values**

For Metal Temperatures Not Exceeding, °F	Maximum Allowable Stress Values, ksi [Note (1)]
1700	0.96
1750	0.72
1800	0.54

NOTE:

(1) Values are obtained from time-dependent properties.

**Table 2M  
Maximum Allowable Stress Values**

For Metal Temperatures Not Exceeding, °C	Maximum Allowable Stress Values, MPa [Note (1)]
925	6.75
950	5.21
975	3.99
1000	3.04 [Note (2)]

NOTES:

(1) Values are obtained from time-dependent properties.

(2) The maximum use temperature for this grade is 982°C, and the value listed at 1000°C is provided for interpolation purposes only.

**Table 3**  
**Physical Properties**

Temperature, °F	Density, lb/in. <sup>3</sup>	Thermal Diffusivity, ft <sup>2</sup> /hr	Thermal Conductivity, Btu/hr-ft-°F	Dynamic Modulus of Elasticity, ×10 <sup>6</sup> psi	Mean Coefficient of Thermal Expansion 78°F to Temp., ×10 <sup>-6</sup> in./in./°F
Room	0.291	0.118	6.5	28.6	...
200	...	0.125	7.0	28.2	8.0
400	...	0.135	8.0	27.2	8.3
600	...	0.145	9.0	26.3	8.6
800	...	0.158	10.1	24.9	8.8
1000	...	0.168	11.2	23.6	9.0
1200	...	0.178	12.5	22.5	9.3
1400	...	0.185	14.0	21.3	9.5
1600	...	0.188	15.0	20.0	9.7
1800	...	0.195	15.9	18.8	9.9
2000	...	0.205	17.1	...	...
2200	...	0.215	18.0	...	...

GENERAL NOTE: Poisson's Ratio = 0.31

**Table 3M**  
**Physical Properties**

Temperature, °C	Density, kg/m <sup>3</sup>	Thermal Diffusivity, ×10 <sup>-6</sup> m <sup>2</sup> /sec	Thermal Conductivity, W/(m-°C)	Dynamic Modulus of Elasticity, ×10 <sup>3</sup> MPa	Mean Coefficient of Thermal Expansion 25°C to Temp., ×10 <sup>-6</sup> mm/mm/°C
Room	8070	3.04	11.4	197	...
100	...	3.24	12.7	194	14.3
200	...	3.48	14.1	188	14.9
300	...	3.72	15.4	182	15.3
400	...	3.97	17.1	174	15.8
500	...	4.22	18.7	165	16.1
600	...	4.47	21.0	159	16.4
700	...	4.69	23.3	152	16.9
800	...	4.81	24.9	143	17.3
900	...	4.88	26.2	136	17.6
1000	...	5.07	28.0	128	17.8
1100	...	5.29	29.6	...	...
1200	...	5.55	...	...	...

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Approval Date: June 16, 2011

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2673**  
**Tolerance for External Pressure Design Conditions**  
**Section VIII, Division 2**

*Inquiry:* Under what conditions may the requirements for measurement of out-of-roundness in para. 4.4.4 be waived?

*Reply:* It is the opinion of the Committee that the requirements for measurement of out-of-roundness in para. 4.4.4 may be waived, provided the following conditions are met.

(a) For cylindrical shell,  $t/r$  shall be greater than 0.02, and for spherical shell and hemispherical head,  $t/r$  shall be greater than 0.01,

where

$r$  = outer radius

$t$  = nominal thickness of cylindrical shell, spherical shell, and hemispherical head

(b) The maximum allowable external pressure calculated in accordance with paras. 4.4.5 and 4.4.7, respectively, shall be more than five times the required design external pressure.

(c) The external pressure to be stamped on the name plate shall be no greater than 20% of the calculated maximum allowable external pressure.

(d) If the cylindrical shell, spherical shell, and hemispherical head are subjected to uniform axial compression and axial compression due to bending moment, the allowable stress calculated in accordance with para. 4.4.12 shall be more than five times the stress due to combined loading.

(e) This Case number shall be shown on the Manufacturer's Data Report.

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Approval Date: September 30, 2018

(19)

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2674-1**  
**Use of SA/EN 10028-2, Grade 13CrMoSi5-5+QT Steels**  
**for Class 2**  
**Section VIII, Division 2**

*Inquiry:* Is it permissible to use steel plates manufactured in accordance with SA/EN 10028-2 Grade 13CrMoSi5-5+QT in the construction of pressure vessels under the rules of Section VIII, Division 2, Class 2?

*Reply:* It is the opinion of the Committee that that steel plates manufactured in accordance with SA/EN 10028-2 Grade 13CrMoSi5-5+QT may be used in Section VIII, Division 2, Class 2 construction, provided the additional requirements are met:

(a) The design temperature shall not exceed 1058°F (570°C).

(b) This material shall conform to SA-20/SA-20M, Table 1 whenever Table 1 is more restrictive.

(c) The maximum allowable stress values shall be as given in [Tables 1](#) and [1M](#).

(d) The material shall be considered as P-No. 4, Group No. 1.

(e) For external pressure design, use Fig. CS-3 of Section II, Part D.

(f) For physical properties in Section II, Part D, this material shall be considered as 1¼Cr-½Mo-Si alloy.

(g) This Case number shall be shown on the Manufacturer's Data Report.

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**Table 1**  
**Maximum Allowable Stress Values**

For Metal Temperatures Not Exceeding, °F	Maximum Allowable Stress Values, ksi [Note (1)] for Thickness range, in.		
	Up to 2.25 incl.	2.25 to 4 incl.	4 to 10 incl.
100	30.8	30.2	29.6
150	30.8	30.2	29.6
200	30.8	30.2	29.6
250	30.8	30.2	29.6
300	30.8	30.2	29.6
350	30.8	30.2	29.6
400	30.8	30.2	29.6
450	30.8	30.2	29.6
500	30.8	30.2	29.6
550	30.8	30.2	29.6
600	30.8	30.2	29.6
650	30.8	30.2	29.6
700	30.8	30.2	29.4
750	30.3	29.5	28.7
800	29.5	28.8	28.0
850	20.2	20.2	20.2
900	13.7	13.7	13.7
950	9.3	9.3	9.3
1,000	6.3	6.3	6.3
1,050	4.2	4.2	4.2
1,100 [Note (2)]	2.8	2.8	2.8

GENERAL NOTE: This material may be susceptible to temper embrittlement. See Section II, Part D, Appendix A, A-250.

NOTES:

- (1) Allowable stresses for temperatures of 850°F and above are values obtained from time-dependent properties.
- (2) These values are provided for interpolation purposes only. The maximum use temperature is 1,058°F.

**Table 1M**  
**Maximum Allowable Stress Values**

For Metal Temperatures Not Exceeding, °C	Maximum Allowable Stress Values, MPa [Note (1)] for Thickness range, mm		
	Up to 60 incl.	60 to 100 incl.	100 to 250 incl.
40	213	208	204
65	213	208	204
100	213	208	204
125	213	208	204
150	213	208	204
175	213	208	204
200	213	208	204
225	213	208	204
250	213	208	204
275	213	208	204
300	213	208	204
325	213	208	204
350	213	208	204
375	213	208	202
400	209	203	198
425	204	199	194
450	199	194	189
475	104	104	104
500	73.7	73.7	73.7
525	52.0	52.0	52.0
550	36.3	36.3	36.3
575 [Note (2)]	25.2	25.2	25.2

GENERAL NOTE: This material may be susceptible to temper embrittlement. See Section II, Part D, Appendix A, A-250.

NOTES:

- (1) Allowable stresses for temperatures of 475°C and above are values obtained from time-dependent properties.
- (2) These values are provided for interpolation purposes only. The maximum use temperature is 570°C.

Approval Date: April 6, 2011

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2675**  
**Use of Noncode Pressure Relief Valves**  
**Section VIII, Division 1**

*Inquiry:* When overpressure protection by system design is used per UG-140(b), under what conditions may a user utilize a pressure relief valve without a Certification Mark to provide overpressure protection for a vessel whose MAWP is less than 15 psi and stamped in accordance with Division 1?

*Reply:* It is the opinion of the Committee that when overpressure protection by system design is used per UG-140(b), a user may utilize a pressure relief valve without a Certification Mark to provide overpressure protection for a vessel whose MAWP is less than 15 psi and stamped in accordance with Division 1, provided the following conditions are met:

(a) The decision to use a pressure relief valve without a Certification Mark is the responsibility of the user. Acceptance by the jurisdiction may be required. The user shall request that the Manufacturer's Data Report state that overpressure protection is provided by system design per this Code Case number. This Case number shall also be applied to a metal tag that is attached with a wire to the pressure relief valve.

(b) The user shall evaluate the acceptability of the pressure relief valve without a Certification Mark for the application and its expected performance by comparing it to appropriate relief valve design, construction, performance, and installation requirements in UG-125(d), UG-125(f), UG-125(g), UG-126, UG-128, UG-129(a), UG-131(b) through (j), UG-134, UG-135, and UG-136. The results of the evaluation shall be incorporated into the documentation required in para. (f).

(c) The user shall conduct a detailed analysis to identify and examine all scenarios that could result in an overpressure condition and magnitude of the overpressure. The causes of overpressure as described in ANSI/API Standard 21, Pressure-Relieving and Depressuring Systems, shall be considered. Other standards or recommended practices that are more appropriate to the

specific application may also be considered. A multidisciplinary team experienced in methods such as hazards and operability analysis (HazOp); failure modes, effects, and criticality analysis (FMECA); "what-if" analysis; or other equivalent methodology shall conduct the analysis.

(d) The overpressure scenario shall be readily apparent so that operators or protective instrumentation will take corrective action to prevent operation above the MAWP at the coincident temperature.

(e) The combination of the pressure relief valve's set pressure, set pressure tolerance, and required overpressure shall not exceed 116% of the MAWP times the ratio of the allowable stress value at the temperature of the overpressure scenario to the allowable stress value at the design temperature. The overpressure limit shall not exceed the test pressure. Credible events or scenario analysis as described in WRC Bulletin 498, "Guidance on the Application of Code Case 2211 — Overpressure Protection by Systems Design" shall be considered.

(f) The results of the analysis shall be documented and signed by the individual in responsible charge of the management of the operation of the vessel. This documentation shall include as a minimum the following:

(1) detailed process and instrument flow diagrams (P&IDs), showing all pertinent elements of the system associated with the vessel

(2) a description of all operating and upset scenarios, including those involving fire and those that result from operator error, and equipment and/or instrumentation malfunctions

(3) a detailed description of any safety critical instrumentation used to limit the system pressure, including the identification of all truly independent redundancies and a reliability evaluation (qualitative or quantitative) of the overall safety system

(4) an analysis showing the maximum pressure that can result from each of the scenarios

(5) the evaluation of the acceptability of the pressure relief valve without a Certification Mark

(6) this Code Case number

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Approval Date: June 16, 2011

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2676**  
**Alternative Procedure for Calculating Allowable Axial Compressive Stress in Cylindrical Shells Constructed of 2<sup>1</sup>/<sub>4</sub>Cr-1Mo Steel at Temperatures Greater Than 700°F and Less Than or Equal to 1000°F**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions may cylindrical shells constructed of 2<sup>1</sup>/<sub>4</sub>Cr-1Mo steel be designed for axial compression for design temperatures greater than 700°F and less than or equal to 1000°F?

*Reply:* It is the opinion of the Committee that cylindrical shells constructed of 2<sup>1</sup>/<sub>4</sub>Cr-1Mo steel may be designed for axial compression for design temperatures greater than 700°F and less than or equal to 1000°F, provided the following requirements are met:

(a) The maximum allowable longitudinal compressive stress shall be the smaller of the following values:

- (1) the maximum allowable tensile stress value permitted for the material at the design temperature
- (2) the value of the factor  $B$  determined by the following procedure

$E$  = modulus of elasticity of material obtained from Figures 1 and 1M

$$K_1 = \frac{5}{5 - 0.3048 \ln(T)}$$

$R_o$  = outside radius of cylindrical shell or tube

$t$  = minimum required thickness of the cylindrical shell or tube

$T$  = number of operating hours. The minimum value of  $T$  (for hot tensile) is equal to 1.0 hr, and the maximum value is equal to 500,000 hr.

*Step 1.* Using the selected values of  $t$  and  $R_o$ , calculate the value of factor  $A$  using the following formula:

$$A = \frac{0.125}{(R_o/t)} K_1$$

*Step 2.* Using the value of  $A$  calculated in Step 1, enter external pressure chart, Figures 1 and 1M (see also Tables 1 and 1M). Move vertically to an intersection with the material/time line. Interpolation may be made between lines for intermediate times. If tabular values are used, interpolation may be used to determine a  $B$  value that lies between two adjacent tabular values for a specific number of hours. Such interpolation methods may also be used to determine a  $B$  value at an intermediate number of hours that lie between two sets of tabular values, after first determining  $B$  values for each set of tabular values.

In cases where the value at  $A$  falls to the right of the end of the material/time line, assume an intersection with the horizontal projection of the upper end of the material/time line. If tabular values are used, the last (maximum) tabulated value shall be used. For values of  $A$  falling to the left of the material/time line, see Step 4.

*Step 3.* From the intersection obtained in Step 2, move horizontally and read the value of factor  $B$ . This is the maximum allowable compressive stress for the values of  $t$  and  $R_o$  used in Step 1.

*Step 4.* For values of factor  $A$  falling to the left of the applicable material/time line, the value of  $B$  shall be calculated using the following formula:

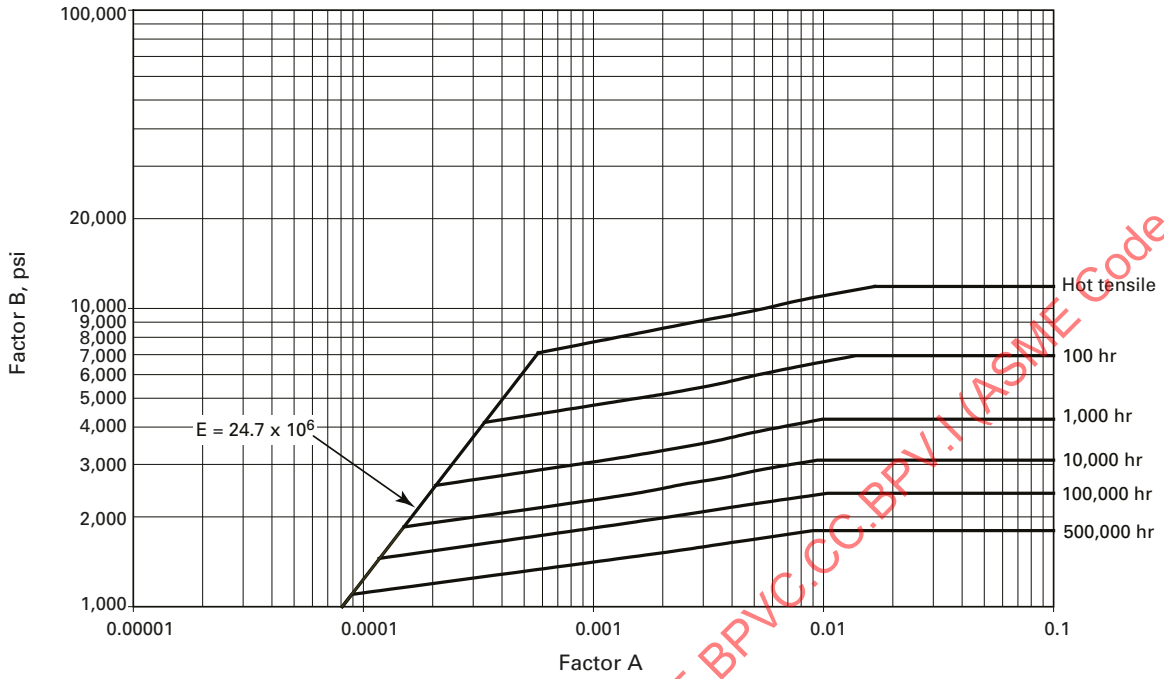
$$B = AE/2$$

*Step 5.* Compare the value of  $B$  determined in Step 3 and Step 4 with the computed longitudinal compressive stress in the cylindrical shell or tube, using the selected values of  $t$  and  $R_o$ . If the value of  $B$  is smaller than the computed compressive stress, a greater value of  $t$  must be selected and the procedure repeated until a value of  $B$  is obtained that is greater than the compressive stress computed for the loading on the cylindrical shell or tube.

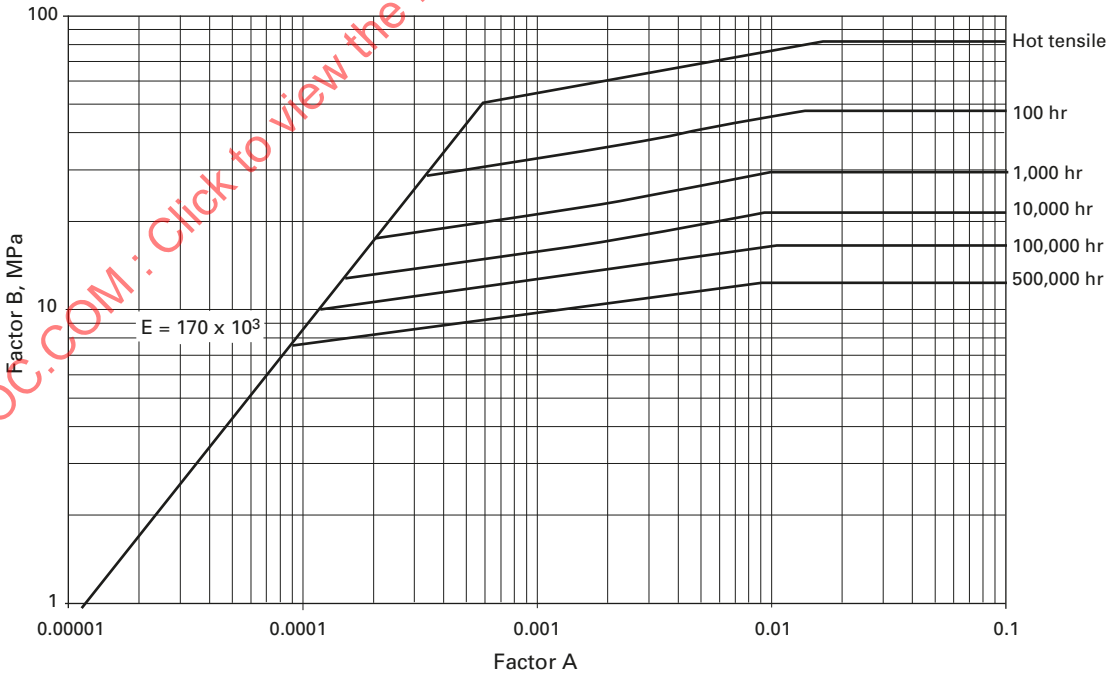
(b) This Case number shall be recorded in the Remarks section of the Manufacturer's Data Report.

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**Figure 1**  
**External Pressure Chart for 2<sup>1</sup>/<sub>4</sub> Cr-1Mo Steel (Annealed) at 1,000°F**



**Figure 1M**  
**External Pressure Chart for 2<sup>1</sup>/<sub>4</sub> Cr-1Mo Steel (Annealed) at 538°C**



**Table 1**  
**Tabular Values for Figure 1**

Time, hr	A	B, psi	Time, hr	A	B, psi	
Hot tensile	1.00E-05	124	1,000	9.88E-03	4,250	
	8.10E-05	1,000		1.00E-01	4,250	
	5.75E-04	7,100	10,000	1.00E-05	124	
	1.50E-03	8,200		8.10E-05	1,000	
	2.74E-03	9,000		1.50E-04	1,850	
	5.05E-03	9,850		1.29E-03	2,350	
	8.35E-03	10,750		2.50E-03	2,580	
	1.67E-02	11,850		3.62E-03	2,700	
	1.00E-01	11,850		5.61E-03	2,900	
1.00E-05	124	9.39E-03		3,100		
8.10E-05	1,000	1.00E-01	3,100			
100	3.36E-04	4,150	100,000	1.00E-05	124	
	1.32E-03	4,900		8.10E-05	1,000	
	2.28E-03	5,250		1.17E-04	1,450	
	3.57E-03	5,600		6.47E-04	1,750	
	5.22E-03	6,000		1.72E-03	1,950	
	8.72E-03	6,500		4.76E-03	2,200	
	1.38E-02	6,950		1.04E-02	2,400	
	1.00E-01	6,950		1.00E-01	2,400	
	1.00E-05	124		500,000	1.00E-05	124
	8.10E-05	1,000			8.10E-05	1,000
2.06E-04	2,550	8.91E-05	1,100			
1.12E-03	3,100	1.79E-03	1,500			
2.01E-03	3,340	4.17E-03	1,650			
3.42E-03	3,600	9.00E-03	1,800			
5.04E-03	3,850	1.00E-01	1,800			

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**Table 1M**  
**Tabular Values for Figure 1M**

Time, hr	A	B, MPa	Time, hr	A	B, MPa
Hot tensile	1.00E-05	1	10,000	1.00E-05	1
	8.10E-05	7		8.10E-05	7
	5.75E-04	49		1.50E-04	13
	1.50E-03	57		1.29E-03	16
	2.74E-03	62		2.50E-03	18
	5.05E-03	68		3.62E-03	19
	8.35E-03	74		5.61E-03	20
	1.67E-02	82		9.39E-03	21
	1.00E-01	82		1.00E-01	21
	100	1.00E-05		1	100,000
8.10E-05		7	8.10E-05	7	
3.36E-04		29	1.17E-04	10	
1.32E-03		34	6.47E-04	12	
2.28E-03		36	1.72E-03	13	
3.57E-03		39	4.76E-03	15	
5.22E-03		41	1.04E-02	17	
8.72E-03		45	1.00E-01	17	
1.38E-02		48	1.00E-05	1	
1.00E-01		48	8.10E-05	7	
1,000	1.00E-05	1	500,000	8.91E-05	8
	8.10E-05	7		1.79E-03	10
	2.06E-04	18		4.17E-03	11
	1.12E-03	21		9.00E-03	12
	2.01E-03	23		1.00E-01	12
	3.42E-03	25			
	5.04E-03	27			
	9.88E-03	29			
	1.00E-01	29			

Approval Date: April 6, 2011

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2677**  
**Welding of Aluminum Alloy Tube-to-Tubesheet Joints**  
**by Friction Stir Welding (FSW) Process**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions may friction stir welding (FSW), including the use of mechanical pressure inherent to the FSW process, be used for welding tube-to-tubesheet joints constructed using the aluminum alloys listed in Table UNF-23.1 under the rules of Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that friction stir welding (FSW), including the use of mechanical pressure inherent to the FSW process, may be used for welding tube-to-tubesheet joints constructed using the aluminum alloys listed in Table UNF-23.1 under the rules of Section VIII, Division 1, provided that the following requirements are met.

## 1 TESTS AND EXAMINATIONS

(a) *Procedure Qualification Specimens.* Figure 1 shows an acceptable type of friction stir tube-to-tubesheet joint in the as-welded condition. The forge zone is principally the region where the metal has been “stirred” by the probe of the weld tool, but it also extends to the region that is mechanically modified by the shoulder of the tool. The weld dimensions follow the nomenclature of UW-20.1.

Figure 2 shows a weld in which the surface has been machined to remove surface roughness and flashing left by the shoulder, and to round-off the internal edge of the tube. In this case the weld leg,  $a_g$ , is measured to the final machined surface.

A tube-to-tubesheet weld demonstration qualification mockup assembly, consisting of ten mockup welds, shall be prepared and examined in accordance with Section IX, QW-193, except that the acceptance criteria shall be as follows:

(1) *Visual Examination.* The accessible surfaces of the welds shall be examined visually with no magnification required. The weld track shall show complete contact across the width of the shoulder. Depression of the

shoulder-track is acceptable, and of locally deeper areas, provided that the tool subsequently climbs out of any local surface depression. Weld track depression that will be removed by machining and has no impact upon the design tubesheet thickness is acceptable regardless of depth. However weld track depressions that will not be removed by machining, and any probe exit holes must be allowed for in the tubesheet design.

Weld-flash at the edge of the weld-track is acceptable provided that it is less than 0.025 in. (0.6 mm) in thickness, measured at the lip, without further analysis. However greater flash thickness shall be allowable if permitted by the design.

The tube inside surface shall show no deformation or collapse beyond any allowed in the design.

(2) *Liquid Penetrant Examination.* After visual examination, the rough surfaces of the forge zone shall be removed and etched in preparation for liquid penetrant testing.

(-a) Surface removal to clean may be by machining or sanding to a maximum depth of 0.03 in. (0.7 mm) maximum below the shoulder track, but not to exceed 25% of the probe length, and extending at least 0.5 in. (12 mm) beyond all test-tube weld edges.

(-b) The machined surface shall be etched to remove 0.0002 in. (0.005 mm) to 0.0004 in. (0.01 mm) of metal, followed by a water rinse. The etch rate may be determined by experiment on tube or tubesheet base metal, or by published data from the etchant manufacturer for the same alloy. After etch and rinse, the surface shall be deoxidized using dilute nitric acid, rinsed and dried, and thereafter handled only with dry cotton gloves prior to penetrant testing.

(-c) After surface preparation, liquid penetrant examination and acceptance standards shall meet the requirements of Appendix 8, except that section 8-5, Repair Requirements shall not be mandatory, provided that the repair is to be made using a qualified friction-stir repair procedure.

(3) *Macroexamination.* The mockup welds shall be sectioned through the center of the tube for macroexamination. The four exposed surfaces shall be smoothed and etched with a suitable etchant (see QW-470) to give a clear definition of the weld forge zone. If the weld perimeter incorporates regions with multiple weld passes,

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additional welds shall be made and sectioned to provide four exposed surfaces showing the minimum number of weld passes, and four more showing the maximum number of passes.

Using a nominal 10× magnification, the exposed cross sections of the weld shall confirm

(-a) minimum leak path dimension, dimension  $a_g$  of Figure 1 and 2, as required by the design

(-b) no voids, inconsistencies, or joint line remnants

(-c) consolidation within the forge zone and at the sides, to the tube wall, and to the tubesheet

(b) *Welding*. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs) shall address the requirements specified in section 2, Essential Variables. The original and any required renewal of a welder's or welding operator's performance qualifications shall be performed in accordance with QW-303.5.

(c) *Shear Load Test*. The allowable loads for welds made in accordance with this code case shall be established using the rules provided by Appendix A, except that the no-test option of Table A-2 will not apply under any circumstance, and the shear strength test will be established, in every case, using the rules of sections A-3 and A-4.

## 2 ESSENTIAL VARIABLES

All of the Tube-to-Tubesheet Qualification Essential Variables listed in Section IX, QW-288.1 shall be replaced by the following:

(a) a change in tube or tubesheet material specification, type, grade, or temper condition.

(b) for tubesheets with a nominal thickness less than or equal to 2.0 in. (51 mm), the minimum qualified tubesheet thickness shall be 0.9 times the thickness used for procedure qualification. There is no upper limit to the maximum thickness qualified. For tubesheets thicker than 2.0 in. (51 mm), thickness is not an essential variable.

(c) the minimum qualified ligament width shall be not less than 90% of the ligament width used for the procedure qualification. The maximum qualified ligament width is unlimited. Ligament width greater than  $\frac{3}{8}$  in. (9.5 mm) is not an essential variable.

(d) a change in tube nominal outside diameter.

(e) the minimum qualified tube thickness shall be the thickness used for procedure qualification. The maximum qualified tube thickness shall be no greater than 1.1 times the thickness used for the procedure qualification.

(f) a change in the method of preparing the base metal surfaces prior to welding (e.g., changing from mechanical cleaning to chemical cleaning or to abrasive cleaning or vice versa) or a change in the type or application method for any solvent used immediately prior to welding. As a minimum for welds made under this Case, the base metal surface preparation shall remove all debris and visible

surface oxides, and thereafter the surfaces shall be kept in an air-conditioned and condensation-free environment until welding is complete.

(g) a change, including material type (but not including temper), in a plug or tooling that supports the inside surface of the tube during welding. In the case of a tube support plug where plug material may become incorporated into the forge zone, the plug nominal chemical composition must match either the tube or tubesheet material.

(h) a change from tubes expanded in the tubesheet to unexpanded, or an increase in the diametral clearance between the tube and tubesheet greater than 0.01 in. (0.3 mm), subject to an absolute maximum clearance of 0.03 in. (0.8 mm). A reduction in radial clearance, or a change to add tube expansion is not a significant variable, except that shear testing will be required if the design requires the change in order to provide an allowable shear load greater than that originally qualified.

(i) a change in the number of segments that make up the weld track around the tube circumference, or in the number of duplicate passes over any portion of any segment(s).

(j) a change from "as welded" to PWHT within a specified temperature range, or vice versa.

(k) a change in the rotating tool, its shape, its coating material, if any, or its operation, from that used during qualification, beyond the following limits:

(1) a change in the tool and any applied coating material(s) specifications or nominal chemical composition, or a reduction in minimum hardness

(2) shoulder:

(-a) a change in diameter greater than 10%

(-b) a change in surface or concavity profile greater than 0.005 in. (0.1 mm) at any point on the contact surface

(3) probe:

(-a) a change in diameter greater than 5%

(-b) a change in radial eccentricity greater than 0.002 in. (0.05 mm)

(-c) a change in length greater than 5%

(-d) a change in taper semi-cone angle greater than 3 deg

(-e) flutes, if applicable (see Figure 3 for an example):

(-1) a change in number

(-2) a change in pitch angle greater than 5 deg

(-3) a change in flute channel radius greater than 10%

(-4) a change in flute depth greater than 0.005 in. (0.1 mm)

(-f) threads, if applicable (see Figure 4 for an example): a change in thread form, pitch, or in the number of thread starts

(-g) flats, if applicable

(-1) a change in number

(-2) a change in flat surface profile, relative to that used in qualification, greater than 0.010 in. (0.3 mm) at any location

(-h) tip: a change in the surface profile from that qualified greater than 0.002 in. (0.05 mm)

(4) a change in the direction of tool rotation, or a change in speed of rotation greater than +10% or -2% of that used for qualification.

(5) for FSW under force control only, except at the starting and stopping points:

(-a) a change in the axial force applied to the tool during welding greater than 10%

(-b) a change in the lateral force applied to the tool during welding greater than 10%

(6) for FSW under position control only: an increase in travel speed greater than 5%, except at the starting and stopping points

(7) a change in tool angular tilt greater than 1 deg relative to the direction of tool (probe tip) motion, except at the starting and stopping points

(l) a change in welding equipment:

(1) a change from direct visual control to remote visual control, or vice versa

(2) a change in the method of tool path control, e.g., a change from numerical electro-hydraulic servo-control to analog (tracer) servo-control or to hard metallic guide-way control

(m) an increase in the elapsed time between the start of base metal surface cleaning and weld completion, over that during qualification, except as follows:

(1) For elapsed times of 48 hr or less, elapsed time is not a significant variable.

(2) Requalification of a qualified procedure for the sole purpose of extending the allowable elapsed time shall be permissible by completion of new shear tests made with the extended elapsed time.

(3) Figure 5 shows the placement of the probe relating to the joint line that provides good mixing in the stir-zone, which is associated with freedom from residual oxide defects. For tool paths that provide centered seam alignment or seam alignment on the advancing (good mixing) side of the probe at every location around the tube perimeter, elapsed time is not an essential variable.

(n) a change in the location of the probe axis relative to the interface between the tube and tube sheet more than 20% of the probe diameter, except at path transitions from one tube's weld to another.

quality shall be evaluated by visual observation of the welding process, by monitoring of welding variables, and by gas bubble leak test.

(a) Welding variables shall be monitored during welding operations. Monitoring may be by using operator alarms or by conducting a postweld review of variable data records from the FSW machine or from separate data recording equipment.

(b) Weld tracking (relative to tube perimeter) shall be either monitored visually during welding operations, or controlled by machine setup to reference points on the tubesheet to ensure concentricity of the tool path to the tube axis.

(c) Weld penetration shall be verified by the visible appearance of the tool's shoulder track and/or weld flash at the periphery of the shoulder track.

(d) Drift in the probe operating variables listed above, including speed of rotation, axial force, lateral force, travel speed, and tool angular tilt shall be allowable provided that the following limits are not exceeded:

(1) Variable drift less than or equal to 200% of the limit provided for the same variable in section 2, para. 2(k) shall be acceptable provided that the accumulated duration of the periods in excess of the limit does not exceed 0.25 sec within any 10 sec welding interval.

(2) Variable drift greater than 200% of the stated limits is unacceptable for any duration when it applies to welding tool operation unless such drift is attributable to instrumentation or data collection errors.

(e) Production welds shall be subject to a gas-bubble test and leakage evaluation by application of bubble forming solution at operating pressure in accordance with Section V, Article 10, Appendix I, Bubble Test — Direct Pressure Technique. Welds showing evidence of leakage shall be marked and retested after repairs have been made. Welds shall be acceptable provided that:

(1) They were made by a qualified operator using a certified machine and qualified procedure.

(2) The operator judged the welds to be following the intended track, to have the intended penetration to completion, and confirmed that the probe operational parameters were maintained within the allowed limits during welding.

(3) They showed no evidence of leakage during gas bubble testing.

### 3 PRODUCTION WELD QUALITY

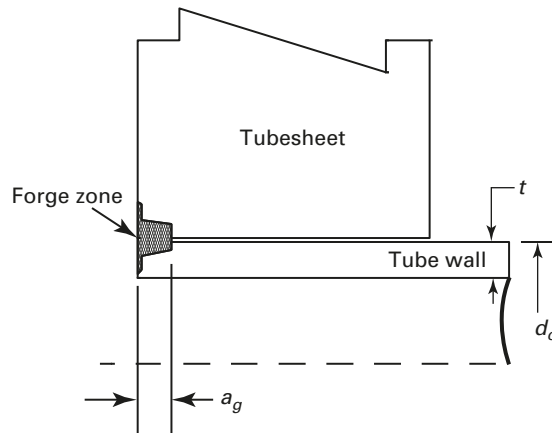
Production welds shall only be made by qualified operators using certified welding equipment and qualified weld procedures. Welding machines and data logging equipment shall be certified for operational accuracy using standards that are traceable to NIST. Certification for making welds under this Case shall expire no more than 1 yr after the date of calibration. Production weld

Welds that would be acceptable except for having exceeded the elapsed time, between base metal preparation and the completion of welding, as indicated in section 2, para. 2(m) shall become acceptable upon completion of a requalification with the extended elapsed time in accordance with section 2, para. 2(m). Welds not meeting the requirements of section 3, paras. (a) through (e) shall be repaired using a qualified repair procedure.

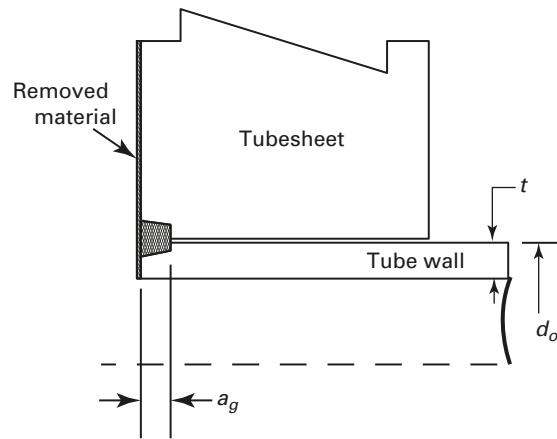
**4 REPORT**

This Case number shall be shown on the Manufacturer's Data Report.

**Figure 1**  
**Acceptable Friction Stir Welded Tube-to-Tubesheet Joint**



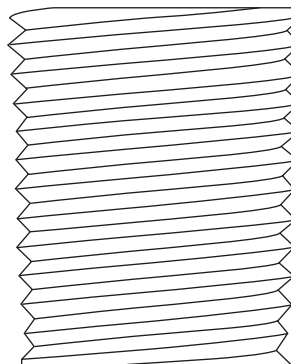
**Figure 2**  
**Weld Leg Dimension After Optional Surface Cleanup**

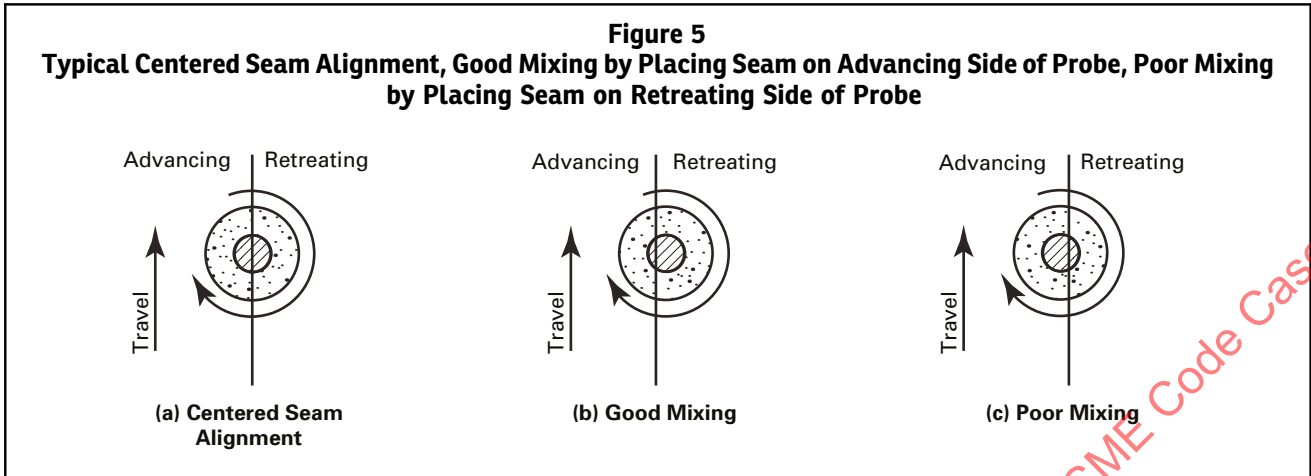


**Figure 3**  
**Example of Probe With Flutes**



**Figure 4**  
**Example of Probe With Thread**





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**Case 2678-1**  
**Replacement Parts for Pressure Vessels**  
**Section VIII, Division 3**

*Inquiry:* May replacement parts for pressure vessels constructed to Section VIII, Division 3 for which Partial Data Reports with a nameplate or stamping are required be constructed using the Edition and Addenda used for the original construction of the vessel or any subsequent Edition and Addenda?

*Reply:* It is the opinion of the Committee that replacement parts for pressure vessels constructed to Section VIII, Division 3 for which Partial Data Reports with a nameplate or stamping are required may be constructed using the Edition and Addenda used for the original construction or any subsequent Edition and Addenda, provided the following additional requirements are met:

(a) Replacement parts shall meet all applicable requirements of the User's Design Specification for the pressure vessel that the part will be used in.

(b) Changes to Code rules made subsequent to the Code Edition, Addenda, and cases established for construction of the replacement part may be critical to the integrity of the part in the intended service. The Manufacturer shall review these changes and shall implement any that are identified as critical to the integrity of the part in the intended service. The Manufacturer shall describe any

changes that are made in the remarks section of Form K-2. The Authorized Inspector shall verify that the review has been made by the Manufacturer.

(c) Replacement parts shall have a design pressure equal to or greater than the design pressure of the pressure vessel that the part will be used in.

(d) Replacement parts shall have a coincident design metal temperature equal to or greater than (i.e., warmer than) the coincident design metal temperature of the pressure vessel that the part will be used in.

(e) Replacement parts shall have a minimum design metal temperature equal to or less than (i.e., colder than) the minimum design metal temperature of the pressure vessel that the part will be used in.

(f) If the design pressure, coincident design metal temperature, or the minimum design metal temperature is different from the pressure vessel that the part will be used in, a supplementary nameplate shall be applied immediately adjacent to the nameplate on the replacement part.

(g) The supplementary nameplate shall have characters no less than  $\frac{5}{16}$  in. (8 mm) high and shall be attached to the part in the same manner as the part nameplate.

(h) The supplementary nameplate shall state: "REPLACEMENT PART. DESIGN CONDITIONS OF THE VESSEL THAT THIS PART IS USED IN ARE SHOWN ON THE ORIGINAL VESSEL NAMEPLATE."

(i) This Case number shall be shown on the Manufacturer's Design Report and the Manufacturer's Data Report as applicable.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: June 16, 2011

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**Case 2679**  
**Implementing in Parts 4 and 5 the Changes in ASCE/SEI**  
**7-10, Paras. 2.3.2 and 2.4.1 for Wind Load Factors**  
**Section VIII, Division 2**

*Inquiry:* May the Table 4.1.2 and Table 5.3, Design Load Combinations and Table 5.4 and Table 5.5, Load Case Combinations including  $W$  (Wind Loads) be revised as shown in this Code Case?

*Reply:* It is the opinion of the Committee that the Table 4.1.2 and Table 5.3, Design Load Combinations and Table 5.4 and Table 5.5, Load Case Combinations including  $W$  (Wind Loads) may be revised as follows:

*(a) Part 4*

*(1) Table 4.1.2, Design Load Combinations:*

*(-a)* In fifth, sixth, and seventh rows, change  $W$  to  $0.6W$ .

*(-b) Replace existing Note (3) with the following:*

This load combination addresses an overturning condition for foundation design. It does not apply to design of anchorage (if any) to the foundation. Refer to ASCE/SEI 7-10, 2.4.1 Exception 2 for an additional reduction to  $W$  that may be applicable.

*(2) In para. 4.1.5.3(b), add the following:*

The factors for wind loading,  $W$  in Table 4.1.2, Design Load Combinations, are based on ASCE/SEI 7-10 wind maps and probability of occurrence.

*(3) In Table 4.1.1, after Wind Loads, add the following:*  
See para. 4.1.5.3(b).

*(b) Part 5*

*(1) At the end of para. 5.1.3.2, add the following:*

The factors for wind loading,  $W$  in Table 4.1.2, Design Load Combinations, are based on ASCE/SEI 7-10 wind maps and probability of occurrence.

*(2) In Table 5.2, after Wind Loads, add the following:*  
See para. 5.1.3.2.

*(3) In Table 5.3, Design Load Combinations (5), (6), and (8), change  $W$  to  $0.6W$ .*

*(4) In Table 5.3, replace existing Note (2) with the following:*

This load combination addresses an overturning condition for foundation design. It does not apply to design of anchorage (if any) to the foundation. Refer to ASCE/SEI 7-10, 2.4.1 Exception 2 for an additional reduction to  $W$  that may be applicable.

*(5) In Table 5.4, Load Combination (3), change  $0.86W$  to  $0.54W$ .*

*(6) In Table 5.4, Load Combination (4), change  $1.7W$  to  $1.1W$ .*

*(7) In Table 5.5, Load Combination (3), change  $1.4W$  to  $0.86W$ .*

*(8) In Table 5.5, Load Combination (4), change  $2.7W$  to  $1.7W$ .*

*(c) This Case number shall be shown on the Manufacturer's Data Report.*

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**Case 2680**  
**Other Recognized Standards for Definition of Wind and Earthquake Loading in Lieu of ASCE/SEI 7 Section VIII, Division 2**

*Inquiry:* Is it permissible to use recognized load definition standards other than ASCE/SEI 7 for determination of the Design Load Parameters  $E$  and  $W$  in Table 4.1.1 and Table 5.2?

*Reply:* It is the opinion of the Committee that recognized standards for wind and earthquake may be used in lieu of ASCE/SEI 7, provided the User's Design Specification shall cite the Standard to be applied and specify suitable load factors for  $E$  (earthquake) and  $W$  (wind), where these design parameters are included in the Design Load Combinations in Table 4.1.2 and Table 5.3, and the Load Case Combinations in Table 5.4 and Table 5.5. This Case number shall be shown on the Manufacturer's Design Data Report.

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Approval Date: September 30, 2018

(19)

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**Case 2681-1**  
**Use of 9Ni, 8Ni, and 5Ni- $\frac{1}{4}$ Mo Materials in Welded**  
**Condition for Class 2 Construction**  
**Section VIII, Division 2**

*Inquiry:* Under what conditions may the materials listed in Table 6.18 of Section VIII, Division 2 and in Table 1 of this Case be used in welded condition for Section VIII, Division 2, Class 2 construction?

*Reply:* It is the opinion of the Committee that the materials listed in Table 6.18 of Section VIII, Division 2, Class 2 and in Table 1 of this Case may be used in welded condition for Division 2, Class 2 construction provided the following additional requirements are met:

(a) The filler metals for welding the 9Ni, 8Ni, and 5Ni- $\frac{1}{4}$ Mo materials listed in Table 6.18 and the 9Ni materials listed in Table 1 shall meet the additional requirements in (b) if any of the following are true:

(1) The filler metal has an unspecified yield strength.

(2) The specified minimum yield or ultimate tensile strength of the filler metal is below the specified minimums for the base metal.

(3) The welding procedure qualification test shows that the deposited weld metal tensile test strength is lower than the specified minimum ultimate tensile strength of the base metal.

(b) When any of the conditions of (a) are true, the following additional requirements shall apply and shall be met in the procedure qualification tests:

(1) All weld-metal tension test specimen that conform to the dimensional standards of SFA-5.11, para. 12.1, shall be tested to determine the minimum tensile strength and yield strength.

(2) The weld metals for welding the 8Ni and the 9Ni materials listed in Table 6.18 of Section VIII, Division 2 and the 9Ni materials in Table 1 shall meet 690 MPa (100 ksi) minimum tensile strength and 430 MPa (62.5 ksi) minimum yield strength.

(3) The weld metals for welding the 5Ni- $\frac{1}{4}$ Mo steel SA-645, Gr. A material listed in Table 6.18 shall meet 655 MPa (95 ksi) minimum tensile strength and 405 MPa (59 ksi) minimum yield strength. These weld metals may also be used for welding the 8Ni and 9Ni materials listed in Table 6.18 of Section VIII, Division 2 and the 9Ni materials in Table 1 of this Case when the allowable design stresses in Section II, Part D, Table 5A do not exceed those for ultimate tensile strength of 655 MPa (95 ksi) (see Table 5A, Note W4).

(c) The materials listed in Table 1 are exempt from production impact tests of the weld metal in accordance with para. 6.6.5.2(b) of Section VIII, Division 2, Class 2.

(d) This Case number shall be shown on the Manufacturer's Data Report.

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**Table 1  
Materials**

Specification	UNS	P-No./Group No.
SA-333, Grade 8	K81340	11A/1
SA-334, Grade 8	K81340	11A/1
SA-420, Grade WPL8	K81340	11A/1

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**Case 2682**  
**Alternative Procedure for Calculating Allowable Axial Compressive Stress and External Pressure in Cylindrical Shells Constructed of Stainless Steel Alloy 253MA (UNS S30815) at Temperatures Greater Than 1200°F (650°C) and Less Than or Equal to 1650°F (900°C)**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions may cylindrical shells constructed of stainless steel alloy 253MA (UNS S30815) be designed for axial compression and external pressure for design temperatures greater than 1200°F (650°C) and less than or equal to 1650°F (900°C)?

*Reply:* It is the opinion of the Committee that cylindrical shells constructed of stainless steel alloy 253MA (UNS S30815) may be designed for axial compression and external pressure for design temperatures greater than 1200°F (650°C) and less than or equal to 1650°F (900°C), provided the following requirements are met.

## 1 AXIAL COMPRESSION

The maximum allowable longitudinal compressive stress shall be the smaller of the following values:

(a) the maximum allowable tensile stress value permitted for the material at the design temperature

(b) the value of the factor,  $B$ , determined by the following procedure

where

$$K_1 = \frac{5}{5 - 0.304 \ln(T)}$$

$R_o$  = outside radius of cylindrical shell or tube

$t$  = minimum required thickness of the cylindrical shell or tube

$\ln(T)$  = natural log of the number of operating hours. The minimum value of  $T$  (for hot tensile) is equal to 1.0 hr, and the maximum value is equal to 200,000 hr.

*Step 1.* Using the selected values of  $t$  and  $R_o$ , calculate the value of factor  $A$  using the following formula:

$$A = \frac{0.125}{(R_o/t)} K_1$$

*Step 2.* Using the value of  $A$  calculated in Step 1, enter external pressure chart, Figure 1 or Figure 1M (see also Tables 1 and 1M). Move vertically to an intersection with the material/time line. Interpolation may be made between lines for intermediate times. If tabular values are used, interpolation may be used to determine a  $B$  value that lies between two adjacent tabular values for a specific number of hours. Such interpolation may also be used to determine a  $B$  value at an intermediate number of hours that lies between two sets of tabular values, after first determining  $B$  values for each set of tabular values.

In cases where the value at  $A$  falls to the right of the end of the material/time line, assume an intersection with the horizontal projection of the upper end of the material/time line. If tabular values are used, the maximum tabulated value shall be used. The minimum value of  $A$  to be used is 0.00001.

*Step 3.* From the intersection obtained in Step 2, move horizontally and read the value of factor  $B$ . This is the maximum allowable compressive stress for the values of  $t$  and  $R_o$  used in Step 1.

*Step 4.* Compare the value of  $B$  determined in Step 3 with the computed longitudinal compressive stress using the selected values of  $t$  and  $R_o$ . If the value of  $B$  is smaller than the computed compressive stress, a greater value of  $t$  must be selected and the procedure repeated until a value of  $B$  is obtained that is greater than the compressive stress computed.

## 2 EXTERNAL PRESSURE

The maximum allowable external pressure shall be the smaller of the following values:

(a) the maximum allowable tensile stress value permitted for the material at the design temperature

(b) the value of the factor  $B$  determined by the following procedure

where

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$$K_2 = \frac{3}{3 - 0.1303 \ln(T)}$$

$D_o$  = outside diameter of cylindrical shell or tube

$L$  = effective length of shell or tube

$t$  = minimum required thickness of the cylindrical shell or tube

$\ln(T)$  = natural log of the number of operating hours. The minimum value of  $T$  (for hot tensile) is equal to 1.0 hr, and the maximum value is equal to 200,000 hr.

*Step 1.* Using the selected values of  $t$ ,  $L$ , and  $D_o$ , determine the value of factor  $A$  from Fig. G of Section II, Part D.

*Step 2.* Using the value of  $A$  calculated in Step 1, enter external pressure chart, Figure 1 or Figure 1M (see also Tables 1 and 1M). Move vertically to an intersection with the material/time line. Interpolation may be made between lines for intermediate times. If tabular values are used, interpolation may be used to determine a  $B$  value that lies between two adjacent tabular values for a specific number of hours. Such interpolation methods may also be used to determine a  $B$  value at an intermediate

number of hours that lies between two sets of tabular values, after first determining  $B$  values for each set of tabular values.

In cases where the value at  $A$  falls to the right of the end of the material/time line, assume an intersection with the horizontal projection of the upper end of the material/time line. If tabular values are used, the maximum tabulated value shall be used. The minimum value of  $A$  to be used is 0.00001.

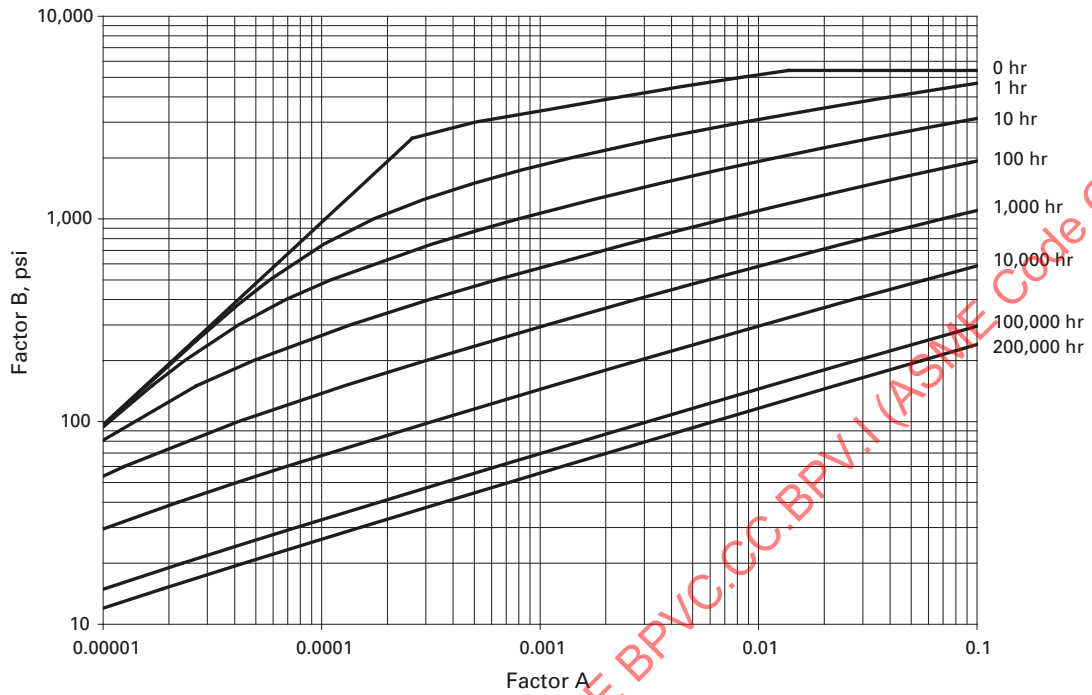
*Step 3.* From the intersection obtained in Step 2, move horizontally and read the value of factor  $B$ . If tabulated values are used, determine  $B$  as in Step 2 and apply it to the equation in Step 4.

*Step 4.* Calculate the value of allowable external pressure from the following equation:

$$P_a = \frac{4BK_2}{3(D_o/t)}$$

*Step 5.* Compare the value of  $P_a$  determined above with the specified design external pressure. If the value of  $P_a$  is smaller than the design external pressure, a greater value of  $t$  must be selected and the procedure repeated until a value of  $P_a$  is obtained that is greater than the specified external pressure for the cylindrical shell or tube.

**Figure 1**  
**External Pressure Chart for Stainless Steel Alloy UNS S30815 At 1650°F**



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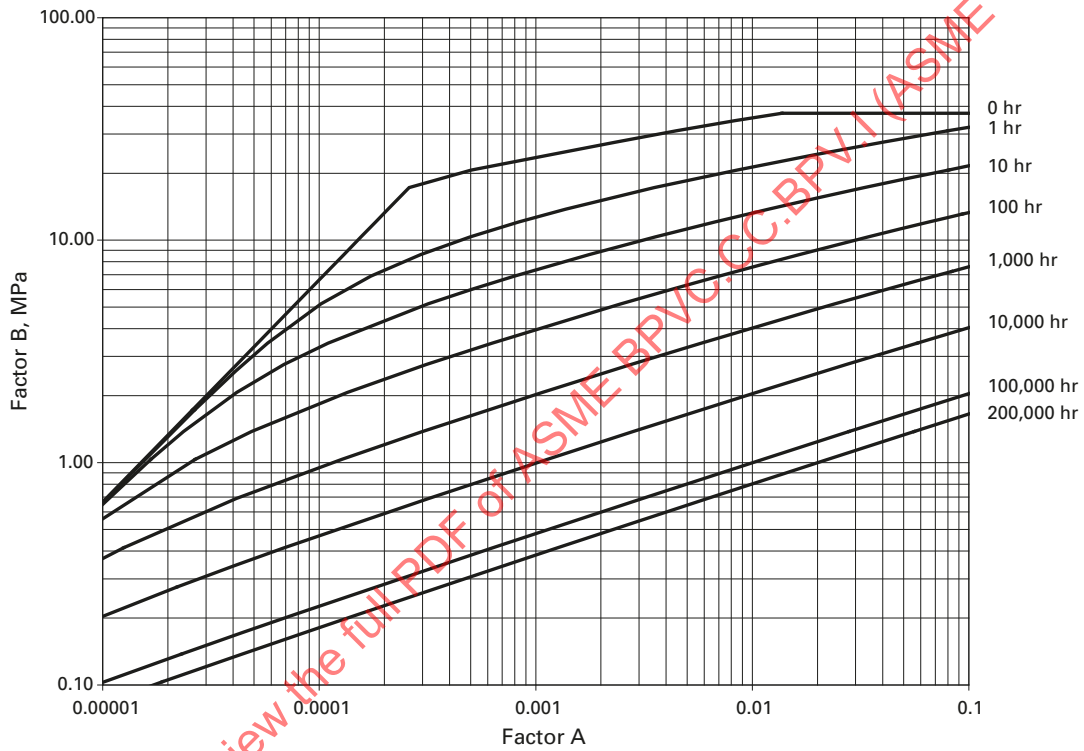
**Table 1**  
**Tabular Values at 1650°F For Figure 1**

Time, hr	A	B, psi	Time, hr	A	B, psi	
0	1.00E -05	96.5	100	2.48E -03	750	
	2.60E -05	250		4.30E -03	875	
	3.90E -05	375		7.03E -03	1000	
	5.20E -05	500		1.10E -02	1125	
	7.80E -05	750		1.65E -02	1250	
	1.04E -04	1000		2.41E -02	1375	
	1.30E -04	1250		3.43E -02	1500	
	1.56E -04	1500		4.78E -02	1625	
	1.82E -04	1750		6.54E -02	1750	
	2.08E -04	2000		7.38E -02	1800	
	2.60E -04	2500		8.31E -02	1850	
	5.04E -04	3000		9.33E -02	1900	
	1.15E -03	3500		1.00E -01	1930	
	2.33E -03	4000		1000	1.00E -05	53.7
	4.46E -03	4500			1.25E -05	60
	8.34E -03	5000			4.14E -05	100
	1.37E -02	5400			1.27E -04	150
1.00E -01	5400	3.00E -04	200			
1	1.00E -05	96	1.07E -03		300	
	2.66E -05	250	2.75E -03		400	
	4.12E -05	375	5.83E -03		500	
	5.78E -05	500	1.88E -02		700	
	1.02E -04	750	2.40E -02		750	
	1.73E -04	1000	3.04E -02		800	
	2.94E -04	1250	3.79E -02		850	
	4.98E -04	1500	4.68E -02		900	
	8.34E -04	1750	5.72E -02		950	
	1.38E -03	2000	6.93E -02		1000	
	3.52E -03	2500	8.34E -02		1050	
	8.52E -03	3000	1.00E -01		1100	
	1.91E -02	3500	10,000	1.00E -05	29.5	
	4.01E -02	4000		2.20E -05	40	
	7.98E -02	4500		4.08E -05	50	
	1.00E -01	4670		6.90E -05	60	
	10	1.00E -05		94	3.20E -04	100
1.67E -05		150		1.13E -03	150	
2.36E -05		200		2.81E -03	200	
4.16E -05		300		1.05E -02	300	
6.87E -05		400		2.71E -02	400	
1.10E -04		500		5.78E -02	500	
3.18E -04		750		1.00E -01	586	
5.12E -04		875		100,000	1.00E -05	14.9
7.96E -04		1000			2.31E -05	20
1.77E -03		1250			4.43E -05	25
3.57E -03		1500			7.64E -05	30
6.71E -03		1750			1.83E -04	40
1.19E -02		2000			3.62E -04	50
2.01E -02		2250	6.34E -04		60	
3.29E -02		2500	3.11E -03		100	
5.21E -02		2750	1.12E -02		150	
8.06E -02		3000	2.80E -02		200	
1.00E -01	3130	1.00E -01	296			
100	1.00E -05	81	200,000		1.00E -05	12
	2.67E -05	150			1.89E -05	15
	4.87E -05	200			4.40E -05	20
	1.35E -04	300			8.61E -05	25
	3.12E -04	400			1.50E -04	30
	6.29E -04	500			3.61E -04	40

**Table 1**  
**Tabular Values at 1650°F For Figure 1 (Cont'd)**

Time, hr	A	B, psi	Time, hr	A	B, psi
200,000	7.18E -04	50	200,000	2.23E -02	150
	1.26E -03	60		5.59E -02	200
	6.21E -03	100		1.00E -01	240

**Figure 1M**  
**External Pressure Chart for Stainless Steel Alloy UNS S30815 At 900°C**



**Table 1M**  
**Tabular Values at 900°C For Figure 1M**

Time, hr	A	B, MPa	Time, hr	A	B, MPa	
0	1.00E -05	0.67	100	2.48E -03	5.17	
	2.60E -05	1.72		4.30E -03	6.03	
	3.90E -05	2.59		7.03E -03	6.90	
	5.20E -05	3.45		1.10E -02	7.76	
	7.80E -05	5.17		1.65E -02	8.62	
	1.04E -04	6.90		2.41E -02	9.48	
	1.30E -04	8.62		3.43E -02	10.34	
	1.56E -04	10.34		4.78E -02	11.20	
	1.82E -04	12.07		6.54E -02	12.07	
	2.08E -04	13.79		7.38E -02	12.41	
	2.60E -04	17.24		8.31E -02	12.76	
	5.04E -04	20.69		9.33E -02	13.10	
	1.15E -03	24.13		1.00E -01	13.35	
	2.33E -03	27.58		1000	1.00E -05	0.37
	4.46E -03	31.03			1.25E -05	0.41
	8.34E -03	34.48			4.14E -05	0.69
	1.37E -02	37.23			1.27E -04	1.03
1.00E -01	37.23	3.00E -04	1.38			
1	1.00E -05	0.66	1.07E -03		2.07	
	2.66E -05	1.72	2.75E -03		2.76	
	4.12E -05	2.59	5.83E -03		3.45	
	5.78E -05	3.45	1.88E -02		4.83	
	1.02E -04	5.17	2.40E -02		5.17	
	1.73E -04	6.90	3.04E -02		5.52	
	2.94E -04	8.62	3.79E -02		5.86	
	4.98E -04	10.34	4.68E -02		6.21	
	8.34E -04	12.07	5.72E -02		6.55	
	1.38E -03	13.79	6.93E -02		6.90	
	3.52E -03	17.24	8.34E -02		7.24	
	8.52E -03	20.69	1.00E -01		7.58	
	1.91E -02	24.13	10,000	1.00E -05	0.20	
	4.01E -02	27.58		2.20E -05	0.28	
	7.98E -02	31.03		4.08E -05	0.34	
	1.00E -01	32.20		6.90E -05	0.41	
	10	1.00E -05		0.65	3.20E -04	0.69
1.67E -05		1.03		1.13E -03	1.03	
2.36E -05		1.38		2.81E -03	1.38	
4.16E -05		2.07		1.05E -02	2.07	
6.87E -05		2.76		2.71E -02	2.76	
1.10E -04		3.45		5.78E -02	3.45	
3.18E -04		5.17		1.00E -01	4.04	
5.12E -04		6.03		100,000	1.00E -05	0.10
7.96E -04		6.90			2.31E -05	0.14
1.77E -03		8.62			4.43E -05	0.17
3.57E -03		10.34			7.64E -05	0.21
6.71E -03		12.07			1.83E -04	0.28
1.19E -02		13.79			3.62E -04	0.34
2.01E -02		15.51	6.34E -04		0.41	
3.29E -02		17.24	3.11E -03		0.69	
5.21E -02		18.96	1.12E -02		1.03	
8.06E -02		20.69	2.80E -02		1.38	
1.00E -01	21.58	1.00E -01	2.04			
100	1.00E -05	0.56	200,000		1.00E -05	0.08
	2.67E -05	1.03			1.89E -05	0.10
	4.87E -05	1.38			4.40E -05	0.14
	1.35E -04	2.07			8.61E -05	0.17
	3.12E -04	2.76			1.50E -04	0.21
	6.29E -04	3.45			3.61E -04	0.28

**Table 1M**  
**Tabular Values at 900°C For Figure 1M (Cont'd)**

Time, hr	A	B, MPa	Time, hr	A	B, MPa
200,000	7.18E -04	0.34	200,000	2.23E -02	1.03
	1.26E -03	0.41		5.59E -02	1.38
	6.21E -03	0.69		1.00E -01	1.65

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Approval Date: July 13, 2011

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**Case 2683**  
**Use of Method A as the Only Design Basis for Class II Vessels**  
**Section X**

*Inquiry:* In lieu of the requirements in RD-1120(a), under what conditions may a Class II vessel use only Method A design rules given in RD-1170?

*Reply:* It is the opinion of the Committee that Method A as defined in RD-1170 may be used for Class II vessels provided:

(a) The vessel inside diameter shall not exceed 48 in. (1200 mm).

(b) The internal design pressure shall not exceed 250 psi (1.72 MPa).

(c) All other requirements of Section X shall apply.

(d) This Case Number shall be shown on the Fabricator's Design Report.

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Approval Date: August 1, 2018

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**Case 2684-5**  
**47Ni-23Cr-23Fe-7W, UNS N06674, Alloy Seamless Pipe and Tube, and Forgings**  
**Section I; Section VIII, Division 1**

*Inquiry:* May solution annealed 47Ni-23Cr-23Fe-7W, UNS N06674, alloy seamless pipe and tube, and forgings conforming to the specifications listed in [Table 1](#), be used for welded construction under the rules of Section I and Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that solution annealed 47Ni-23Cr-23Fe-7W, UNS N06674, alloy seamless pipe and tube, and forgings, conforming to the specifications listed in [Table 1](#), may be used for welded construction under the rules of Section I and Section VIII, Division 1, provided the following additional requirements are met:

(a) For Section I, the  $y$  values (see Section I, PG-27.4.6) shall be as follows:

- (1) 1,050°F (565°C) and below: 0.4
- (2) 1,100°F (595°C): 0.5
- (3) 1,150°F (620°C) and above: 0.7

(b) For Section I, the requirements for post-forming heat treatments after cold-work shall be as required by PG-19. Post-forming heat treatment shall be required for design temperatures exceeding 1,050°F (565°C) but lower than 1,200°F (650°C), and forming strains exceeding 15%, and for design temperatures exceeding 1,200°F (650°C) and forming strains exceeding 10%. The General Note and Notes (1) and (2) of Table PG-19 shall apply. Heat treatment after cold-working shall be solution annealing by heating to a minimum temperature of 2,150°F (1 175°C) followed by quenching in water or rapid cooling by other means.

(c) For Section VIII, Division 1, the rules in Subsection C that apply are those in Part UNF for nickel, cobalt, and high nickel alloys.

(d) For Section VIII, Division 1, the requirements for post-forming heat treatment shall be as required by UNF-79. Post-forming heat treatment shall be required for design temperatures exceeding 1,050°F (565°C) but lower than 1,200°F (650°C) and forming strains exceeding 15%, and for design temperatures exceeding

1,200°F (650°C) and forming strains exceeding 10%. General Notes (a) and (b) and Note (1) of Table UNF-79 shall apply. Heat treatment after cold-working shall be solution annealing by heating to a minimum temperature of 2,150°F (1 175°C) followed by quenching in water or rapid cooling by other means.

(e) The physical properties for the 47Ni-23Cr-23Fe-7W alloy are as follows:

- (1) mean linear thermal expansion coefficients, as given in [Tables 2](#) and [2M](#)
- (2) thermal conductivity, as given in [Tables 3](#) and [3M](#)
- (3) thermal diffusivity, as given in [Tables 4](#) and [4M](#)
- (4) density: 0.306 lb/in.<sup>3</sup> (8 460 kg/m<sup>3</sup>)
- (5) modulus of elasticity, as given in [Tables 5](#) and [5M](#)
- (6) Poisson's ratio: 0.26

(f) The yield strength and tensile strength values for use in design shall be as given in [Tables 6](#) and [6M](#).

(g) The maximum allowable stress values for the material shall be as given in [Tables 7](#) and [7M](#). The maximum design temperature shall be 1,472°F (800°C).

(h) Separate welding procedure qualifications in accordance with Section IX shall be required for this material. This material may be considered P-No. 45 for the purpose of performance qualifications. Procedure and performance qualifications qualified under previous versions of this Case do not require requalification.

(i) Except for dissimilar weld that is welded to a creep strength enhanced ferritic (CSEF) steel, heat treatment after welding is neither required nor prohibited, but if performed, heat treatment shall consist of heating to a minimum temperature of 1,615°F (880°C) followed by rapid cooling or air cooling.

Postweld heat treatment for welds joining this material to CSEF steels shall follow the heat treatment requirements specified for the applicable CSEF steel.

(j) The charts for determining thickness for those components under external pressure are shown in [Figures 1](#) and [1M](#), and the corresponding tabular values are shown in [Table 8](#).

(k) This Case number shall be referenced in the documentation and marking of the material and shown on the Manufacturer's Data Report.

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**Table 1  
Specifications**

Product Form	ASTM Designation
Forgings	B564-11
Seamless pipe and tube	B167-11

**Table 2  
Mean Linear Thermal Expansion Coefficients**

Temperature Range, °F	Coefficient (in./in./°F)
RT - 100	$7.3 \times 10^{-6}$
RT - 200	$7.5 \times 10^{-6}$
RT - 300	$7.7 \times 10^{-6}$
RT - 400	$7.9 \times 10^{-6}$
RT - 500	$8.0 \times 10^{-6}$
RT - 600	$8.1 \times 10^{-6}$
RT - 700	$8.2 \times 10^{-6}$
RT - 800	$8.3 \times 10^{-6}$
RT - 900	$8.4 \times 10^{-6}$
RT - 1,000	$8.4 \times 10^{-6}$
RT - 1,100	$8.4 \times 10^{-6}$
RT - 1,200	$8.5 \times 10^{-6}$
RT - 1,300	$8.8 \times 10^{-6}$
RT - 1,400	$8.9 \times 10^{-6}$
RT - 1,500	$9.0 \times 10^{-6}$
RT - 1,600	$9.1 \times 10^{-6}$
RT - 1,700	$9.2 \times 10^{-6}$
RT - 1,800	$9.3 \times 10^{-6}$

**Table 2M  
Mean Linear Thermal Expansion Coefficients**

Temperature Range, °C	Coefficient (mm/mm/°C)
RT - 100	$13.6 \times 10^{-6}$
RT - 200	$14.2 \times 10^{-6}$
RT - 300	$14.5 \times 10^{-6}$
RT - 400	$14.9 \times 10^{-6}$
RT - 500	$15.1 \times 10^{-6}$
RT - 600	$15.2 \times 10^{-6}$
RT - 700	$15.8 \times 10^{-6}$
RT - 800	$16.2 \times 10^{-6}$
RT - 900	$16.4 \times 10^{-6}$
RT - 1 000	$16.8 \times 10^{-6}$

**Table 3  
Thermal Conductivity**

Temperature, °F	Btu/hr-ft-°F
RT	6.2
100	6.5
200	7.2
300	8.0
400	8.8
500	9.5
600	10.3
700	11.0
800	12.0
900	13.2
1,000	14.0
1,100	14.9
1,200	16.5
1,300	18.1
1,400	19.0
1,500	19.3
1,600	19.3
1,700	19.4
1,800	19.7

**Table 3M  
Thermal Conductivity**

Temperature, °C	W/m°C
RT	10.8
100	12.7
200	15.1
300	17.4
400	19.9
500	23.4
600	26.1
700	31.2
800	33.3
900	33.5
1 000	34.3

**Table 4**  
**Thermal Diffusivity**

Temperature, °F	ft <sup>2</sup> /hr
RT	0.112
100	0.114
200	0.120
300	0.126
400	0.133
500	0.140
600	0.147
700	0.154
800	0.161
900	0.167
1,000	0.172
1,100	0.179
1,200	0.185
1,300	0.191
1,400	0.196
1,500	0.201
1,600	0.209
1,700	0.216
1,800	0.220

**Table 5**  
**Modulus of Elasticity**

Temperature, °F	ksi × 10 <sup>3</sup>
RT	27.8
100	27.7
200	27.3
300	26.9
400	26.4
500	25.8
600	25.2
700	24.7
800	24.3
900	23.9
1,000	23.4
1,100	22.7
1,200	22.1
1,300	21.6
1,400	21.1
1,500	20.6
1,600	20.1
1,700	19.6
1,800	18.9

**Table 4M**  
**Thermal Diffusivity**

Temperature, °C	m <sup>2</sup> /sec × 10 <sup>-6</sup>
RT	2.89
100	3.11
200	3.43
300	3.75
400	4.07
500	4.35
600	4.63
700	4.93
800	5.15
900	5.50
1 000	5.70

**Table 5M**  
**Modulus of Elasticity**

Temperature, °C	MPa × 10 <sup>3</sup>
RT	192
100	188
200	182
300	175
400	169
500	164
600	156
700	149
800	143
900	137
1 000	129

**Table 6  
Yield and Tensile Strength Values**

For Metal Temperature Not Exceeding, °F	Yield Strength, ksi [Note (1)]	Tensile Strength, ksi [Note (2)]
100	34.1	85.6
150	...	...
200	30.5	85.6
250	...	...
300	29.0	85.3
350	...	...
400	27.9	82.8
450	...	...
500	27.0	81.3
550	...	...
600	26.0	80.5
650	25.5	80.3
700	25.1	80.1
750	24.6	79.9
800	24.1	79.6
850	23.7	79.2
900	23.3	78.7
950	23.0	77.8
1,000	22.7	76.7
1,050	22.5	75.3
1,100	22.4	73.5
1,150	22.3	71.3
1,200	22.2	68.6
1,250	22.2	65.5
1,300	22.1	61.9
1,350	21.9	57.8
1,400	21.6	53.3
1,450	21.0	48.3
1,500	20.0	43.0

NOTES:

- (1) The tabulated values of yield strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the yield strength values correspond to the yield strength trend curve adjusted to the minimum specified room temperature yield strength. The yield strength values do not correspond exactly to "minimum" or "average," as those terms are applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section I require elevated temperature testing for yield strength of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated yield strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.
- (2) The tabulated values of tensile strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the tensile strength values tend toward an average or expected value, which may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. The tensile strength values do not correspond exactly to "average" as this term is applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section I require elevated temperature testing for tensile strength of production material for use in

**Table 6  
Yield and Tensile Strength Values (Cont'd)**

NOTES (CONT'D):

Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

**Table 6M**  
**Yield and Tensile Strength Values**

For Metal Temperature Not Exceeding, °C	Yield Strength, MPa [Note (1)]	Tensile Strength, MPa [Note (2)]
40	235	590
65	218	590
100	209	590
125	204	590
150	200	587
175	196	579
200	193	572
225	190	567
250	187	562
275	184	559
300	181	556
325	178	555
350	175	553
375	172	552
400	169	551
425	167	549
450	164	547
475	161	544
500	159	539
525	157	533
550	156	525
575	155	515
600	154	503
625	154	489
650	153	459
675	153	453
700	152	431
725	151	406
750	150	378
775	147	349
800	142	317

## NOTES:

- (1) The tabulated values of yield strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the yield strength values correspond to the yield strength trend curve adjusted to the minimum specified room temperature yield strength. The yield strength values do not correspond exactly to "minimum" or "average," as those terms are applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section I require elevated temperature testing for yield strength of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated yield strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.
- (2) The tabulated values of tensile strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the tensile strength values tend toward an average or expected value, which may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. The tensile strength values do not correspond exactly to "average" as this term is applied to a statistical treatment of a homogeneous set of data. Neither

**Table 6M**  
**Yield and Tensile Strength Values (Cont'd)**

## NOTES (CONT'D):

the ASME Material Specifications nor the rules of Section I require elevated temperature testing for tensile strength of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

**Table 7  
Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F		
Exceeding, °F	Stress, ksi	Stress, ksi
100	22.7	22.7
150	...	22.7 (2)
200	20.3	22.7 (2)
250	...	22.7 (2)
300	19.3	22.7 (2)
350	...	22.7 (2)
400	18.6	22.7 (2)
450	...	22.7 (2)
500	18.0	22.7 (2)
550	...	22.7 (2)
600	17.4	22.7 (2)
650	17.0	22.7 (2)
700	16.7	22.6 (2)
750	16.4	22.1 (2)
800	16.1	21.7 (2)
850	15.8	21.3 (2)
900	15.5	21.0 (2)
950	15.3	20.7 (2)
1,000	15.1	20.4 (2)
1,050	15.0	20.3 (2)
1,100	14.9	17.2 (1), (2)
1,150	14.2 (1)	14.2 (1)
1,200	11.8 (1)	11.8 (1)
1,250	9.8 (1)	9.8 (1)
1,300	8.2 (1)	8.2 (1)
1,350	6.9 (1)	6.9 (1)
1,400	5.7 (1)	5.7 (1)
1,450	4.7 (1)	4.7 (1)
1,500	3.7 (1), (3)	3.7 (1), (3)

NOTES:

- (1) These stress values are obtained from time-dependent properties.
- (2) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of this alloy where slightly greater deformation is acceptable. These higher stress values exceed 66<sup>2</sup>/<sub>3</sub>% but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for applications where slight amounts of distortion can cause leakage or malfunction.
- (3) The maximum use temperature for this alloy is 1472°F (800°C); the value listed at 1500°F is provided for interpolation purposes only.

**Table 7M  
Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C		
Exceeding, °C	Stress, MPa	Stress, MPa
40	157	157
65	145	157 (2)
100	139	157 (2)
125	136	157 (2)
150	133	157 (2)
175	131	157 (2)
200	129	157 (2)
225	127	157 (2)
250	125	157 (2)
275	123	157 (2)
300	121	157 (2)
325	119	157 (2)
350	117	157 (2)
375	115	155 (2)
400	113	152 (2)
425	111	150 (2)
450	109	147 (2)
475	108	145 (2)
500	106	143 (2)
525	105	142 (2)
550	104	140 (2)
575	103	136 (1), (2)
600	103	113 (1), (2)
625	95.2 (1)	95.2 (1)
650	80.6 (1)	80.6 (1)
675	68.6 (1)	68.6 (1)
700	58.4 (1)	58.4 (1)
725	49.6 (1)	49.6 (1)
750	42.0 (1)	42.0 (1)
775	35.2 (1)	35.2 (1)
800	29.2 (1), (3)	29.2 (1), (3)

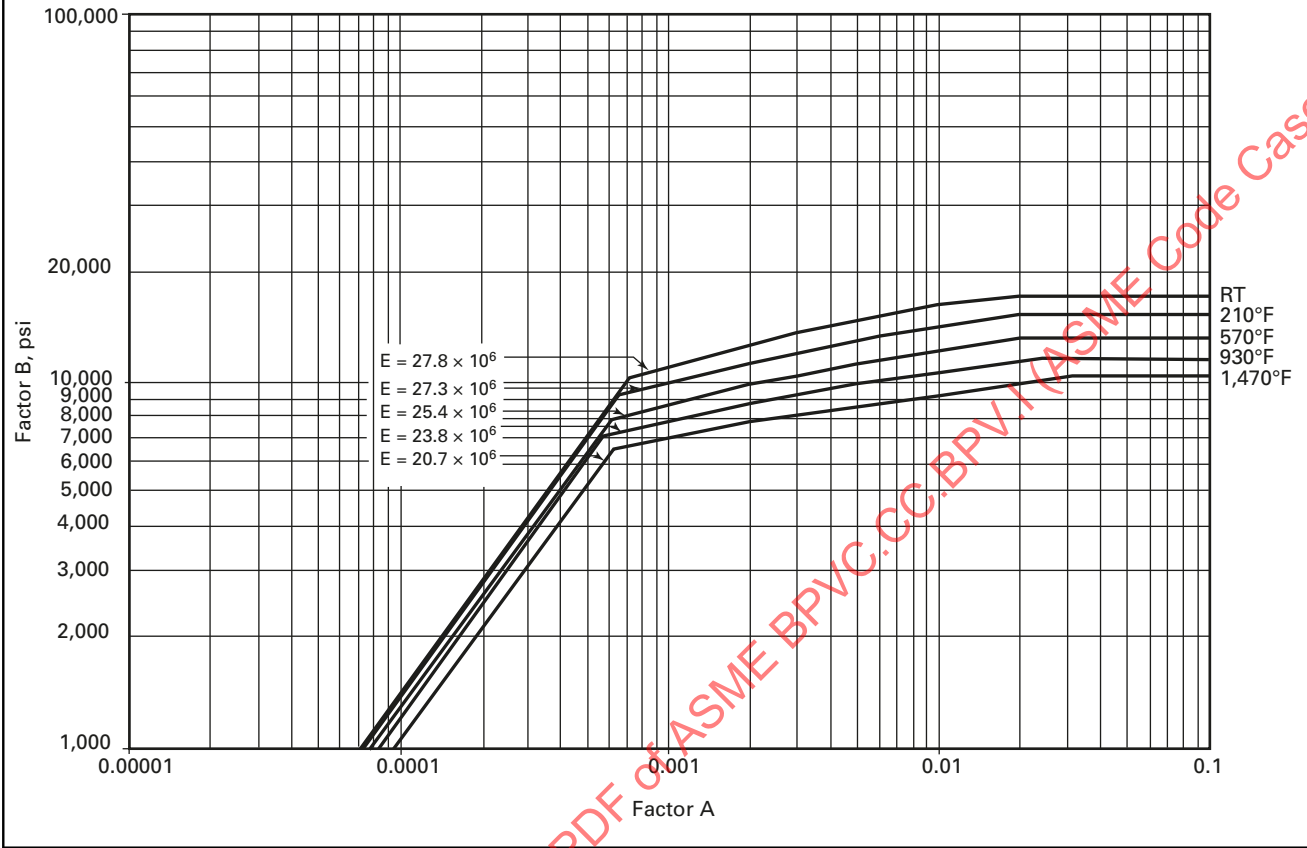
NOTES:

- (1) These stress values are obtained from time-dependent properties.
- (2) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short time tensile properties govern to permit the use of this alloy where slightly greater deformation is acceptable. These higher stress values exceed 66<sup>2</sup>/<sub>3</sub>% but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for applications where slight amounts of distortion can cause leakage or malfunction.
- (3) The maximum use temperature for this alloy is 800°C (1472°F); the value listed at 1500°F is provided for interpolation purposes only.

**Table 8**  
**Tabular Values for Figures 1 and 1M**

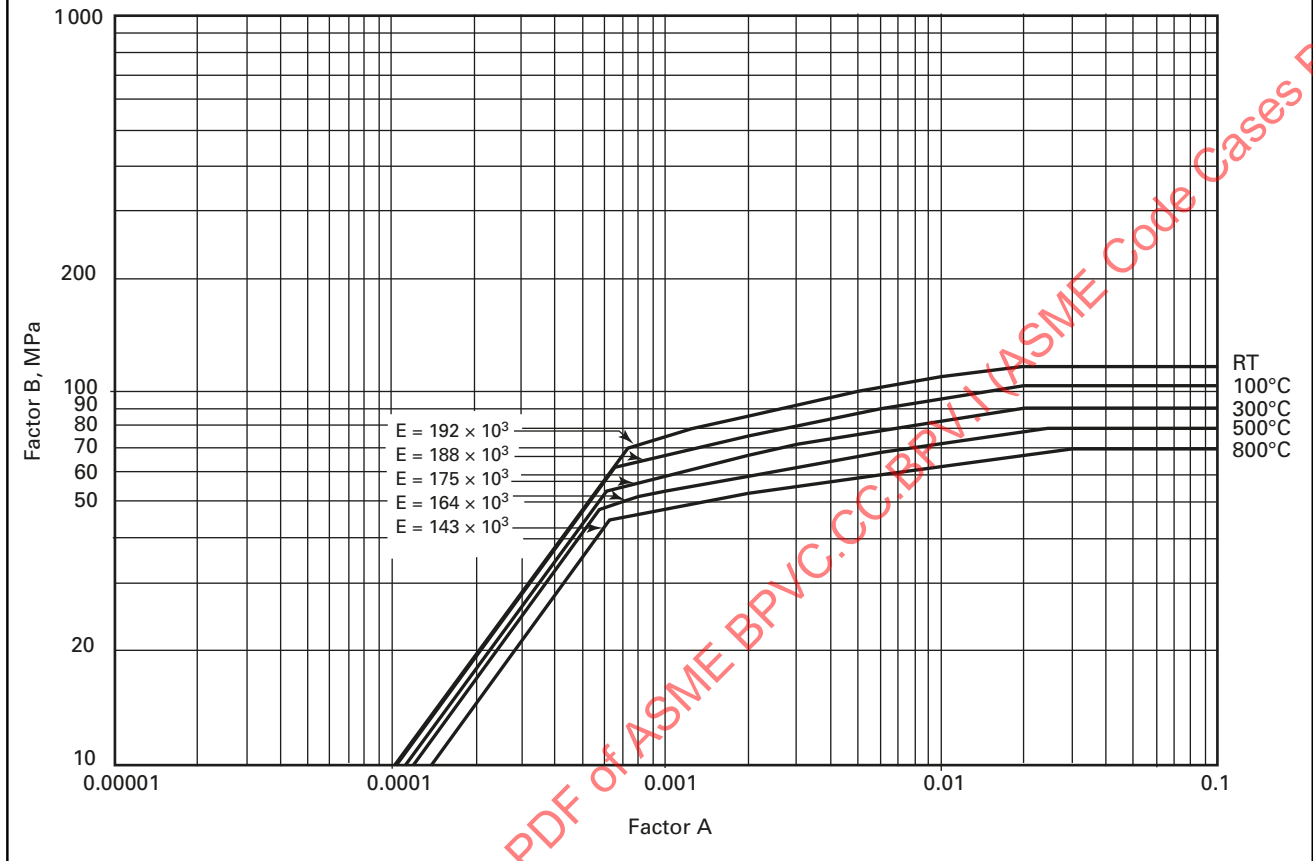
Temperature, °F	A	B, psi	Temperature, °C	A	B, MPa		
RT	1.00E-05	139	RT	1.00E-05	1.0		
	7.19E-05	1,000		1.04E-04	10.0		
	7.29E-04	10,100		7.29E-04	70.0		
	1.26E-03	11,400		1.26E-03	80.0		
	2.34E-03	12,800		2.34E-03	88.0		
	3.85E-03	13,900		3.85E-03	96.0		
	1.02E-02	16,000		1.02E-02	110.0		
	2.00E-02	17,000		2.00E-02	117.5		
	1.00E-01	17,000		1.00E-01	117.5		
	210	1.00E-05		137	100	1.00E-05	0.9
7.33E-05		1,000	1.06E-04	10.0			
6.65E-04		9,100	6.65E-04	62.5			
1.31E-03		10,300	1.31E-03	71.0			
2.97E-03		11,800	2.97E-03	81.0			
6.00E-03		13,100	6.00E-03	90.0			
1.12E-02		14,200	1.12E-02	98.0			
2.00E-02		15,200	2.00E-02	104.5			
1.00E-01		15,200	1.00E-01	104.5			
570		1.00E-05	127	300		1.00E-05	0.9
	7.87E-05	1,000	1.14E-04		10.0		
	6.17E-04	7,800	6.17E-04		54.0		
	1.42E-03	9,100	1.42E-03		63.0		
	2.52E-03	10,000	2.52E-03		70.0		
	5.84E-03	11,300	5.84E-03		78.0		
	2.06E-02	13,100	2.06E-02		90.5		
	1.00E-01	13,100	1.00E-01		90.5		
	930	1.00E-05	119		500	1.00E-05	0.8
		8.40E-05	1,000			1.22E-04	10.0
5.82E-04		7,000	5.82E-04	48.0			
8.05E-04		7,500	8.05E-04	52.0			
1.92E-03		8,600	1.92E-03	59.0			
5.22E-03		9,800	5.22E-03	68.0			
2.45E-02		11,500	2.45E-02	79.5			
1.00E-01		11,500	1.00E-01	79.5			
1,470		1.00E-05	104	800		1.00E-05	0.7
		9.66E-05	1,000			1.40E-04	10.0
	6.29E-04	6,500	6.29E-04		45.0		
	1.32E-03	7,300	1.32E-03		50.0		
	3.04E-03	8,100	3.04E-03		56.0		
	3.16E-02	10,300	3.16E-02		71.0		
	1.00E-01	10,300	1.00E-01		71.0		

**Figure 1**  
**Chart for Determining Shell Thickness of Components under External Pressure Developed for**  
**47Ni-23Cr-23Fe-7W, UNS N06674**



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**Figure 1M**  
**Chart for Determining Shell Thickness of Components under External Pressure Developed for**  
**47Ni-23Cr-23Fe-7W, UNS N06674**



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Approval Date: August 3, 2011

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2685**  
**Special Requirements for Filament-Winding Procedure**  
**Qualification (Class I Vessels)**  
**Section X**

*Inquiry:* Is it permissible to produce Class I pressure vessels and pressure vessel parts without requalifying the design as required by RQ-400 when there is a change to the reinforcing fiber manufacturer's name and fiber designation as required by RQ-400, provided all of the other requirements of Section X have been met?

*Reply:* It is the opinion of the Committee that Class I pressure vessels and pressure vessel parts may be produced without requalifying the design when there is a

change to the reinforcing fiber manufacturer's name and fiber designation, provided only the product labeling has changed as a result of a business or commercial event having no effect on the manufacturing process. The fiber shall be identical in all specifications, fabrication processes, furnace machinery used to produce the fiber, and location of the fabrication site. The fiber sizing shall not be altered. Material certificates shall be identical, with the exception of fiber manufacturer's name and fiber designation, and material traceability shall remain intact. It shall be the manufacturer's responsibility to certify that these requirements have been met and to notify the Authorized Inspector of the fiber manufacturer's name and fiber designation change. This Case number shall be recorded on the appropriate Section X Data Report Form.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: August 5, 2011

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2686**  
**Use of Appendix 23 for External Pressure Design of**  
**Copper and Copper Alloy Condenser and Heat**  
**Exchanger Tubes With Integral Fins at Elevated**  
**Temperatures**  
**Section VIII, Division 1**

*Inquiry:* May copper and copper alloy condenser and heat exchanger tubes with integral fins be used under the rules of Section VIII, Division 1, Appendix 23 at design temperatures exceeding 150°F (65°C)?

*Reply:* It is the opinion of the Committee that copper and copper alloy condenser and heat exchanger tubes with integral fins may be used under the rules of Section VIII, Division 1, Appendix 23 at design temperatures exceeding 150°F (65°C), provided the following requirements are met:

(a) The design temperature shall be limited to the maximum temperature listed in Section II, Part D, Table 1B corresponding to the time independent allowable stress, or the maximum temperature shown on the external pressure chart for the corresponding material, whichever is less.

(b) This Case number shall be identified in the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: December 18, 2017

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2687-1**  
**UNS S31635 Tubing**  
**Section IV**

*Inquiry:* Under what conditions may UNS S31635 austenitic stainless steel in the material specification SA-213/SA-213M Grade TP316Ti be used in the construction of hot water heating boilers?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used in the welded construction of hot water heating boilers, provided the following requirements are met:

(a) The allowable stress values for the tubing in accordance with SA-213/SA-213M Grade TP316Ti shall be as listed in [Tables 1](#) and [1M](#).

(b) For the purpose of welding procedure and performance qualification this material shall be considered P-No. 8, Group 1.

(c) For external pressure, Fig. HA-2 of Section II, Part D shall be used.

(d) The maximum design temperature shall be 500°F (260°C).

(e) The water temperature shall not exceed 210°F (98°C).

(f) Tubing may utilize the thickness requirements of HF-203.4 at pressures up to 160 psi (1 100 kPa).

(g) All other requirements of Section IV shall be met.

(h) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values for**  
**SA-213/SA-213M Grade TP316TI**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi
100	15.0
150	15.0
200	15.0
250	15.0
300	15.0
400	14.3
500	13.2

GENERAL NOTE: This steel may be expected to develop embrittlement after service at moderately elevated temperatures; see Appendix A, A-207 and A-208 of Section II, Part D.

**Table 1M**  
**Maximum Allowable Stress Values for**  
**SA-213/SA-213M Grade TP316TI**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Values, MPa
40	103
100	103
150	103
200	99.3
225	95.3
250	92.0
275 [Note (1)]	89.3

GENERAL NOTE: This steel may be expected to develop embrittlement after service at moderately elevated temperatures; see Appendix A, A-207 and A-208 of Section II, Part D.

NOTE:

(1) The maximum use temperature shall be 260°C. Datum for 275°C temperature is provided for interpolation purposes.

Approval Date: August 19, 2011

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2688**  
**Use of Austenitic Stainless Steel Material With**  
**Minimum Thickness of 0.020 in. (0.5 mm) for Hot Water**  
**Heating Boilers**  
**Section IV**

*Inquiry:* Is it permitted to use stainless steel tubes or pipes with a minimum thickness of 0.020 in. (0.5 mm) and an outside diameter not exceeding 0.913 in. (23.2 mm), attached by brazing to a stainless steel tube-sheet for the construction of hot water heating boilers under Section IV?

*Reply:* It is the opinion of the Committee that stainless steel tubes or pipes with a minimum thickness of 0.020 in. (0.5 mm) and an outside diameter not exceeding 0.913 in. (23.2 mm), attached by brazing to a stainless steel tubesheet may be used in Section IV, Part HF construction of hot water heating boilers, under the following conditions and made of materials as shown in [Table 1](#):

- (a) Maximum Allowable Working Pressure shall not exceed 45 psi (310 kPa).
- (b) External pressure is not permitted.
- (c) The maximum water temperature shall be 210°F (99°C).
- (d) Welding is not permitted.
- (e) All applicable requirements for furnace brazing shall apply as follows:
  - (1) braze filler metal to be used: BNi-1A (SFA-5.8 AWS classification BNi-1A).
  - (2) furnace brazing temperature above annealing temperature of approximately 2160°F (1180°C).
  - (3) brazing time 30 min at above stated temperature.
  - (4) brazed under vacuum conditions, no protective blanket is required.
  - (5) the complete assembly shall be brazed under these conditions.
- (f) All other applicable parts of Section IV shall apply.
- (g) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Materials**

<b>Product Form</b>	<b>Specification</b>	<b>Grade</b>
Pipe	SA-312	TP304L, TP316L
Tube	SA-213/SA-213M	TP304L
	SA-249	TP316L
Plate	SA-240	304L, 316L

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Approval Date: October 2, 2014

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2690-1**  
**Attaching Nozzles and Fittings to Headers and Vessels**  
**Section IV**

*Inquiry:* Under what conditions is it permissible to attach nozzles and fittings to headers and vessels constructed to Section IV, Part HLW using single fillet welds that are smaller than those required by HLW-431.5 and Fig. HLW-431.5, sketches (k) and (l)?

*Reply:* It is the opinion of the Committee that it is permissible to attach nozzles and fittings to headers and vessels constructed to Section IV, Part HLW using single fillet

welds that are smaller than those required by HLW-431.5 and Fig. HLW-431.5, sketches (k) and (l) under the following conditions:

(a) The nozzles and fittings shall not exceed NPS 1½ (DN 40).

(b) The vessel wall thickness shall not exceed ¾ in. (10 mm).

(c) The fillet weld shall have a minimum throat dimension of 0.7t and a minimum leg dimension of ³⁄₃₂ in. (2.5 mm).

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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**Approval Date: August 23, 2011**

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2691**  
**Revised Manufacturer's Data Reports**  
**Section IV**

*Inquiry:* Is it permissible to use revised Manufacturer's Data Reports to avoid conflict with the requirements of QAI-1, which requires the Inspector to have a National Board commission and endorsement?

*Reply:* It is the opinion of the Committee that that it is permissible to use revised Manufacturer's Data Reports requiring only the Inspector's signature, National Board commission number, and endorsement to be recorded, provided the following requirements are met:

(a) Revised data reports shall be as shown in Forms H-2R, H-3R, H-4R, H-6R, HLW-6R, HLW-7R, and HLW-8R.

(b) Preparation of the revised Manufacturer's Data Reports shall be per instructions in [Table 1](#).

(c) All other requirements of Section IV shall be met.

(d) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**FORM H-2R MANUFACTURER'S DATA REPORT FOR ALL TYPES OF BOILERS  
 EXCEPT WATERTUBE AND THOSE MADE OF CAST IRON  
 As Required by the Provisions of the ASME Code Rules, Section IV and Code Case 2691**

1. Manufactured and certified by \_\_\_\_\_ (1) \_\_\_\_\_  
(name and address of manufacturer)
2. Manufactured for \_\_\_\_\_ (2) \_\_\_\_\_  
(name and address of purchaser)
3. Location of installation \_\_\_\_\_ (3) \_\_\_\_\_  
(name and address)
4. Unit identification \_\_\_\_\_ (4) \_\_\_\_\_ (5) \_\_\_\_\_ (6) \_\_\_\_\_  
(complete boiler, superheater, waterwall, economizer, etc.) (manufacturer's serial no.) (CRN) (drawing no.) (National Bd. no.) (year built)

5. The chemical and physical properties of all parts meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE. The design, construction, and workmanship conform to ASME Code, Section IV, \_\_\_\_\_ (7) \_\_\_\_\_ (8) \_\_\_\_\_ (9) \_\_\_\_\_  
(year) [addenda (as applicable)](date) (Code Case no.)

Manufacturer's Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of this report \_\_\_\_\_ (30) \_\_\_\_\_ (55) \_\_\_\_\_  
(name of part, item number, manufacturer's name, and identifying stamp)

6. Shells or drums \_\_\_\_\_ (10) \_\_\_\_\_ (11) \_\_\_\_\_ (41) \_\_\_\_\_ (10) \_\_\_\_\_ \_\_\_\_\_ (6) \_\_\_\_\_  
(no.) (material spec., gr.) (thickness) (inside diameter) [length (overall)] (inside diameter) [length (overall)]
7. Joints \_\_\_\_\_ (12) \_\_\_\_\_ (13) \_\_\_\_\_ (12) \_\_\_\_\_  
[long, (seamless, welded)] [eff. (compared to seamless)] [girth (seamless, welded)] (no. of shell courses)
8. Tubesheet \_\_\_\_\_ (11) \_\_\_\_\_ (thickness) Tube holes \_\_\_\_\_ (number and diameter)
9. Tubes: No. \_\_\_\_\_ (11) \_\_\_\_\_ Diameter \_\_\_\_\_ Length \_\_\_\_\_ Gauge \_\_\_\_\_  
(material spec., grade) (straight or bent) (if various, give max. and min.) (or thickness)
10. Heads \_\_\_\_\_ (11) \_\_\_\_\_ (thickness) \_\_\_\_\_ (flat, dished, ellipsoidal) \_\_\_\_\_ (radius of dish)
11. Furnace \_\_\_\_\_ (11) \_\_\_\_\_ (14) \_\_\_\_\_ (15) \_\_\_\_\_ (16) \_\_\_\_\_ (18) \_\_\_\_\_  
(material spec., gr.) (thickness) (no.) [size (O.D. or W x H)] [length (each section)] (total) [type (plain, corrugated, etc.)] Seams [type (seamless, welded)]
12. Staybolts \_\_\_\_\_ (17) \_\_\_\_\_ (11) \_\_\_\_\_ (18) \_\_\_\_\_ (19) \_\_\_\_\_  
(no.) [size (diameter)] (material spec., gr.) (size) (telltale) (net area) [pitch (horizontal and vertical)] (MAWP)
13. Stays or braces:

Location	Material Spec.	Type	Number and Size	Pitch	Total Net Area	Fig. HG-343 L/I	Dist. Tubes to Shell	MAWP
(a) F.H. above tubes	(11)	(20)			(21)	(22)		
(b) R.H. above tubes								
(c) F.H. below tubes								
(d) R.H. below tubes								
(e) Through stays								

14. Other parts: 1. \_\_\_\_\_ (23) \_\_\_\_\_ 2. \_\_\_\_\_ 3. \_\_\_\_\_  
(brief description, i.e., dome, boiler piping)
1. \_\_\_\_\_ (24) \_\_\_\_\_ (11) \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_  
(material spec., grade, size, material thickness, MAWP)

15. Nozzles, inspection, and safety valve openings: \_\_\_\_\_ (25)

Purpose (inlet, outlet, drain, etc.)	No.	Diameter or Size	Type	How Attached	Material	Nominal Thickness	Reinforcement Material	Location
Handhole					NA		NA	
Manhole					(11)			

FORM H-2R (Back)

16. Boiler supports \_\_\_\_\_ (no.) \_\_\_\_\_ [type (saddles, legs, lugs)] \_\_\_\_\_ [attachment (bolted or welded)] \_\_\_\_\_

17. MAWP <sup>(26)</sup> \_\_\_\_\_ Based on <sup>(27)</sup> \_\_\_\_\_ Heating surface <sup>(28)</sup> \_\_\_\_\_ Shop hydro. test <sup>(29)</sup> \_\_\_\_\_  
(Code par. and/or formula) (total) (complete boiler)

18. Maximum water temperature <sup>(73)</sup> \_\_\_\_\_

19. Remarks \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**CERTIFICATE OF SHOP COMPLIANCE**

We certify that the statements made in this data report are correct and that all details of design, material, construction, and workmanship of this boiler conform to Section IV of the ASME BOILER AND PRESSURE VESSEL CODE.

"H" Certificate of Authorization no. <sup>(31)</sup> \_\_\_\_\_ expires \_\_\_\_\_, \_\_\_\_\_

Date <sup>(32)</sup> \_\_\_\_\_ Signed \_\_\_\_\_ Name \_\_\_\_\_  
(by representative) (manufacturer that constructed and certified boiler)

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**<sup>(33)</sup> CERTIFICATE OF SHOP INSPECTION**

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by \_\_\_\_\_

\_\_\_\_\_ have inspected parts of this boiler referred to as data items <sup>(34)</sup> \_\_\_\_\_ and have examined Manufacturers' Partial Data Reports for items <sup>(35)</sup> \_\_\_\_\_ and state that, to the best of my knowledge and belief, the manufacturer has constructed this boiler in accordance with the applicable sections of the ASME BOILER AND PRESSURE VESSEL CODE.

By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the boiler described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date \_\_\_\_\_ Signed \_\_\_\_\_ Commission <sup>(36)</sup> \_\_\_\_\_  
(Authorized Inspector) (National Board commission number and endorsement)

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**CERTIFICATE OF FIELD ASSEMBLY COMPLIANCE**

We certify that the field assembly construction of all parts of this boiler conforms with the requirements of Section IV of the ASME BOILER AND PRESSURE VESSEL CODE.

"H" Certificate of Authorization no. <sup>(37)</sup> \_\_\_\_\_ expires \_\_\_\_\_, \_\_\_\_\_

Date <sup>(38)</sup> \_\_\_\_\_ Signed \_\_\_\_\_ Name \_\_\_\_\_  
(by representative) (assembler that certified and constructed field assembly)

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**<sup>(39)</sup> CERTIFICATE OF FIELD ASSEMBLY INSPECTION**

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by \_\_\_\_\_

\_\_\_\_\_ have compared the statements in this Manufacturer's Data Report with the described boiler and state that the parts referred to as data items <sup>(40)</sup> \_\_\_\_\_, not included in the certificate of shop inspection, have been inspected by me and that to the best of my knowledge and belief the manufacturer and/or the assembler has constructed and assembled this boiler in accordance with the applicable sections of the ASME BOILER AND PRESSURE VESSEL CODE. The described boiler was inspected and subjected to a hydrostatic test of <sup>(29)</sup> \_\_\_\_\_.

By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the boiler described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date \_\_\_\_\_ Signed \_\_\_\_\_ Commission <sup>(36)</sup> \_\_\_\_\_  
(Authorized Inspector) (National Board commission number and endorsement)

(12/11)

**FORM H-3R MANUFACTURER'S DATA REPORT FOR WATERTUBE BOILERS**  
**As Required by the Provisions of the ASME Code Rules, Section IV and Code Case 2691**

1. Manufactured and certified by \_\_\_\_\_ (1)  
(name and address of manufacturer)
2. Manufactured for \_\_\_\_\_ (2)  
(name and address of purchaser)
3. Location of installation \_\_\_\_\_ (3)  
(name and address)
4. Unit identification \_\_\_\_\_ (4) \_\_\_\_\_ (5) \_\_\_\_\_ (6)  
(complete boiler, superheater, waterwall, etc.) (manufacturer's serial no.) (CRN) (drawing no.) (National Bd. no.) (year built)
5. The chemical and physical properties of all parts meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE. The design, construction, and workmanship conform to ASME Code, Section IV, \_\_\_\_\_ (7) \_\_\_\_\_ (8) \_\_\_\_\_ (9)  
(year) (addenda (as applicable)(date)) (Code Case no.)

6. (a) Drums:

No.	Inside Diameter	Inside Length	Shell Plates			Tube Sheets		Tube Hole Ligament Efficiency, %	
			Material Spec. Grade	Thickness	Inside Radius	Thickness	Inside Radius	Longitudinal	Circumferential
1			(11)	(41)		(41)			
2									

No.	Longitudinal Joints		Circum. Joints		Heads				Hydro-static Test
	No. & Type*	Efficiency	No. & Type	Efficiency	Material Spec. Grade	Thickness	Type**	Radius of Dish	
1					(11)	(42)		(43)	(44)
2									

\*Indicate if (1) seamless, (2) fusion welded.

\*\*Indicate if (1) flat, (2) dished, (3) ellipsoidal, (4) hemispherical.

6. (b) Boiler tubes:

Diameter	Thickness	Material Spec. No. Grade	No.	How Attached

6. (c) Headers no \_\_\_\_\_ (45)

\_\_\_\_\_ (11) \_\_\_\_\_ (41) or \_\_\_\_\_ (42)  
(box or sinuous or round, material spec. no., thickness)

Heads or ends \_\_\_\_\_ (46) \_\_\_\_\_ (11) \_\_\_\_\_ (42) Hydro. test \_\_\_\_\_ (44)  
(shape, material spec. no., thickness)

6. (d) Staybolts \_\_\_\_\_ (11)

\_\_\_\_\_ (material spec. no., diameter, size telltale, net area)

Pitch \_\_\_\_\_ Net area \_\_\_\_\_ Design pressure \_\_\_\_\_  
(supported by one bolt)

6. (e) Mud drum \_\_\_\_\_ (47) \_\_\_\_\_ (48) \_\_\_\_\_ (11) \_\_\_\_\_ (41) or \_\_\_\_\_ (42)

Heads or ends \_\_\_\_\_ (46) \_\_\_\_\_ (11) \_\_\_\_\_ (42)  
(for sect. header boilers state size, shape, material spec. no., thickness)

\_\_\_\_\_ (46) \_\_\_\_\_ (11) \_\_\_\_\_ (42) Hydro. test \_\_\_\_\_ (44)  
(shape, material spec. no., thickness)

7. Waterwall headers:

No.	Size and Shape	Material Spec. No. Gr.	Thickness	Shape	Thickness	Material Spec. No. Gr.	Hydro. Test	Diameter	Thickness	Material Spec. No. Gr.
1	(47) (48)	(11)	(41) or (43)	(46)	(42)	(11)	(44)	(49)	(50)	(11)
2										
3										

8. (a) Other parts (1) \_\_\_\_\_ (2) \_\_\_\_\_ (3) \_\_\_\_\_

(b) Tubes for other parts \_\_\_\_\_

1										
2										
3										

9. Nozzles, inspection, and safety valve openings: (25)

Purpose (inlet, outlet, drain, etc.)	No.	Diameter or Size	Type	How Attached	Material	Nom. Thickness	Reinforcement Material	Location
Handhole		(51)	(52)		NA		NA	
Manhole					(11)			

FORM H-3R (Back)

10.

		MAWP	Maximum water temp.	Shop Hydro. Test	Heating Surface
a	Boiler	(26)	(73)		
b	Waterwall				
c	Superheater				
d	Other parts				

Heating surface to be stamped on drum heads. This heating surface not to be used for determining minimum safety valve capacity.

11. Field Hydro. Test


12. Manufacturer's Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of this report \_\_\_\_\_ (30) \_\_\_\_\_ (55)

(name of part, item number, manufacturer's name, and identifying stamp)

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

13. Remarks \_\_\_\_\_

**CERTIFICATE OF SHOP COMPLIANCE**

We certify that the statements made in this data report are correct and that all details of design, material, construction, and workmanship of this boiler conform to Section IV of the ASME BOILER AND PRESSURE VESSEL CODE.

"H" Certificate of Authorization No. \_\_\_\_\_ (31) expires \_\_\_\_\_.

Date \_\_\_\_\_ (32) Signed \_\_\_\_\_ Name \_\_\_\_\_ (manufacturer that constructed and certified boiler)

(33) **CERTIFICATE OF SHOP INSPECTION**

Boiler constructed by \_\_\_\_\_ at \_\_\_\_\_.

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by \_\_\_\_\_

\_\_\_\_\_ have inspected parts of this boiler referred to as data items \_\_\_\_\_ (34) and have examined Manufacturer's Partial Data Reports for items \_\_\_\_\_ (35) and state that, to the best of my knowledge and belief, the manufacturer has constructed this boiler in accordance with Section IV of the ASME BOILER AND PRESSURE VESSEL CODE.

By signing this certificate neither the inspector nor his employer makes any warranty, expressed or implied, concerning the boiler described in this Manufacturer's Data Report. Furthermore, neither the inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date \_\_\_\_\_ Signed \_\_\_\_\_ (Authorized Inspector) Commission \_\_\_\_\_ (36) (National Board commission number and endorsement)

**CERTIFICATE OF FIELD ASSEMBLY COMPLIANCE**

We certify that the field assembly construction of all parts of this boiler conforms with the requirements of Section IV of the ASME BOILER AND PRESSURE VESSEL CODE.

"H" Certificate of Authorization no. \_\_\_\_\_ (37) expires \_\_\_\_\_.

Date \_\_\_\_\_ (38) Signed \_\_\_\_\_ Name \_\_\_\_\_ (assembler that certified and constructed field assembly)

(39) **CERTIFICATE OF FIELD ASSEMBLY INSPECTION**

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by \_\_\_\_\_

\_\_\_\_\_ have compared the statements in this Manufacturer's Data Report with the described boiler and state that the parts referred to as data items \_\_\_\_\_ (40) not included in the certificate of shop inspection, have been inspected by me and that to the best of my knowledge and belief the manufacturer and/or the assembler has constructed and assembled this boiler in accordance with Section IV of the ASME BOILER AND PRESSURE VESSEL CODE. The described boiler was inspected and subjected to a hydrostatic test of \_\_\_\_\_.

By signing this certificate neither the inspector nor his employer makes any warranty, expressed or implied, concerning the boiler described in this Manufacturer's Data Report. Furthermore, neither the inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date \_\_\_\_\_ Signed \_\_\_\_\_ (Authorized Inspector) Commission \_\_\_\_\_ (36) (National Board commission number and endorsement)

(12/11)

**FORM H-4R MANUFACTURER'S PARTIAL DATA REPORT**  
**As Required by the Provisions of the ASME Code Rules and Code Case 2691**  
**(Attach to the Applicable Data Report, Section IV)**

1. Manufactured and certified by \_\_\_\_\_ (1) \_\_\_\_\_ H-4 ID# \_\_\_\_\_ (72)  
(name and address of manufacturer)

2. Manufactured for \_\_\_\_\_ (2) \_\_\_\_\_  
(name and address of purchaser)

3. Location of installation \_\_\_\_\_ (3) \_\_\_\_\_  
(name and address)

4. Identification of part(s):

Name of Part	Line No.	Manufacturer's Serial No.	Manufacturer's Drawing No.	CRN	National Bd. No.	Year Built
(53)	(54)	(5)				(6)

5. The chemical and physical properties of all parts meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE. The design, construction, and workmanship conform to ASME Code, Section IV, \_\_\_\_\_ (7) \_\_\_\_\_ (8) \_\_\_\_\_ (9)  
(year) (addenda (as applicable)(date)) (Code Case no.)

6. (a) Drums:

No.	Inside Diameter	Inside Length	Shell Plates			Tube Sheets		Tube Hole Ligament Efficiency, %	
			Material Spec. No. Grade	Thickness	Inside Radius	Thickness	Inside Radius	Longitudinal	Circumferential
1			(11)	(41)		(41)			
2									

No.	Longitudinal Joints		Circum. Joints		Heads				Hydro-static Test
	No. & Type*	Efficiency	No. & Type	Efficiency	Material Spec. No. Grade	Thickness	Type**	Radius of Dish	
1					(11)	(42)		(43)	(44)
2									

\*Indicate if (1) seamless, (2) fusion welded.

\*\*Indicate if (1) flat, (2) dished, (3) ellipsoidal, (4) hemispherical.

6. (b) Boiler tubes:

Diameter	Thickness	Material Spec. No. Grade	No.	How Attached

6. (c) Headers no \_\_\_\_\_ (45) \_\_\_\_\_ (11) \_\_\_\_\_ (41) or (42)  
(box or sinuous or round, material spec. no., thickness)

Heads or ends \_\_\_\_\_ (46) \_\_\_\_\_ (11) \_\_\_\_\_ (42) Hydro. test \_\_\_\_\_ (44)  
(shape, material spec. no., thickness)

6. (d) Staybolts \_\_\_\_\_ (11) \_\_\_\_\_  
(material spec. no. diameter, size telltale; net area)

Pitch \_\_\_\_\_ Net area \_\_\_\_\_ Design pressure \_\_\_\_\_  
(supported by one bolt)

6. (e) Mud drum \_\_\_\_\_ (47) \_\_\_\_\_ (48) \_\_\_\_\_ (11) \_\_\_\_\_ (41) or (42) Heads or ends \_\_\_\_\_ (46) \_\_\_\_\_ (11) \_\_\_\_\_ (42) Hydro. test \_\_\_\_\_ (44)  
(for sect. header boilers, state size, shape, material spec. no., thickness) (shape, material spec. no., thickness)

7. Waterwall headers:

No.	Size and Shape	Material Spec. No. Gr.	Thickness	Shape	Thickness	Material Spec. No. Gr.	Hydro Test	Diameter	Thickness	Material Spec. No. Gr.
1	(47)	(11)	(41) or (42)	(46)	(42)	(11)	(44)	(49)	(45)	(11)
2										
3										

8. (a) Other parts (1) \_\_\_\_\_ (2) \_\_\_\_\_ (3) \_\_\_\_\_ (b) Tubes for other parts \_\_\_\_\_

1										
2										
3										

FORM H-4R (Back)

9. Nozzles, inspection and safety valve openings: (25)

Purpose (inlet, outlet, drain, etc.)	No.	Diameter or Size	Type	How Attached	Material	Nom. Thickness	Reinforcement Material	Location
Handhole		(51)	(52)		NA		NA	

10.

		MAWP	Maximum Water Temp.	Shop Hydro. Test	Heating Surface	
a	Boiler	(26)	(73)			Heating surface or kW to be stamped on drum heads This heating surface not to be used for determining minimum safety valve capacity.
b	Waterwall					
c	Other parts					

11. Field Hydro. Test

12. Remarks (55)

\_\_\_\_\_

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\_\_\_\_\_

**CERTIFICATE OF SHOP COMPLIANCE**

We certify that the statements made in this partial data report are correct and that all details of design, material, construction, and workmanship of these parts conform to Section IV of the ASME BOILER AND PRESSURE VESSEL CODE.

"H" Certificate of Authorization no. (31) expires \_\_\_\_\_, \_\_\_\_\_.

Date (32) Signed \_\_\_\_\_ Name \_\_\_\_\_  
(by representative) (manufacturer that constructed and certified boiler)

(33) **CERTIFICATE OF SHOP INSPECTION**

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by \_\_\_\_\_

\_\_\_\_\_ have inspected the part of a boiler described in this Manufacturer's Partial Data Report on \_\_\_\_\_, \_\_\_\_\_, and state that to the best of my knowledge and belief, the manufacturer has constructed this part in accordance with Section IV of the ASME BOILER AND PRESSURE VESSEL CODE. By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the part described in this Manufacturer's Partial Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date \_\_\_\_\_ Signed \_\_\_\_\_ Commission (36) \_\_\_\_\_  
(Authorized Inspector) (National Board commission number and endorsement)



**FORM HLW-6R MANUFACTURER'S DATA REPORT FOR WATER HEATERS OR STORAGE TANKS**  
**As Required by the Provisions of the ASME Code Rules and Code Case 2691**

1. Manufactured and certified by \_\_\_\_\_ (1)  
(name and address of manufacturer)
2. Manufactured for \_\_\_\_\_ (2)  
(name and address of purchaser)
3. Location of installation \_\_\_\_\_ (3)  
(name and address)
4. Identification \_\_\_\_\_ (5) \_\_\_\_\_ (CRN) \_\_\_\_\_ (drawing no.) \_\_\_\_\_ (National Board no.) \_\_\_\_\_ (year built) (6)
5. The chemical and physical properties of all parts meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE. The design, construction, and workmanship conform to Part HLW, Section IV \_\_\_\_\_ (year) \_\_\_\_\_ (addenda (as applicable)(date)) \_\_\_\_\_ (Code Case no.) (7) (8) (9)
6. Shell \_\_\_\_\_ (63) \_\_\_\_\_ (11) \_\_\_\_\_ (41) \_\_\_\_\_ (64) \_\_\_\_\_ (63) \_\_\_\_\_ (length (overall)) (12)  
(no.) (material spec., gr.) thickness (lining) (diameter)
7. Joints \_\_\_\_\_ (12) \_\_\_\_\_ (13) \_\_\_\_\_ (12) \_\_\_\_\_ (no. of shell courses)  
[long. (seamless, welded)] [eff. (compared to seamless)] [girth (seamless, welded)]
8. Heads \_\_\_\_\_ (46)

Location	Material Spec., Gr., Thickness	Crown Radius	Knuckle Radius	Elliptical Ratio	Flat Diameter	Side Pressure (concave, convex)

9. Tubesheet \_\_\_\_\_ (11) Tubes \_\_\_\_\_ (11) \_\_\_\_\_ (11) \_\_\_\_\_ (11) \_\_\_\_\_ (11) \_\_\_\_\_ (11)  
(material spec., gr.) (no.) (size) [length (overall)] (material spec., gr.) (thickness) (rolled or welded)
10. Nozzles, inspection, and safety valve openings: (25)

Purpose (inlet, outlet, drain, etc.)	No.	Diameter or Size	Type	How Attached	Material	Nominal Thickness	Reinforcement Material	Location
Handhole			NA		NA		NA	
					(11)			

11. MAWP \_\_\_\_\_ (65) Max. input \_\_\_\_\_ (66) Max. temp. \_\_\_\_\_ (67) Hydrostatic test \_\_\_\_\_ (68)

12. Manufacturer's Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of this report \_\_\_\_\_ (30) \_\_\_\_\_ (55)  
(name of part, item no., manufacturer's name, identification stamps)
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_

13. Remarks \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
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- \_\_\_\_\_
- \_\_\_\_\_

FORM HLW-6R (Back)

<b>CERTIFICATE OF SHOP COMPLIANCE</b>	
We certify that the statements made in this data report are correct and that all details of design, material, construction, and workmanship of this water heater or storage tank conform to Section IV of the ASME BOILER AND PRESSURE VESSEL CODE. "HLW" Certificate of Authorization no. _____ expiration date _____	
Date _____	Name _____ <small>(manufacturer that constructed and certified water heater or storage tank)</small>
Signed _____ <small>(by representative)</small>	
<b>CERTIFICATE OF SHOP INSPECTION</b>	
Constructed by _____ at _____	
I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by _____	
have inspected parts referred to as data items _____	
and have examined Manufacturer's Partial Data Reports for items _____	
and state that, to the best of my knowledge and belief, the manufacturer has constructed this water heater or storage tank in accordance with Section IV of the ASME BOILER AND PRESSURE VESSEL CODE.	
By signing this certificate, neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the water heater or storage tank described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.	
Date _____	Signed _____ <small>(Authorized Inspector)</small>
Commission _____ <small>(National Board commission number and endorsement)</small>	

**FORM HLW-7R MANUFACTURER'S PARTIAL DATA REPORT FOR WATER HEATERS AND STORAGE TANKS**  
**As Required by the Provisions of the ASME Code Rules and Code Case 2691**  
**(Attach to the Applicable Form HLW-6R Data Report)**

1. Manufactured and certified by \_\_\_\_\_ (1) \_\_\_\_\_ HLW-7 ID# \_\_\_\_\_ (72)  
(name and address of manufacturer)

2. Manufactured for \_\_\_\_\_ (2) \_\_\_\_\_  
(name and address of purchaser)

3. Identification of part(s):

Name of Part	Line No.	Identifying No.	Manufacturer's Drawing No.	Year Built
(53)	(54)	(5)		(6)

4. The chemical and physical properties of all parts meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE. The design, construction, and workmanship conform to Part HLW, Section IV \_\_\_\_\_ (7) \_\_\_\_\_ and Addenda (as applicable) to \_\_\_\_\_ (8) \_\_\_\_\_  
(year) (date)

5. Shell \_\_\_\_\_ (63) \_\_\_\_\_ (11) \_\_\_\_\_ (41) \_\_\_\_\_ (64) \_\_\_\_\_ (63) \_\_\_\_\_  
(no.) (material spec., gr.) (thickness) (lining) (diameter) [length (overall)]

6. Joints \_\_\_\_\_ (12) \_\_\_\_\_ (13) \_\_\_\_\_ (12) \_\_\_\_\_  
[long. (seamless, welded)] [eff. (compared to seamless)] [girth (seamless, welded)] (no. of shell courses)

7. Heads \_\_\_\_\_ (4b) \_\_\_\_\_

Location	Material Spec., Gr., Thickness	Crown Radius	Knuckle Radius	Elliptical Ratio	Flat Diameter	Side Pressure (concave, convex)

8. Tubesheet \_\_\_\_\_ (11) \_\_\_\_\_ Tube holes \_\_\_\_\_  
(material spec., gr.) (no. and diameter)

9. Tubes \_\_\_\_\_ (no.) \_\_\_\_\_ Size \_\_\_\_\_ Length \_\_\_\_\_ Material spec., gr. \_\_\_\_\_ (11) \_\_\_\_\_ Thickness \_\_\_\_\_

10. Connections:

Purpose	No.	Size or Diameter	Material Spec., Gr.	Thickness	Reinforcement Material

11. MAWP \_\_\_\_\_ (65) \_\_\_\_\_ Max. input \_\_\_\_\_ (66) \_\_\_\_\_ Max. temp. \_\_\_\_\_ (67) \_\_\_\_\_ Hydrostatic test \_\_\_\_\_ (68) \_\_\_\_\_

12. Remarks \_\_\_\_\_ (55) \_\_\_\_\_

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FORM HLW-7R (Back)

<b>CERTIFICATE OF SHOP COMPLIANCE</b>
<p>We certify the statements in this Manufacturer's Partial Data Report to be correct and that all details of material, construction, and workmanship of this water heater or storage tank conform to Section IV of the ASME BOILER AND PRESSURE VESSEL CODE.</p> <p>Certificate of Authorization no. _____<sup>(31)</sup> to use the "HLW" symbol expires _____.</p> <p>Date _____<sup>(32)</sup> Signed _____ by _____ <small>(manufacturer that constructed and certified parts) (authorized representative)</small></p>
<b><sup>(33)</sup> CERTIFICATE OF SHOP INSPECTION</b>
<p>I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by _____</p> <p>have inspected the part described in this Manufacturer's Partial Data Report on _____ and state that, to the best of my knowledge and belief, the manufacturer has constructed this part in accordance with Section IV of the ASME BOILER AND PRESSURE VESSEL CODE.</p> <p>By signing this certificate, neither the inspector nor his employer makes any warranty, expressed or implied, concerning the part described in this Manufacturer's Partial Data Report. Furthermore, neither the inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.</p> <p>Date _____ Signed _____ Commission _____<sup>(36)</sup> <small>(Authorized Inspector) (National Board commission number and endorsement)</small></p>

**FORM HLW-8R MANUFACTURER'S MASTER DATA PROOF TEST REPORT  
FOR WATER HEATERS OR STORAGE TANKS  
As Required by the Provisions of the ASME Code Rules, Section IV and Code Case 2691**

1. Manufactured and certified by \_\_\_\_\_ <sup>①</sup>  
(name and address)

2. Vessel type or model no. (HLW-500) \_\_\_\_\_ <sup>④</sup>

3. Vessel proof test data:

Vessel Parts	Description or Part No.	Material Spec., Gr., Thickness According to Drawing	Specified Yield Strength	Minimum Tensile
(a) _____		<sup>⑪</sup> <sup>④①</sup>		
(b) _____				
(c) _____				
(d) _____				
(e) _____				

4. Type of coating \_\_\_\_\_  
(lime wash or other brittle coating)

5. Test data to determine yielding:

Part Designation Yielding	Yielding Pressure by Flaking of Coating or by Strain Lines	Location of Yielding Whether Bending or Tension (indicate on sketch)
<sup>⑥⑨</sup>	<sup>⑦⑩</sup>	<sup>⑦①</sup>

6. Yield strength of test specimens [HLW-502.1(c)]: (a) \_\_\_\_\_ <sup>⑦②</sup> (b) \_\_\_\_\_ (c) \_\_\_\_\_ Average \_\_\_\_\_

7. Maximum allowable working pressure of vessel \_\_\_\_\_ <sup>⑥⑤</sup> [determined by formulas in HLW-502.1(d)]

8. Examination data: <sup>⑧①</sup>

(a) Test engineer \_\_\_\_\_

(b) Witness of test \_\_\_\_\_

(c) Date(s) of proof test \_\_\_\_\_

**MANUFACTURER'S CERTIFICATION**

We certify that the above data is correct and that the proof test procedure conforms with HLW-500 of Section IV of the ASME BOILER AND PRESSURE VESSEL CODE.

ASME Certificate of Authorization no. \_\_\_\_\_ <sup>⑧①</sup> to use the "HLW" symbol expiration date \_\_\_\_\_

Date \_\_\_\_\_ <sup>③②</sup> Certified to be true record \_\_\_\_\_  
(authorized representative)\* (manufacturer)

\*NOTE: Signature of manufacturer's designated responsible engineering representative is required.

<sup>③③</sup> **PROOF TEST CERTIFICATE**

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by \_\_\_\_\_

have witnessed the proof test and the procedures conforming to HLW-500 of Section IV of the ASME BOILER AND PRESSURE VESSEL CODE.

By signing this certificate, neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the water heater or storage tank described in this Manufacturer's Proof Test Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with the witnessing of this proof test.

Date \_\_\_\_\_ Signed \_\_\_\_\_  
(Authorized Inspector) Commission \_\_\_\_\_ <sup>③⑦</sup>  
(National Board commission and endorsement)

**Table 1**  
**Guide for Completing Forms**

References to Circled Numbers in the Forms	Description
(1)	Name and address of manufacturer (i.e., maker of all components not covered by the Partial Data Reports).
(2)	Name and address of purchaser and/or owner.
(3)	Name and address of location where unit is to be installed. If not known, so indicate (e.g., "not known — built for stock").
(4)	Show type or model of unit documented by this data report.
(5)	Identification of unit by applicable numbers. If intended for installation in Canada, indicate the Canadian design registration number and drawing number.
(6)	Year in which fabrication was completed in shop.
(7)	Date (year) of Section IV edition under which boiler or part was constructed.
(8)	Issue date of most recent addenda to Section IV under which boiler or part was constructed (e.g., "December 1997").
(9)	Code Case number, if applicable.
(10)	Show quantity and inside dimensions. If more than two shells or drums are used, enter data in line 14.
(11)	Show the complete ASME material specification number and grade as listed in the appropriate stress allowance table in Section IV (e.g., "SA-285-B"). Exception: A specification number for a material not identical to an ASME Specification may be shown only if such material has been approved for Section IV construction by an ASME interpretation case ruling and provided the applicable case number is also shown.
(12)	Indicate type of joint(s).
(13)	Show joint efficiency for welded joints.
(14)	Show number of furnaces in boiler.
(15)	For cylindrical furnaces of the Adamson, ring-reinforced, and combined types, show total length only.
(16)	For stayed (firebox) type furnace, complete line 12 also.
(17)	If threaded, show diameter at root of thread.
(18)	Minimum cross-sectional area after deducting for telltale hole.
(19)	Maximum allowable working pressure for the stayed area calculated according to the rules contained in Part HG of Section IV.
(20)	Type of stay or brace (e.g., diagonal, gusset, girder, through, etc.).
(21)	Minimum cross-sectional area of the stay or brace multiplied by the number of stays or braces supporting the area under consideration.
(22)	See applicable paragraphs and figures in Part HG of Section IV.
(23)	List parts not covered elsewhere on the data report. If insufficient space, attach a supplementary sheet.
(24)	Tabulate data for parts listed on line 14.
(25)	Show data for main and auxiliary inlets and outlets, nozzles, inspection openings, safety valve openings, drains, and blowoffs. This does not apply to small openings for water column, controls, vents, etc.
(26)	Maximum allowable working pressure.
(27)	Show Section IV paragraph that applies to the weakest part of the unit as established by calculation or deformation test.
(28)	Boiler heating surface calculated in accordance with HG-403 of Section IV.
(29)	Hydrostatic pressure applied in accordance with HG-510 and witnessed by the Authorized Inspector.
(30)	To be completed when one or more components comprising the unit are furnished by others and certified by the applicable Partial Data Report(s).
(31)	The manufacturer's ASME Certificate of Authorization number and date of expiration of said authorization.
(32)	This line is to be completed and signed by an authorized representative of the manufacturer.
(33)	This certificate is to be completed by the Authorized Inspection Agency representative who performs the in-shop inspection.
(34)	Indicate the data items covered on the applicable form by line numbers.
(35)	Indicate by line numbers those items furnished by others and for which the applicable Partial Data Reports have been examined.
(36)	The Inspector's National Board Commission Number and endorsement must be shown.
(37)	The assembler's ASME Certificate of Authorization number and date of expiration of said authorization.
(38)	This line to be completed, when applicable, and signed by an authorized representative of the organization responsible for field assembly of the boiler.
(39)	This certificate to be completed by the Authorized Inspection Agency representative who performs the field assembly inspection.
(40)	Indicate by line numbers from the applicable form those items inspected in the field that were not inspected in the shop.
(41)	Nominal thickness of plate.
(42)	Minimum thickness after forming.
(43)	Radius on concave side of dish.
(44)	Shop hydrostatic test, if any, applied to individual part prior to test applied to the assembled boiler (see lines 33 and 34).
(45)	This line for headers not covered as items 7 through 10. It is intended primarily for sectional headers on straight tub watertube boilers.
(46)	Indicate shape as flat, dished, ellipsoidal, torispherical, or hemispherical.
(47)	Use inside dimensions for size.
(48)	Indicate shape as square, round, etc.

**Table 1**  
**Guide for Completing Forms (Cont'd)**

References to Circled Numbers in the Forms	Description
(49)	Outside diameter.
(50)	Minimum thickness of tubes.
(51)	Size.
(52)	Describe type as flanged, welding neck, etc.
(53)	Show name of part (e.g., steam drum, waterwall header).
(54)	Show data line number on applicable form for the named part.
(55)	Any additional information to clarify the report should be entered here.
(56)	List each individual section that makes up boiler assembly. Show pattern and/or part number for each section. Show drawing number for each section. Show metal thickness for each section as indicated on the drawings. List each section of the complete boiler.
(57)	Show bursting pressure of each section of boiler. Show thickness measured at the break or fracture of each section. Indicate weight of each section.
(58)	Indicate minimum specified tensile strength for the class of iron as set forth in Table HC-300.
(59)	Indicate sections of boiler that represent specimen test bars. Show results of each specimen tested (tensile strength).
(60)	Show maximum allowable working pressure as determined by Formula HC-402 and by values allowed by Formula HC-402.
(61)	The individual designated to conduct tests, the designated manufacturer's representative who witnesses test, and date or dates on which destruction tests were conducted.
(62)	Designated responsible engineering head certifying the tests and date.
(63)	Show quantity and dimensions.
(64)	Type of lining, if applicable.
(65)	Maximum allowable working pressure established in accordance with HLW-300 or HLW-500 of Section IV.
(66)	Indicate maximum allowable input, _____. For tanks used for storage, indicate "storage only."
(67)	Maximum temperature in accordance with HLW-300 of Section IV.
(68)	Hydrostatic pressure applied in accordance with HLW-505 of Section IV and witnessed by the Authorized Inspector.
(69)	Part of vessel yielding first should be indicated.
(70)	Pressure at which yielding occurs as evidenced by flaking of the brittle coating or by appearance of strain lines.
(71)	Show yield strength for each of the three specimens and average of the three.
(72)	This ID number is a unique identifying number for this form, which may be assigned by the Certificate Holder if desired.
(73)	Maximum water temperature.
(74)	Fill in information identical to that shown on the Data Report Form to which this sheet is supplementary.
(75)	Indicate minimum specified tensile strength for the aluminum alloy as set forth in Table HF-300.2.
(76)	Show maximum allowable working pressure as determined by Formula HA-402.

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Approval Date: August 19, 2011

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2692**  
**Allowance to Use Provisions of HG-402.5 as Alternative to Using Steam to Determine Set Pressure for "Pressure Only" Safety Relief Valves During Capacity Certification Testing**  
**Section IV**

*Inquiry:* Under what conditions may set pressure be determined using the requirements of HG-402.5 as an alternative to using the popping point on steam for "pressure only" safety relief valves during capacity certification testing?

*Reply:* It is the opinion of the Committee that the set pressure definition for a hot water boiler safety relief valve may be determined as provided in HG-402.5. The test medium shall be room temperature water. The set pressure shall be defined as the pressure of room temperature water at the valve inlet when the flow rate through the valve is 40 cc/min. The valve shall demonstrate a pop action when tested by steam as required by HG-401.1(b) during capacity test per HG-402.4.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: April 4, 2012

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2693-1**  
**Use of Nickel Alloy UNS N08367 in Construction of Boilers**  
**Section IV**

*Inquiry:* May nickel alloy UNS N08367, meeting the requirements of the applicable Section II, Part B specifications, be used in the construction of heating boilers in accordance with the rules of Section IV?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used in the construction of heating boilers in accordance with the rules of Section IV, under the following conditions:

(a) Material shall conform to one of the specifications listed in [Table 1](#).

(b) The maximum allowable mean temperature is 500°F (260°C).

(c) The maximum allowable stress values for UNS N08367 are listed in [Tables 2](#) and [2M](#) for material with yield and tensile strength of 45 ksi and 95 ksi, and 310 MPa and 655 MPa, respectively, and in [Tables 3](#) and [3M](#) for material with yield and tensile strength of 45 ksi and 100 ksi, and 310 MPa and 690 MPa, respectively.

(d) This material may utilize the minimum thickness exceptions of HF-301.1(c).

(e) This Case number shall be shown on the Manufacturer's Data Report.

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**Table 1  
 Product Specifications**

Fittings	SB-366, SB-462
Forgings	SB-564
Plate, sheet, and strip	SB-688
Rod (bar)	SB-691
Seamless pipe and tube	SB-690
Welded pipe	SB-675
Welded tube	SB-676

**Table 3  
 Maximum Allowable Stress Values for  
 Material with 45 ksi Yield Strength and  
 100 ksi Tensile Strength**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi (welded)
100	20.0 (17.0)
200	20.0 (17.0)
300	18.9 (16.1)
400	18.1 (15.4)
500	17.5 (14.9)

**Table 2  
 Maximum Allowable Stress Values for  
 Material with 45 ksi Yield Strength and  
 95 ksi Tensile Strength**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi (welded)
100	19.0 (16.1)
200	19.0 (16.1)
300	18.0 (15.3)
400	17.2 (14.6)
500	16.7 (14.2)

**Table 3M  
 Maximum Allowable Stress Values for  
 Material with 310 MPa Yield Strength and  
 690 MPa Tensile Strength**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Values, MPa (welded)
40	138 (117)
100	138 (117)
150	130 (111)
200	125 (106)
250	122 (103)
275	119 (102) [Note (1)]

**Table 2M  
 Maximum Allowable Stress Values for  
 Material with 310 MPa Yield Strength and  
 655 MPa Tensile Strength**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Values, MPa (welded)
40	131 (111)
100	131 (111)
150	124 (105)
200	119 (101)
250	115 (98.1)
275	114 (97.1) [Note (1)]

NOTE:

(1) The maximum use temperature shall be 260°C. The value at 275°C temperature is provided for interpolation purposes.

NOTE:

(1) The maximum use temperature shall be 260°C. The value at 275°C temperature is provided for interpolation purposes.

Approval Date: September 26, 2011

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2694**  
**Use of Magnetically Impelled Arc Butt Welding (MIABW)**  
**Section I**

*Inquiry:* Under what conditions may Magnetically Impelled Arc Butt Welding (MIABW) be acceptable for butt welding of boiler tubes for Section I construction?

*Reply:* It is the opinion of the Committee that Magnetically Impelled Arc Butt Welding (MIABW) may be acceptable for butt welding of boiler tubes for Section I construction, provided the following conditions are met:

(a) *Applicability.* MIABW shall only be used for butt welding boiler tubes of P-No.1, Gr. 1 and 2 tube materials of the same nominal wall thickness, where wall thickness is between 0.16 in. to 0.3 in. (4 mm to 7.6 mm). MIABW shall be conducted using welding equipment containing permanent magnets in a fabrication shop environment.

(b) *Welding Procedure Specification (WPS) Qualification*

(1) The welding procedure shall be qualified by preparing a boiler tube butt weld test coupon, observing and recording the values for the essential variables from Table 1.

(2) The completed test coupon shall be subjected to the mechanical tests required by QW-451.1 of Section IX procedure qualification. The test coupon shall be subdivided as shown in QW-463.1(d). Test specimens shall be prepared as shown in QW-462.1(b) or (c) and tested in accordance with QW-150 for tension testing. Test specimens shall be prepared as shown in QW-462.3(a) and tested in accordance with QW-160 for bend testing. Acceptance criteria shall be in accordance with QW-153.1 for tension testing and QW-163 for bend testing.

(3) At least two of the remaining segments of the test coupon shall have one of their edges smoothed and etched with a suitable etchant (see QW-470), and the etched surface examined using 5× magnification. An acceptable examination shall demonstrate evidence of complete penetration and fusion of the base metal with no open defects.

(4) Test results shall be documented as set forth in QW-201 on a Welding Procedure Specification Qualification Record (PQR) certified by the Manufacturer.

(c) *Operator Performance Qualification*

(1) Welding operators shall be qualified by preparing a weld test coupon following a qualified WPS for MIABW. The applicable Essential Variables — Automatic Welding given in QW-361.1 shall be observed.

(2) Each end of the performance qualification test coupon shall be cut approximately 1 in. (25 mm) from the weld joint after the test specimen welding has been completed, and then cut longitudinally in segments approximately 60 deg apart on one end, for a length of approximately 1/2 in. (13 mm) beyond the weld joint, producing six approximately equal width segments (see Figure 1).

(3) The test coupon shall be secured in a vise or other secure fixture. All six segments shall be bent outwards from the center through an angle not less than 90 deg. The bends shall be examined and compared to the acceptance criteria of QW-163 for bend testing. As an alternative, the coupon may be sectioned and bend tested in accordance with QW-160.

(4) Test results shall be documented as set forth in QW-304.1 on a Welding Operator Performance Qualification Record (WPQ) certified by the Manufacturer. Welding operator performance qualifications using MIABW shall only qualify the welding operator for the MIABW process.

(d) *Nondestructive Examination (NDE)*

(1) Prior to performing the nondestructive examination, the internal and external weld upset scarf produced by the MIABW process shall be removed to a height not greater than 0.01 in. (0.25 mm).

(2) UT Examination personnel shall be qualified and certified in accordance with their employer's written practice in compliance with Section V, Article 1, T-120 (e) or (f).

(3) The ultrasonic examination shall be performed with a written procedure prepared in accordance with the requirements of Section V, Article 4, Mandatory Appendix VII. Examination results shall be documented as required by Section V, Article 4, VII-492.

(4) All MIABW welds in boiler tubes shall be evaluated for acceptance by ultrasonic examination using an encoded, pulse-echo, phased array S-scan technique in accordance with Section V, Article 4, Mandatory Appendix V. A sixteen-element phased array probe not larger than 30 mm shall be used with a frequency range of 5 MHz

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**CASE (continued)**  
**2694**

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to 10 MHz. The reference block shown in Figure 2 shall be prepared to represent the production weld joint, including weld upset removal of the I.D. and O.D. The reference block shall be used to establish the reference sensitivity level for all individual beams used in the examination.

(5) The time corrected gain (TCG) shall be calibrated so that the hole with the weakest response (i.e., axial or radial) has a corrected response not less than 40% of full screen height.

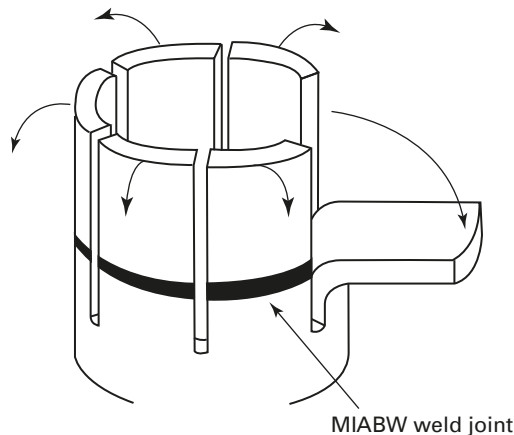
(6) Indications exceeding the reference level shall be investigated to determine their size, shape, location, and characterization. Flaws exceeding the following acceptance criteria are unacceptable:

(-a) cracks, lack of fusion, or incomplete penetration regardless of length

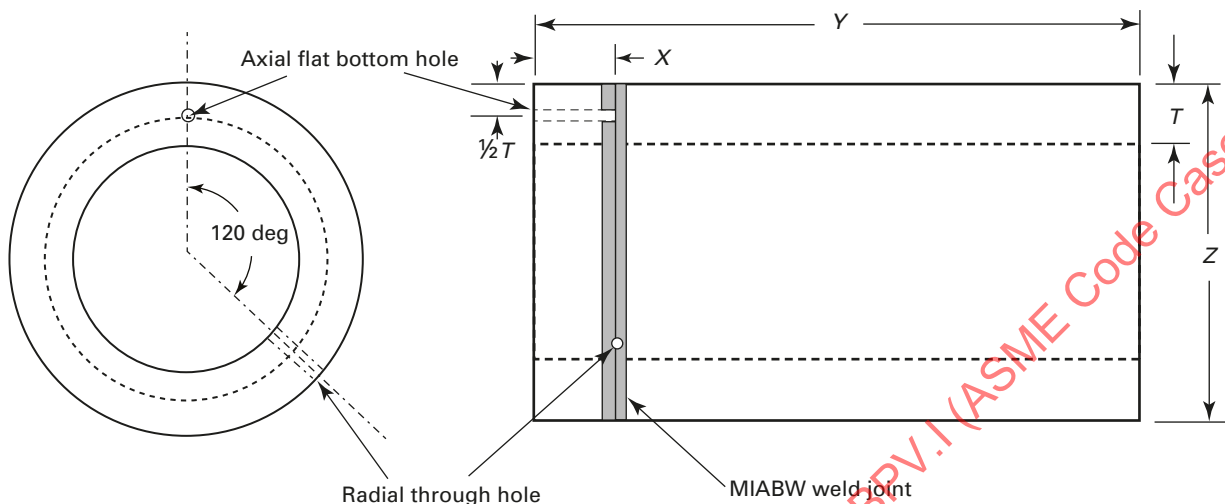
(-b) other imperfections whose length exceeds  $\frac{1}{4}$  in. (6 mm)

(e) Report. This Case number shall be shown on the Manufacturer's Data Report.

**Figure 1**  
**Performance Qualification Test Coupon**



**Figure 2**  
**Reference Examination Block**



**Nominal Dimensions:** Hole diameter = 0.040 in. (1 mm) max.

$T$  = between 0.16 in. and 0.3 in. (4 mm and 7 mm)

$X$  =  $\frac{3}{4}$  in. (19 mm) min.

$Y$  = 6 in. (150 mm) min.

$Z$  = as selected, where  $Z \geq 0.9 \times \text{Tube O.D.}$  and  $\leq 1.5 \times \text{Tube O.D.}$

**Table 1**  
**MIABW Variables**

Variable Description	Essential	Nonessential
Change in the Welding Controller Module from that qualified	X	...
Change in welding machinery type, manufacturer, or the machinery components	X	...
Change in welding voltage greater than $\pm 5$ volts from that qualified	X	...
Change in welding amperage greater than $\pm 50$ amps from that qualified	X	...
Increase in tube thickness greater than 10% from that qualified	X	...
Increase in tube diameter greater than 10% from that qualified	X	...
Increase in the distance from tube ends to electrode grips greater than 10% from that qualified	X	...
Change in programmed arc initiation current greater than $\pm 10\%$ from that qualified	X	...
Change in programmed arc stabilization current greater than $\pm 10\%$ from that qualified	X	...
Change in programmed arc rotation current greater than $\pm 10\%$ from that qualified	X	...
Change in programmed cleaning/upset current greater than $\pm 10\%$ from that qualified	X	...
Change in programmed arc initiation time greater than $\pm 10\%$ from that qualified	X	...
Change in programmed arc stabilization time greater than $\pm 10\%$ from that qualified	X	...
Change in programmed arc rotation time greater than $\pm 10\%$ from that qualified	X	...
Change in programmed upset time greater than $\pm 10\%$ from that qualified	X	...
Decrease in clamping pressure from that qualified	X	...
Decrease in upset pressure from that qualified	X	...
Change in shielding gas composition from that qualified	X	...
Change in shielding gas flow rate greater than $\pm 10\%$ from that qualified	X	...
Change in the included angle between the axis of each tube end greater than $\pm 5$ deg	X	...
Change in the condition of heat treatment from "as welded" to PWHT within a specified time and temperature range, and vice versa	X	...
Change in the base metal cleaning method from mechanical cleaning to chemical cleaning, and vice versa	...	X
Change in the type of tube edge preparation from square butt to bevel prep at a specified angle, and vice versa	...	X

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Approval Date: December 11, 2017

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2695-1**  
**Allowing Section VIII, Division 2 Design Rules to Be Used**  
**for Section VIII, Division 1 Pressure Vessel**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions may the design-by-rule requirements in Part 4 of Section VIII, Division 2 be used to design the components for a Section VIII, Division 1 pressure vessel?

*Reply:* It is the opinion of the Committee that the design-by-rule requirements in Part 4 of Section VIII, Division 2 may be used to design the components for a Section VIII, Division 1 pressure vessel, provided the following conditions are met:

(a) The allowable design tensile stress shall be in accordance with UG-23 of Section VIII, Division 1.

(b) The weld joint efficiency shall be established in accordance with UW-11 and UW-12 of Section VIII, Division 1.

(c) Material impact test exemptions shall be in accordance with the rules of Section VIII, Division 1.

(d) If the thickness of a shell section or formed head is determined using Section VIII, Division 2 design rules, the following requirements apply:

(1) For design of nozzles, any nozzle and its reinforcement attached to that shell section or formed head shall be designed in accordance with Section VIII, Division 2.

(2) For conical transitions, each of the shell elements comprising the junction and the junction itself shall be designed in accordance with Section VIII, Division 2.

(3) For material impact test exemptions, the required thickness used in the coincident ratio defined in Section VIII, Division 1 shall be calculated in accordance with Section VIII, Division 2.

(e) The fatigue analysis screening in accordance with Part 4, para. 4.1.1.4 of Section VIII, Division 2 is not required. However, it may be used when required by UG-22 of Section VIII, Division 1.

(f) The provisions shown in Part 4 of Section VIII, Division 2 to establish the design thickness and/or configuration using the design-by-analysis procedures of Part 5 of Section VIII, Division 2 are not permitted.

(g) The Design Loads and Load Case Combinations specified in Part 4, para. 4.1.5.3 of Section VIII, Division 2 are not required.

(h) The primary stress check specified in Part 4, para. 4.1.6 of Section VIII, Division 2 is not required.

(i) Weld Joint details shall be in accordance with Part 4, para. 4.2 of Section VIII, Division 2 with the exclusion of Category E welds.

(j) The fabrication tolerances specified in Part 4, paras. 4.3 and 4.4 of Section VIII, Division 2 shall be satisfied. The provision of evaluation of vessels outside of tolerance per Part 4, para. 4.14 of Section VIII, Division 2 is not permitted.

(k) The vessel and vessel components designed using these rules shall be noted on the Manufacturer's Data Report.

(l) All other requirements for construction shall comply with Section VIII, Division 1.

(m) This Case number shall be shown on the Manufacturer's Data Report.

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*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2696**  
**Use of SA-240/SA-240M UNS S41003 Plates in the**  
**Construction of Boilers**  
**Section I**

*Inquiry:* May SA-240/SA-240M UNS S41003 plate be used in Section I construction?

*Reply:* It is the opinion of the Committee that SA-240/SA-240M UNS S41003 plate may be used for Section I construction, provided the following requirements are met:

(a) The material shall conform to the requirements of SA-240/SA-240M UNS S41003.

(b) For external pressure design, Fig. CS-2 in Section II, Part D shall be used.

(c) For welding procedure and performance qualifications the material shall be classified as P-No. 7, Gr. 1 in accordance with Section IX.

(d) The maximum design temperature shall be 500°F (260°C).

(e) After any thermal cutting, the cut face shall be ground or machined to a bright finish.

(f) Material shall be welded with a filler metal that produces a low carbon content austenitic chromium-nickel weld deposit (e.g., 309L).

(g) For gas metal arc welding processes using a solid wire or metal cored wire, the shielding gas shall have a maximum CO<sub>2</sub> content of 5%.

(h) The heat input during welding shall be controlled between 12.5 kJ/in. and 38 kJ/in. (0.5 kJ/mm and 1.5 kJ/mm).

(i) The interpass temperature shall not exceed 212°F (100°C).

(j) The preheating temperature shall be above 70°F (20°C).

(k) For postweld heat treatment the material shall be treated as P-No. 7, Gr. 1, per the requirements of Table PW-39 except for the following:

(1) Postweld heat treatment is not mandatory when the thickness at the welded joint does not exceed 1/2 in. (13 mm).

(2) If postweld heat treatment is performed, the minimum holding temperature shall be 1290°F (700°C), and maximum holding temperature shall be 1380°F (750°C).

(l) Maximum allowable stress values shall be as shown in Tables 1 and 1M.

(m) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi
100	18.9
200	18.9
300	18.9
400	18.4
500	17.7

**Table 1M**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Values, MPa
40	130
65	130
100	130
125	130
150	130
200	127
250	123
300 [Note (1)]	119

## NOTE:

(1) As stated in (d), the maximum use temperature is 500°F (260°C), and the value at 300°C is provided for interpolation only.

Approval Date: August 1, 2016

*Code Cases will remain available for use until annulled by the applicable Standards Committee.***Case 2697-1  
Unstayed Flat Head Constructed From Forged Material  
Section I**

*Inquiry:* Is it permissible in Section I construction to utilize flat heads with integral flanges constructed from forged material?

*Reply:* It is the opinion of the Committee that it is permissible to utilize flat heads with integral flanges constructed from forged material attached to cylindrical shells, headers, or pipe as shown in [Figure 1](#). Flat heads of NPS 4 (DN 100) and smaller shall be constructed in accordance with SA-105, SA-181, SA-182, SA-234, SB-366, SB-462, or SA-815 (UNS S31803 only). Flat heads larger than NPS 4 (DN 100) shall meet the following requirements:

(a) The flange may be formed by machining a forged blank or it may be formed by direct forging action.

(b) The flat head

(1) The flat head shall comply with PG-31.

(2)  $C = 0.33m$  but not less than 0.20

(3) The flat head thickness shall not be less than the shell thickness.

(4) The corner radius ([Figure 1](#)) on the inside is not less than the following:

$r = 0.375$  in. (10 mm) for  $t_s \leq 1\frac{1}{2}$  in. (38 mm)

$r = 0.25t_s$  for  $t_s > 1\frac{1}{2}$  in. (38 mm) but need not be greater than  $\frac{3}{4}$  in. (19 mm)

(c) The welding shall meet the requirements for circumferential joints given in Part PW.

(d) The center of the butt weld to the shell shall be located at a distance not less than corner radius,  $r$ , as in (b)(4); see [Figure 1](#).

(e) The forged stock shall have a forging reduction ratio not less than 2:1 in the direction radial to the plane of the blank disk and an upset reduction not less than 2:1 in the direction normal to the plane of the blank disk. The forging reduction ratio shall be calculated by dividing the cross-sectional area prior to forging by the cross-sectional area after forging. For upset forging the inverse ratio shall be taken. The forging ratios in each plane may be calculated as the arithmetic sum of the ratios of more than one forging operation in that plane. The forging operations may be undertaken in any order.

(f) *Tension Test Specimen*

(1) The flange shall have the minimum tensile strength and elongation specified for the material, measured in the direction parallel to the axis of the vessel. Proof of this shall be furnished by a tension test specimen (subsize, if necessary) taken in this direction.

(2) For heads machined from a forged blank, the tensile specimen shall be taken as close to the flange as practical ([Figure 2](#)) and may be located inside or outside the flange.

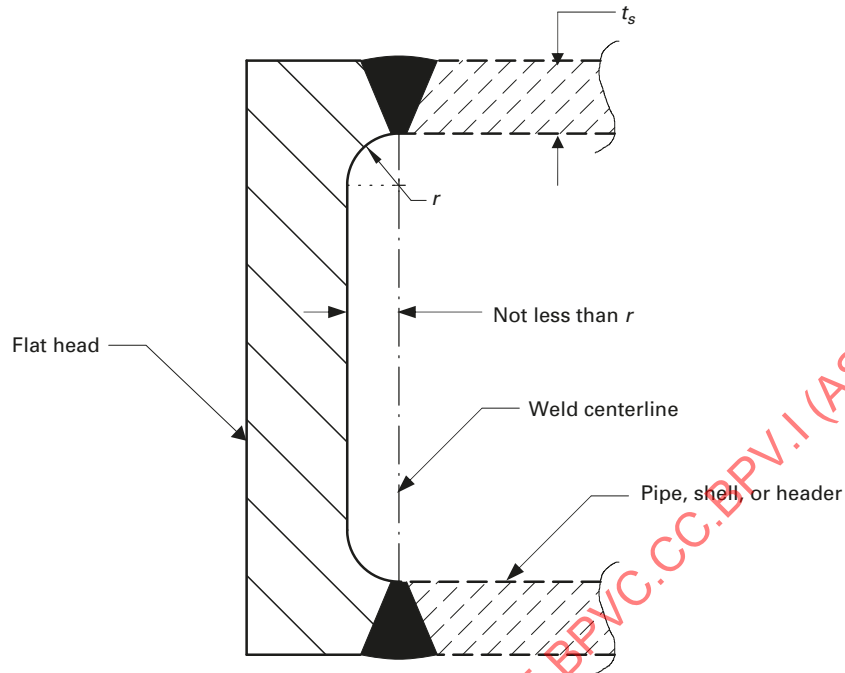
(3) For heads with flanges formed by direct forging action, the specimen shall be taken from material in the flange or an extension of the flange ([Figure 3](#)).

(4) One test specimen may represent a group of forgings provided they are of the same design, are from the same heat of material, and are forged in the same manner.

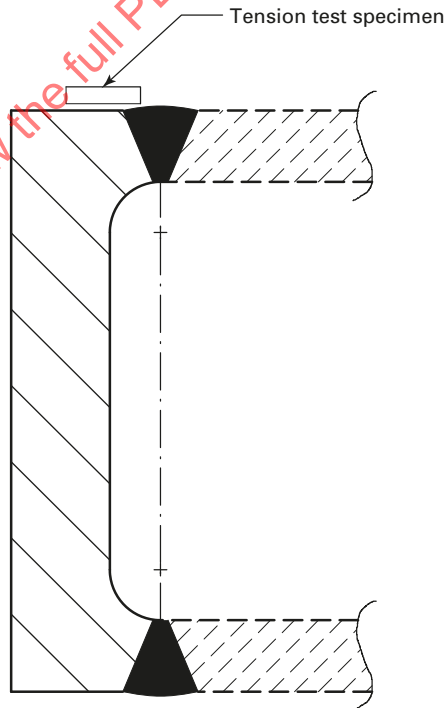
(g) This Case number shall be shown on the Manufacturer's Data Report.

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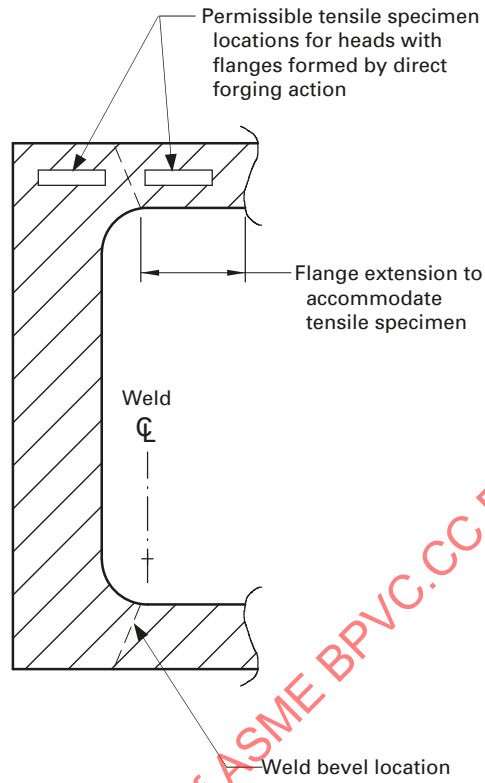
**Figure 1**  
**Flat Head Dimensions**



**Figure 2**  
**Machined Flat Head Tensile Specimen Location**



**Figure 3**  
**Flat Head with Flange Formed by Direct Forging Action, Tensile Specimen Locations**



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Approval Date: September 12, 2017

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2698-1**  
**Use of High Strength Low Alloy Steel Castings**  
**Section VIII, Division 3**

*Inquiry:* Under what circumstances may high strength low alloy steel castings be allowed for pressure parts under Section VIII, Division 3?

*Reply:* It is the opinion of the Committee that high strength low alloy steel castings that utilize Code Case 2564, latest revision, are acceptable for use in Section VIII, Division 3, subject to the following conditions.

**1 DESIGN TEMPERATURE RANGE**

The vessel shall have a minimum design temperature of 32°F (0°C) and a maximum design temperature of 100°F (38°C).

**2 MATERIAL**

The steel composition shall be as given in Table 1. The steel shall be degassed to achieve a hydrogen content of less than 3 ppm.

**3 CASTING AND HEAT TREATMENT**

Material furnished to this Case shall meet the requirements of SA-703/SA-703M except as modified as follows.

(a) Castings shall be made from a single heat and shall not exceed a final mass of 22 U.S. tons (20 000 kg). The maximum final diameter shall be less than 8 ft (2.4 m).

(b) Casting design shall ensure directional solidification of all casting sections back to the feeder heads. Feeder head sizes shall be calculated to ensure complete feeding of the casting during solidification. Machining allowances shall not exceed 1 in. (25 mm) except where this conflicts with these casting design requirements.

(c) The ladle composition shall be confirmed before pouring and the values reported in the Manufacturer's Data Report.

(d) Castings shall be allowed to cool below the transformation range directly after pouring and solidification, before they are reheated for normalizing.

(e) All castings shall receive heat treatment consisting of normalizing, austenitizing, double-liquid quenching, followed by tempering. After annealing and before other treatment, the casting may be hot isostatically pressed at 14.5 ksi  $\pm$  0.3 ksi (1 000 bar  $\pm$  20 bar) and 2,085°F  $\pm$  18°F (1 140°C  $\pm$  10°C). Castings shall be tempered at a minimum temperature of 1,100°F (590°C) followed by liquid cooling. Strong agitation may be required during cooling.

(f) *Temperature Control.* Furnace temperature for heat treating shall be controlled by the use of pyrometers, and the recorded temperature during heat treatment shall be included in the Manufacturer's Data Report.

(g) Casting should be cast oversize and machined to final dimensions to remove surface imperfections. The maximum final wall thickness,  $T$ , shall not exceed 13 in. (330 mm).

**4 PROPERTIES**

Material properties given in Tables 2 and 2M shall be reported in the Manufacturer's Data Report. Test coupons to SA-703/SA-703M (including supplementary requirement S26) cast with the vessel shall have tensile and impact properties at a depth  $T/4$  of at least those in Tables 2 and 2M. In addition, fracture toughness,  $K_{Ic}$  determined according to ASTM E1820 at  $T/4$  and at 32°F (0°C) shall exceed 137 ksi in.<sup>0.5</sup> (150 MPa m<sup>0.5</sup>). The validity requirement on crack extension (ASTM E1820, para. 9.1.5.1) may be waived.

The prolongations shall be taken from the feeder head end. If the casting is over 78 in. (2 m) length, tensile and impact values shall be obtained from both ends of the casting. Physical properties of the steel are given in Table 3.

Fatigue crack growth may be calculated using the methods of KD-430 but the constants  $C$  and  $m$  in Tables KD-430 and KD-430M may be replaced by the values given in Table 4.

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**Table 1  
 Steel Composition**

Element	Composition, %
Carbon	0.15–0.20
Silicon	0.20–0.50
Manganese	0.55–0.70
Phosphorus, max.	0.010
Sulfur, max.	0.005
Chromium	1.35–1.60
Molybdenum	0.35–0.60
Nickel	3.00–3.80
Aluminum	0.015–0.040
Vanadium, max.	0.03
Titanium, max.	0.02
Copper, max.	0.20
Arsenic, max.	0.020
Antimony, max.	0.005
Lead, max.	0.005
Nitrogen, max.	0.010
Tin, max.	0.015
Boron, max.	0.001

**5 EXAMINATION OF CASTINGS**

Nondestructive examination shall be conducted in accordance with the examination methods of Section V except as modified by the following requirements.

Castings shall be examined by the ultrasonic method in accordance with 5.1, except configurations that do not yield meaningful examination results by ultrasonic methods shall be examined by radiographic methods in accordance with Article 2 of Section V using acceptance standards of KE-332. In addition, all external surfaces shall be examined by the magnetic particle method or liquid penetrant method, see 5.2.

Acceptance examination shall be performed after hydrotest.

**5.1 ULTRASONIC EXAMINATION**

(a) *Examination Procedure.* All castings shall be examined on all external surfaces and all accessible internal surfaces in accordance with SA-609/SA-609M as shown

in Article 23 of Section V, both by the straight beam technique and the angle beam technique. The angle beam examination shall be in two circumferential directions and two axial directions.

(b) *Acceptance Standards.* The casting wall thickness shall be divided into thirds: Zone A covers the thirds adjacent to the external and internal surfaces, and Zone B covers the central third.

(1) *Straight Beam Rule.* A casting shall be unacceptable if the results of straight beam examinations show one or more reflectors of measurable length that produces indications accompanied by a complete loss of back wall reflection not associated with or attributable to geometric configurations. Complete loss of back reflection is assumed when the back reflection falls below 5% of full calibration screen height.

A casting shall also be unacceptable if the results of the straight beam examinations show one or more reflectors that either

(-a) produces a 75% or greater loss of back wall reflection that has been determined to be caused by a discontinuity, or

(-b) shows a response equal to or greater than the dynamic amplitude correction curve over an area specified by quality level 1 in Zone A and quality level 2 in Zone B where the quality levels are as defined in Table 2 of SA-609/SA-609M.

(2) *Angle Beam Rule.* A casting shall be unacceptable if the results of angle beam examinations show one or more reflectors that produces indications exceeding in amplitude the indication from the appropriate calibration notches over an area specified by quality level 1 in Zone A and quality level 2 in Zone B, where the quality levels are as defined in Table 2 of SA-609/SA-609M.

More stringent acceptance criteria may be specified in the User's Design Specification.

**Table 2  
 Minimum Tensile and Impact Properties Required**

Thickness When Heat Treated, in.	Minimum Yield Strength, ksi	Minimum Ultimate Tensile Strength, ksi	Minimum Elongation, % [Note (1)]	Minimum Reduction in Area, %	Impact Energy, ft-lb, (Min. of 3) at -100°F	Impact Energy, ft-lb, (Avg. of 3) at -100°F
0 – 6	97	113	15	30	44	48
>6 to <8	94	110	15	30	44	48
8 – 14	91	106	15	30	44	48

NOTE:

(1) Gage length = 4 × specimen diameter

**Table 2M**  
**Minimum Tensile and Impact Properties Required**

Thickness When Heat Treated, mm	Minimum Yield Strength, MPa	Minimum Ultimate Tensile Strength, MPa	Minimum Elongation, % [Note (1)]	Minimum Reduction in Area, %	Impact Energy, J, (Min. of 3) at -73°C	Impact Energy, J, (Avg. of 3) at -73°C
0 - 150	670	780	15	30	60	65
>150 to <200	650	760	15	30	60	65
200 - 360	625	730	15	30	60	65

NOTE:

(1) Gage length = 4 × specimen diameter

## 5.2 MAGNETIC PARTICLE AND LIQUID PENETRANT EXAMINATION

Surface examination shall be performed using a wet magnetic particle method or a liquid penetrant examination. It shall be demonstrated that inspections performed are capable of finding relevant surface defects defined as follows:

(a) *Evaluation of Indications.* Alternating current methods are prohibited. When utilizing magnetic particle examination, mechanical discontinuities at or near the surface will be indicated by the retention of the examination medium. However, all indications are not necessarily imperfections, since certain metallurgical discontinuities may produce similar indications that are not relevant to the detection of unacceptable discontinuities.

Linear indications are indications in which the length is more than three times the width. Rounded indications are indications that are circular or elliptical with length less than three times the width.

### (b) Acceptance Standards

(1) Only indications with major dimensions greater than  $\frac{1}{16}$  in. (1.6 mm) shall be considered relevant.

(2) The relevant indications given in (-a) through (-d) are unacceptable. More stringent acceptance criteria may be specified in the User's Design Specification.

(-a) any linear indications greater than  $\frac{1}{16}$  in. (1.6 mm) long for material less than  $\frac{5}{8}$  in. (16 mm) thick, greater than  $\frac{1}{8}$  in. (3.2 mm) long for material from  $\frac{5}{8}$  in. (16 mm) thick to under 2 in. (50 mm) thick, and  $\frac{3}{16}$  in. (4.8 mm) long for material 2 in. (50 mm) thick or greater

(-b) rounded indications with dimensions greater than  $\frac{1}{8}$  in. (3.2 mm) for thicknesses less than  $\frac{5}{8}$  in. (16 mm) and greater than  $\frac{3}{16}$  in. (4.8 mm) for thicknesses  $\frac{5}{8}$  in. (16 mm) or greater

(-c) four or more rounded indications in a line separated by  $\frac{1}{16}$  in. (1.6 mm) or less, edge to edge

(-d) ten or more rounded indications in any 6 in.<sup>2</sup> (3 900 mm<sup>2</sup>) of area whose major dimension is no more than 6 in. (150 mm), with the dimensions taken in the most unfavorable location relative to the indications being evaluated

## 5.3 QUALIFICATION OF NONDESTRUCTIVE PERSONNEL

Qualification and certification of Nondestructive Personnel shall be as specified by KE-110.

## 6 REMOVAL OF FLAWS

It will generally be necessary to machine external surfaces to remove surface casting imperfections. Any remaining surface flaws in excess of  $\frac{1}{8}$  in. (3 mm) height shall be removed by grinding and blending. Reduction in thickness due to blend grinding is permitted to the extent given in KE-211. Any greater blend grinding shall be included in the component structural assessment as a change in geometry but such grinding shall not exceed one-quarter of the thickness or extend over a length greater than 4 in. (100 mm). After defect elimination, the area is to be re-examined by the magnetic particle method or the liquid penetrant method in accordance with 5.2 to ensure that the imperfection has been removed or reduced to an acceptable size.

## 7 WELDING AND WELD REPAIRS

No weld repairs are allowed. No welding of component parts or to other components is allowed.

**Table 3**  
**Physical Properties**

Density	0.283 lb/in. <sup>3</sup> (7820 kg/m <sup>3</sup> )
Modulus of elasticity	29.7 × 10 <sup>3</sup> ksi (205 GPa)

**Table 4**  
**Crack Growth Rate Factors**

	<i>C</i>	<i>m</i>
U.S. Customary units	2.47E-9 in./cycle (ksi-in. <sup>0.5</sup> ) <sup>-m</sup>	2.4
SI units	5.0 E-11 m/cycle (MPa m <sup>0.5</sup> ) <sup>-m</sup>	2.4

**8 ADDITIONAL REQUIREMENTS**

In accordance with KM-101, the Materials Manufacturer shall certify that all requirements of the applicable materials specifications in Section II, such as SA-703/SA-703M, all special requirements of Part KM that are to be fulfilled by the Materials Manufacturer, all supplementary material requirements specified by the User's Design Specification (KG-311), and all requirements specified in this Case have been complied with.

**9 REPORT**

Use of this material shall be specified in the User's Design Specification. This Case number shall be listed on the Manufacturer's Data Report and vessel nameplate.

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Approval Date: September 26, 2011

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2699**  
**Values of Tensile Strength for SA-564 and SA-705,**  
**Grade XM-12, Condition H1100 Materials**  
**Section VIII, Division 3**

*Inquiry:* What values of tensile strength at design temperature,  $S_u$ , may be used in design for SA-564 and SA-705, Grade XM-12 (UNS S15500), Condition H1100 materials in Section VIII, Division 3 applications?

*Reply:* It is the opinion of the Committee that the values of tensile strength at design temperature,  $S_u$ , listed in [Table 1](#) may be used for SA-564 and SA-705, Grade XM-12 (UNS S15500), Condition H1100 materials.

This Case Number shall be shown on the Manufacturer's Data Report.

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**Table 1**  
**Tensile Strength Values**

For Metal Temperature Not Exceeding, °F	
Exceeding, °F	Tensile Strength $S_u$ , ksi
100	140.0
200	140.0
300	138.5
400	134.2
450	132.4
500	130.6
550	128.9

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Approval Date: January 10, 2013

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2701-1**  
**Maximum Dynamic Pressure During Vented**  
**Deflagration for Vessels in Low Density Polyethylene**  
**Service**  
**Section VIII, Division 3**

*Inquiry:* Under what conditions shall a Section VIII, Division 3 vessel in Low Density Polyethylene (LDPE) Service be designed so that the maximum dynamic pressure during a vented deflagration exceeds 110% of the design pressure permitted by KR-150?

*Reply:* It is the opinion of the Committee that the maximum dynamic pressure for vented deflagrations for these vessels may exceed 110% of the design pressure permitted by KR-150, provided the following conditions are met:

(a) The frequency of deflagrations shall not exceed once every 5 yr. A deflagration is the propagation of a combustion zone at a velocity that is less than the speed of sound in the unreacted medium (see Section VIII, Division 1, Nonmandatory Appendix H).

(b) The maximum dynamic pressure developed in the vented vessel,  $P_{dyn}$  does not exceed the pressure determined per the following:

$$P_{dyn} \leq 1.25P_D S_{yO} / S_{yD} \quad (1)$$

$$P_{dyn} \leq P_t \quad (2)$$

Where

$$P_{dyn} = P_{static} + (P_{peak} - P_{static})(DLF) \quad (3)$$

$P_{dyn}$  = maximum dynamic pressure in a vented vessel

$P_{static}$  = operating pressure at the time right before the deflagration

$P_{peak}$  = peak pressure developed in a vented vessel

$P_t$  = hydrostatic test pressure as defined in Article KT-3

$DLF$  = Dynamic Load Factor,  $X_m / X_s$

$X_m$  = maximum dynamic deflection in the vessel

$X_s$  = static deflection produced when the peak pressure is applied statically at the same point of maximum dynamic deflection

$P_D$  = vessel design pressure

$S_{yO}$  = material yield strength at the operating temperature immediately before the deflagration. The material strengths shall be taken from Section II, Part D, Table Y-1.

$S_{yD}$  = material yield strength at the design temperature

(c) The DLF shall be determined by performing a detailed dynamic structural analysis of the vessel based on the pressure versus time curve of the deflagration event. If no detailed analysis is performed and the deflagration pulse period to vessel structural period ratio is less than or equal to 0.9, a  $DLF = 1.5$  shall be used.

(d) A complete stress analysis shall be performed in accordance with Article KD-2 for the deflagration event including all applicable loading combinations of pressure and temperature.

(e) The fracture mechanics analysis shall consider the load-rate dependent fracture toughness during the deflagration event (see API 579-1/ASME FFS-1).

(f) The calculated number of design cycles shall consider the load frequency, sequence, and magnitude of all loading, including the deflagration loads.

(g) The User shall state in the User's Design Specification that after a deflagration event, an assessment of the vessel (see API 579-1/ASME FFS-1) will be conducted to ensure vessel integrity prior to returning the vessel to service.

(h) This Case number shall be shown on the User's Design Specification and Manufacturer's Data Report as applicable.

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Approval Date: January 7, 2019

(19)

*Code Cases will remain available for use until annulled by the applicable Standards Committee.***Case 2702-5  
Ni-25Cr-20Co Material  
Section I**

*Inquiry:* May precipitation-hardenable Ni-25Cr-20Co alloy (UNS N07740) ASTM B983-16 seamless alloy pipe and tube, and ASTM B637-16 bars, forgings, and forging stock; wrought plate, sheet, strip, and fittings material conforming to the chemical requirements shown in Table 1, the mechanical properties listed in Table 2, and otherwise conforming to the applicable requirements in the specifications listed in Table 3 and in this Case be used in welded and nonwelded construction under Section I rules?

*Reply:* It is the opinion of the Committee that precipitation-hardenable Ni-25Cr-20Co alloy (UNS N07740) ASTM B983-16 seamless alloy pipe and tube, and ASTM B637-16 bars, forgings, and forging stock; wrought plate, sheet, strip, and fittings as described in the Inquiry may be used in welded and nonwelded construction complying with the rules of Section I, provided the following additional rules are met:

(a) Material shall be supplied in the solution heat treated and aged condition. ASTM B983-16 and ASTM B637-16 contains their own heat treatment in Table 2, however, for all other product forms listed in Table 3 of this Case, the solution heat treatment shall be performed at 2,010°F (1,100°C) minimum for ½ hr per 1 in. of thickness but not less than 5 min. Aging shall be performed at 1,400°F to 1,500°F (760°C to 816°C) for 4 hr minimum up to 2 in. (50 mm) of thickness, plus an additional ½ hr per additional 1 in. (25 mm) of thickness. Aging shall be followed by air cooling.

(b) As an alternative to the delivery conditions of (a), where the material is to be subjected to additional fabrication operations, the material may be supplied in the solution heat treated condition provided:

(1) The marking shall include the suffix "Y" immediately following the Specification number and preceding any other suffix. The "Y" suffix shall not be removed until the material specification requirements have been completed and the material test report supplemented.

(2) The material supplier shall carry out the full heat treatment requirements of (a) on a sample, as defined by SB-622, section 10, from the delivery batch to demonstrate compliance with the delivery conditions of this Code Case. The extent of testing shall be as defined in SB-622, section 11.

(3) On completion of all fabrication operations, the entire component shall be heat treated in accordance with the requirements of (a). Local heat treatment is not permitted.

(c) The maximum allowable stress values for the material shall be those given in Tables 4 and 4M.

(d) Separate welding procedure qualifications in accordance with Section IX shall be required for this material. This material may be considered P-No. 46 for the purpose of performance qualifications. Procedure and performance qualifications qualified under previous versions of this Case do not require requalification. Qualifications shall be performed with material that is first annealed and aged in accordance with (a). When welding this alloy to itself, the weld metal shall be of matching composition, and welding shall be limited to either solid bare-wire GTAW or GMAW processes. The welding procedure qualification shall be conducted as prescribed in Section IX except that the guided bend test required by QW-160 may use a 4T minimum bend radius.

(e) Postweld heat treatment for this material is mandatory. The postweld heat treatment shall be performed at 1,400°F to 1,500°F (760°C to 815°C) for a minimum of 4 hr for thickness up to 2 in. (50 mm), plus an additional 1 hr per additional 1 in. (25 mm) of thickness. If a longitudinal weld seam is required in the construction of a component, a weld strength reduction factor of 0.70 shall apply in accordance with rules in PG-26 for applications at temperatures above 1,112°F (600°C).

(f) Resistance welding may be used to join non-load-bearing attachments to precipitation hardenable Ni-25Cr20Co alloy (UNS N07740) ASTM B983-16 seamless alloy pipe and tube materials. Postweld heat treatment in accordance with (e) is not mandatory for electric resistance welds used to attach extended heat-absorbing fins to pipe and tube materials, provided the following requirements are met:

(1) The maximum pipe or tube size shall be NPS 4 (DN 100).

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(2) The maximum fin thickness or other nonload-bearing attachment shall be 0.125 in. (3 mm).

(3) Prior to using the welding process, the manufacturer shall demonstrate that the heat-affected zone does not encroach upon the minimum wall thickness.

(4) Fins or other nonload-bearing attachments can be of any austenitic stainless steel.

(g) After cold forming to strains in excess of 5%; after any swages, upsets, or flares; or after any hot forming of this material, the component shall be heat treated in accordance with the requirements specified in (a). No local solution annealing may be performed. The entire affected component or part that includes the cold-strained area and transition to unstrained material must be included in both heat treatments. The calculations of cold strains shall be made as described in Section I, PG-19.

(h) The maximum use temperature is 1,472°F (800°C).

(i)  $S_u$  and  $S_y$  values are listed in Tables 5 and 5M and Tables 6 and 6M, respectively.

(j) *Physical Properties.* See also Tables 7 and 7M, Physical Properties.

(1) density: 0.291 lb/in.<sup>3</sup> (8 072 kg/m<sup>3</sup>)

(2) melting range: 2,350°F to 2,484°F (1 288°C to 1 362°C)

(3) electrical resistivity: 702.7 Ω-circ mil/ft

(k) For Section I, which requires a temperature-dependent parameter,  $y$  (see PG-27.4.6), the  $y$  values shall be as follows:

(1) 1,150°F (620°C) and below: 0.4

(2) 1,200°F (650°C): 0.5

(3) above 1,200°F (650°C): 0.7

(l) External pressure design is prohibited.

(m) For ASTM B983-16 and ASTM B637-16 material, this Case number shall appear on the Manufacturer's Data Report.

(n) For product forms listed in Table 3, this Case number shall appear in the marking and certification for the material and on the Manufacturer's Data Report. For the postweld heat treatment exemption listed in (f), this Case number shall be shown on the Manufacturer's Data Report or Manufacturer's Partial Data Report for the welded component.

**Table 1  
Chemical Requirements**

Element	Composition Limits, %
Chromium	23.5–25.5
Cobalt	15.0–22.0
Aluminum	0.2–2.0
Titanium	0.5–2.5
Columbium + Tantalum	0.50–2.5
Iron	3.0 max.
Carbon	0.005–0.08
Manganese	1.0 max.
Molybdenum	2.0 max.
Silicon	1.0 max.
Copper	0.50 max.
Phosphorous	0.03 max.
Sulfur	0.03 max.
Boron	0.0006–0.006
Nickel	remainder

**Table 2  
Mechanical Properties Requirements**

Tensile strength, min., ksi (MPa)	150 (1035)
Yield strength, min., ksi (MPa)	90 (620)
Elongation in 2 in., min., %	20

**Table 3  
Specification**

Plate, sheet, and strip	SB-435
Wrought fittings	SB-366

**Table 4**  
**Maximum Allowable Stress Values**

For Metal	
Temperature Not Exceeding, °F	Stress Values, ksi
-20 to 100	42.9
200	42.9
300	42.9
400	42.6
500	41.1
600	40.3
650	40.1
700	40.0
750	40.0
800	40.0
850	40.0
900	40.0
950	40.0
1,000	40.0
1,050	40.0
1,100	39.8
1,150	39.1
1,200	33.1 [Note (1)]
1,250	26.2 [Note (1)]
1,300	20.2 [Note (1)]
1,350	15.1 [Note (1)]
1,400	10.7 [Note (1)]
1,450	6.9 [Note (1)]
1,500	3.2 [Note (1)], [Note (2)]

## NOTES:

- (1) These stress values are obtained from time-dependent properties.
- (2) The maximum use temperature shall be 1,472°F. Datum for 1,500°F temperature is provided for interpolation purposes.

**Table 4M**  
**Maximum Allowable Stress Values**

For Metal	
Temperature Not Exceeding, °C	Stress Values, MPa
-30 to 40	295
65	295
100	295
150	295
200	294
250	285
300	279
325	277
350	276
375	276
400	276
425	276
450	276
475	276
500	276
525	276
550	276
575	276
600	274
625	269
650	226 [Note (1)]
675	183 [Note (1)]
700	146 [Note (1)]
725	113 [Note (1)]
750	84.1 [Note (1)]
775	59.1 [Note (1)]
800	34.5 [Note (1)]

## NOTE:

- (1) These stress values are obtained from time-dependent properties.

**Table 5**  
**Tensile Strength Values,  $S_u$**

For Metal Temperature Not Exceeding, °F	$S_u$ Values, ksi [Note (1)]
-20 to 100	150
200	150
300	150
400	149
500	144
600	141
650	140
700	140
750	140
800	140
850	140
900	140
950	140
1,000	140
1,050	140
1,100	139
1,150	137
1,200	134
1,250	129
1,300	124
1,350	117
1,400	109
1,450	99.1
1,500	88.2 [Note (2)]

NOTES:

- (1) The tabulated values of tensile strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the values of tensile strength tend toward an average or expected value that may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. The tensile strength values do not correspond exactly to "average" as this term is applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section I require elevated temperature testing for tensile strengths of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile strength values for ASME Code acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.
- (2) The maximum use temperature shall be 1,472°F. Datum for 1,500°F temperature is provided for interpolation purposes.

**Table 5M**  
**Tensile Strength Values,  $S_u$**

For Metal Temperature Not Exceeding, °C	$S_u$ Values, MPa [Note (1)]
-30 to 40	1 034
65	1 034
100	1 034
150	1 034
200	1 030
250	998
300	976
325	970
350	967
375	966
400	966
425	966
450	966
475	966
500	966
525	966
550	966
575	966
600	957
625	942
650	921
675	894
700	860
725	819
750	771
775	715
800	651

NOTE:

- (1) The tabulated values of tensile strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the values of tensile strength tend toward an average or expected value that may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. The tensile strength values do not correspond exactly to "average" as this term is applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section I require elevated temperature testing for tensile strengths of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile strength values for ASME Code acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

**Table 6**  
**Yield Strength Values,  $S_y$**

For Metal Temperature Not Exceeding, °F	$S_y$ Values, ksi [Note (1)]
-20 to 100	90.0
200	86.5
300	83.8
400	81.2
500	79.1
600	77.6
650	77.2
700	76.8
750	76.7
800	76.7
850	76.7
900	76.7
950	76.7
1,000	76.7
1,050	76.7
1,100	76.7
1,150	76.7
1,200	76.7
1,250	76.7
1,300	76.7
1,350	75.3
1,400	72.7
1,450	69.2
1,500	64.5 [Note (2)]

## NOTES:

- (1) The tabulated values of yield strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the yield strength values correspond to the yield strength trend curve adjusted to the minimum specified room temperature yield strength. The yield strength values do not correspond exactly to "minimum" or "average," as those terms are applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section I require elevated temperature testing for yield strength of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated yield strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.
- (2) The maximum use temperature shall be 1,472°F. Datum for 1,500°F temperature is provided for interpolation purposes.

**Table 6M**  
**Yield Strength Values,  $S_y$**

For Metal Temperature Not Exceeding, °C	$S_y$ Values, MPa [Note (1)]
-30 to 40	621
65	606
100	594
150	577
200	562
250	548
300	538
325	534
350	531
375	530
400	529
425	529
450	529
475	529
500	529
525	529
550	529
575	529
600	529
625	529
650	529
675	529
700	529
725	522
750	508
775	489
800	463

## NOTE:

- (1) The tabulated values of yield strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the yield strength values correspond to the yield strength trend curve adjusted to the minimum specified room temperature yield strength. The yield strength values do not correspond exactly to "minimum" or "average," as those terms are applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section I require elevated temperature testing for yield strength of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated yield strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

**Table 7  
Physical Properties**

Temperature, °F	Modulus of Elasticity, Tension, 10 <sup>3</sup> ksi [Note (1)]	Thermal Conductivity, Btu/ft-hr-°F	Mean CTE, 10 <sup>-6</sup> in./in./°F [Note (2)]	Specific Heat, Btu/lb-°F
73	31.99	72.9	...	0.108
200	31.58	79.9	6.84	0.112
400	30.85	90.9	7.25	0.117
600	29.83	102.0	7.53	0.119
800	28.68	113.3	7.80	0.120
1,000	27.67	124.9	7.96	0.121
1,200	26.37	136.9	8.24	0.126
1,400	25.08	149.3	8.61	0.133
1,600	23.43	162.1	8.88	0.143
1,800	...	175.6	...	0.152
2,000	...	189.6	...	0.155
2,100	...	196.9	...	0.152

## NOTES:

(1) Aged at 1,472°F/4h/AC.

(2) Mean CTE (coefficient of thermal expansion) values are those from 70°F to indicated temperature.

**Table 7M  
Physical Properties**

Temperature, °C	Modulus of Elasticity, Tension, 10 <sup>3</sup> MPa [Note (1)]	Thermal Conductivity, W/ (m <sup>2</sup> ·°C)	Mean CTE, 10 <sup>-6</sup> mm/mm/°C [Note (2)]	Specific Heat, J/kg-°C
22	221	10.2	...	449
100	218	11.7	12.38	476
200	212	13.0	13.04	489
300	206	14.5	13.50	496
400	200	15.7	13.93	503
500	193	17.1	14.27	513
600	186	18.4	14.57	519
700	178	20.2	15.03	542
800	169	22.1	15.72	573
900	...	23.8	...	635
1 000	...	25.4	...	656
1 100	...	27.3	...	669

## NOTES:

(1) Aged at 800°C/4h/AC.

(2) Mean CTE (coefficient of thermal expansion) values are those from 20°C to indicated temperature.

Approval Date: August 1, 2018

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2703-1**  
**Instrumented Indentation Testing as Alternative**  
**Hardness Test for QW-290 Temper Bead Welding**  
**Section I; Section IX**

*Inquiry:* Is it permissible to use instrumented indentation testing as an alternative hardness test to that specified in Section IX, QW-290 for temper bead welding?

*Reply:* It is the opinion of the Committee that instrumented indentation testing may be used as an alternative hardness test to that specified in Section IX, QW-290 for temper bead welding, provided the following requirements are met.

## 1 SCOPE

(a) Instrumented indentation testing for determination of hardness and other materials parameters covers the requirement for a wide range of macro, micro, and nano indentation testing applications. In this Case, test forces in macro (2 N to 30 kN) range shall be used.

(b) The basic steps and the general requirements of instrumented indentation testing shall be in accordance with ASTM E2546, Standard Practice for Instrumented Indentation Testing.

## 2 APPARATUS

(a) The Vickers indenter shall be used.

(b) Testing instrument, instrument verification, instrument compliance, and standard reference blocks shall be in accordance with ASTM E2546.

## 3 PROCEDURE

*Step 1.* Prepare environment. The test shall be carried out within the temperature range defined by the instrument manufacturer. Generally, it is recommended to perform the test within the temperature range  $-22^{\circ}\text{F}$  to  $176^{\circ}\text{F}$  ( $-30^{\circ}\text{C}$  to  $80^{\circ}\text{C}$ ). The test environment should minimize vibrations or other variations that could adversely affect the performance of the instrument.

*Step 2.* Select test location. The indentation testing location shall be as specified in QW-290.5.

*Step 3.* Perform the test. The testing condition shall be as specified in QW-290.5. Force, displacement, and time data shall be continuously and automatically acquired during the test.

*Step 4.* Analyze results. The hardness is defined by dividing the maximum indentation force by the area of indent. The area of indent is determined in accordance with Appendices X3 and X4 of ASTM E2546.

## 4 REPORT

(a) The report shall include the information about the instrument, indenter used, temperature, test sample, test location, and the units of the test results.

(b) This Case number shall be recorded on the Procedure Qualification Record.

(c) This Case number shall be shown on the Manufacturer's Data Report.

## 5 REFERENCE

ASTM E2546-07, Standard Practice for Instrumented Indentation Testing

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: September 26, 2011

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2704**  
**Vessel (Production) Impact Tests for Welded**  
**Construction of Austenitic Stainless Steels**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions may the welded construction of austenitic stainless steels be exempted from vessel (production) impact tests?

*Reply:* It is the opinion of the Committee that the welded construction of austenitic stainless steels may be exempted from vessel (production) impact tests, provided that all of the following requirements are met:

(a) At minimum design metal temperatures (MDMTs) of  $-155^{\circ}\text{F}$  ( $-104^{\circ}\text{C}$ ) and warmer, vessel (production) impact tests are exempted, provided that the impact test exemption requirements for the applicable Welding Procedure Qualification in UHA-51(e) are satisfied.

(b) At MDMTs colder than  $-155^{\circ}\text{F}$  ( $-104^{\circ}\text{C}$ ) but not colder than  $-320^{\circ}\text{F}$  ( $-196^{\circ}\text{C}$ ), vessel (production) impact tests are exempted, provided the requirements for the pre-use test in UHA-51(f) are satisfied.

(c) At MDMTs colder than  $-320^{\circ}\text{F}$  ( $-196^{\circ}\text{C}$ ), the rules in UHA-51(h)(2) apply.

(d) For autogenous welds (welded without filler metal), the rules in UHA-51(i) apply.

(e) This Case number shall be shown on the Manufacturer's Data Report.

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Approval Date: August 9, 2011

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2705**  
**Revised Data Report Forms**  
**Section XII**

*Inquiry:* May revised Forms T-1AR, T-2AR, and T-2CR be used in the construction of Section XII transport tanks?

*Reply:* It is the opinion of the Committee that revised Forms T-1AR, T-2AR, and T-2CR may be used in the construction of Section XII transport tanks, provided the following additional requirements are met.

(a) In the last line of revised Forms T-1AR and T-2AR, the word "Commissions" shall be replaced with the word "Commission."

(b) In the last line of revised Forms T-1AR and T-2AR, the statement "[National Board (incl. endorsement), State, Province, and No.]" Commissions shall be replaced with the statement "(National Board Commission Number and Endorsement)."

(c) In the last line of revised Form T-2CR, the word "Commissions" and the statement "(National Board incl. endorsement, State, Province, and No.)" shall be deleted.

(d) In Table 1, Note (56) that was originally in Table C1 shall be deleted.

(e) In Table 1, Note (57) that was originally in Table C1 shall be changed to Note (56). This new note (56) shall be revised by deleting the words "when the pressure vessel is stamped National Board."

(f) In Table 1, Note (58) that was originally in Table C1 shall be deleted.

(g) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**FORM T-1AR MANUFACTURER'S DATA REPORT FOR CLASS 1 TRANSPORT TANKS**  
**As Required by the Provisions of the ASME Code Rules, Section XII and Code Case 2705**

1. Manufactured and certified by \_\_\_\_\_ (1)  
(Name and address of manufacturer)

2. Manufactured for \_\_\_\_\_ (2)  
(Name and address of purchaser)

3. Competent Authority \_\_\_\_\_ (3)  
(Name of Regulatory Agency and Regulation met)

4. Type \_\_\_\_\_ (4) \_\_\_\_\_ (6) \_\_\_\_\_ (7) \_\_\_\_\_ (8) \_\_\_\_\_ (10) \_\_\_\_\_ (Year built)  
(DOT/UN Spec.) (Manufacturer's serial No.) (CRN) (Drawing No.) (National Bd. No.)

5. The chemical and physical properties of all parts meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE. The design, construction, and workmanship conform to ASME Rules, Section XII, Class 1 \_\_\_\_\_ (11)  
to \_\_\_\_\_ (11) \_\_\_\_\_ (12) \_\_\_\_\_ (13)  
Addenda (if applicable) (Date) Code Case Nos. Capacity, liters (gallons)

6. Shell \_\_\_\_\_ (18) \_\_\_\_\_ (19) \_\_\_\_\_ (20) \_\_\_\_\_ (16) \_\_\_\_\_ (16)  
Material (Spec. No., Grade) Min. Required Thk. Corr. Allow. Diameter I.D. Length (overall)

7. Seams \_\_\_\_\_ (21) \_\_\_\_\_ (22) \_\_\_\_\_ (22) \_\_\_\_\_ (25) \_\_\_\_\_ (25) \_\_\_\_\_ (23) \_\_\_\_\_ (24) \_\_\_\_\_ (16)  
Long. (Welded, Dbl., Sngl., Lap, Butt) R.T. (Spot or Full) Eff. (%) H.T. Temp. Time (hr) Girth, (Welded, Dbl., Sngl., Lap, Butt) R.T. (Spot, Partial, or Full) No. of Courses

8. Heads: (a) Material \_\_\_\_\_ (15) \_\_\_\_\_ (25) \_\_\_\_\_ (29) (b) Material \_\_\_\_\_ (Spec. No., Grade)

	Location (Top, Bottom, Ends)	Minimum Thickness	Corrosion Allowance	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure (Convex or Concave)
(a)		(28)	(20)	(27)	(28)					
(b)										

If removable, bolts used (describe other fastenings) \_\_\_\_\_ (30)  
(Material, Spec. No., Gr., Size, No.)

9. MAWP \_\_\_\_\_ (31) at max. temp. \_\_\_\_\_ (32)  
Min. design metal temp. \_\_\_\_\_ (39) at \_\_\_\_\_ Hydro., pneu., or comb. test pressure \_\_\_\_\_ (35)

10. Nozzles, inspection and safety valve openings:

Purpose (Inlet, Outlet, Drain)	No.	Diameter or Size	Type	Material	Nom. Thk	Reinforcement Material	How Attached	Location
(37)		(38)	(38)	(18)	(42)	(43)	(44)	(46)
			(39)					
			(44)	(40)				

11. Supports: Skirt \_\_\_\_\_ (47) Lugs \_\_\_\_\_ (No.) Legs \_\_\_\_\_ (No.) Other \_\_\_\_\_ Attached \_\_\_\_\_ (Where and how)  
(Yes or no)

12. Remarks: Manufacturer's Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of the report \_\_\_\_\_ (Name of part, item number, Manufacturer's name, and identifying stamp)  
\_\_\_\_\_ (34) \_\_\_\_\_ (36) \_\_\_\_\_ (48) \_\_\_\_\_ (49)

**(54) CERTIFICATE OF SHOP COMPLIANCE**

We certify that the statements made in this report are correct and that all details of design, material, construction, and workmanship of this vessel conform to the ASME Code for Transport Tanks, Section XII, T Certificate of Authorization No. \_\_\_\_\_ (54) expires \_\_\_\_\_.

Date \_\_\_\_\_ Co. name \_\_\_\_\_ (54) Signed \_\_\_\_\_ (54)  
(Manufacturer) (Representative)

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**(55) CERTIFICATE OF SHOP INSPECTION**

Vessel constructed by \_\_\_\_\_ at \_\_\_\_\_.

I, the undersigned, holding a valid credential issued by the National Board of Boiler and Pressure Vessel Inspectors and Competent Authority \_\_\_\_\_ and employed by \_\_\_\_\_ have inspected the component described in this Manufacturer's Data Report on \_\_\_\_\_, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel in accordance with ASME Code, Section XII. By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date \_\_\_\_\_ Signed \_\_\_\_\_ (55) Commission \_\_\_\_\_ (56)  
(Authorized Inspector) (National Board Commission Number and Endorsement)

**FORM T-2AR MANUFACTURER'S PARTIAL DATA REPORT FOR CLASS 1 TRANSPORT TANKS  
 As Required by the Provisions of the ASME Code Rules, Section XII and Code Case 2705**

1. Manufactured and certified by \_\_\_\_\_ (1)  
(Name and address of Manufacturer)

2. Manufactured for \_\_\_\_\_ (2)  
(Name and address of Purchaser)

3. Competent Authority \_\_\_\_\_ (3) (52)  
(Name of Regulatory Agency and Regulation Met)

4. Type \_\_\_\_\_ (5) \_\_\_\_\_ (6) \_\_\_\_\_ (7)  
(DOT/JN Spec.) (Manufacturer's serial No.) (CRN)

\_\_\_\_\_ (10) \_\_\_\_\_ (8) \_\_\_\_\_ (9) \_\_\_\_\_ (53)  
(National Bd. No.) (Drawing No.) (Drawing prepared by) (Year built)

5. ASME Code, Section XII \_\_\_\_\_ (11) \_\_\_\_\_ (12) \_\_\_\_\_ (4) \_\_\_\_\_ (13) \_\_\_\_\_ (52)  
[Edition and Addenda (if applicable) (date)] (Code Case No.) Class Capacity

6. Shell: (a) No. of course(s) \_\_\_\_\_ (14) (b) Overall length \_\_\_\_\_ (15)

No.	Course(s)		Material		Thickness		Long. Joint (Cat. A)			Circum. Joint (Cat A, B & C)			Heat Treatment	
	Diameter	Length	Spec./Grade or Type	Min.	Corr.	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp.	Time	
	(16)	(17)	(18)	(19)	(20)	(21)	(22)		(23)	(24)		(25)		
				(52)										

7. Heads: (a) \_\_\_\_\_ (19) \_\_\_\_\_ (25) (b) \_\_\_\_\_  
(Material Spec. No., Grade or Type) (H.T. — Time & Temp.) (Material Spec. No., Grade or Type) (H.T. — Time & Temp.)

	Location (Top, Bottom, Ends)	Thickness		Radius		Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure		Category A	
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None
(a)		(26)	(20)	(27)	(28)							(29)	
(b)		(52)											

If removable, bolts used (describe other fastenings) \_\_\_\_\_ (30)  
(Material Spec. No., Grade, Size, No.)

8. MAWP (31) (52) at max. temp. \_\_\_\_\_ (32) Min. design metal temp. (33) (52) at \_\_\_\_\_  
(internal) (external) (internal) (external)

9. Impact test \_\_\_\_\_ (34) at test temperature of \_\_\_\_\_ (34)  
[Indicate yes or no and the component(s) impact tested]

10. Hydro., pneu., or comb. test press. \_\_\_\_\_ (35) Proof test \_\_\_\_\_ (36)

11. Nozzles, inspection and safety valve openings:

Purpose (Inlet, Outlet, Drain, etc.)	No.	Diameter or Size	Flange Type	Material		Nozzle Thickness		Reinforcement Material	How Attached		Location (Insp. Open.)
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange	
(37)		(38)	(39)	(40)	(41)	(42)		(43)	(44) (45)	(44) (45)	(46)

12. Supports: Skirt (47) Lugs (47) Legs (47) Other (47) Attached (47)  
(Yes or no) (No.) (No.) (Describe) (Where and how)

13. Remarks \_\_\_\_\_ (35) (36) (49)

(54) **CERTIFICATE OF SHOP COMPLIANCE**  
 We certify that the statements made in this report are correct and that all details of material, construction, and workmanship of this pressure vessel part conform to the ASME Code for Transport Tanks, Section XII, Class 1.  
 T Certificate of Authorization No. \_\_\_\_\_ Expires \_\_\_\_\_  
 Date \_\_\_\_\_ Name \_\_\_\_\_ Signed \_\_\_\_\_  
(Manufacturer) (Representative)

(55) **CERTIFICATE OF SHOP INSPECTION**  
 I, the undersigned, holding a valid credential issued by the National Board of Boiler and Pressure Vessel Inspectors and/or Competent Authority of \_\_\_\_\_ and employed by \_\_\_\_\_ of \_\_\_\_\_, have inspected the pressure vessel part described in this Manufacturer's Data Report on \_\_\_\_\_, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel part in accordance with ASME Code, Section XII, Class 1. By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the pressure vessel part described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.  
 Date \_\_\_\_\_ Signed \_\_\_\_\_ Commission \_\_\_\_\_  
(Authorized Inspector) (National Board Commission Number and Endorsement)

**FORM T-2CR MANUFACTURER'S PARTIAL DATA REPORT FOR CLASS 3 TRANSPORT TANKS  
 As Required by the Provisions of the ASME Code Rules, Section XII and Code Case 2705**

1. Manufactured and certified by \_\_\_\_\_ (1)  
(Name and address of Manufacturer)

2. Manufactured for \_\_\_\_\_ (2)  
(Name and address of Purchaser)

3. Competent Authority \_\_\_\_\_ (3) (52)  
(Name of Regulatory Agency and Regulation Met)

4. Type \_\_\_\_\_ (5) (DOT/UN Spec.) \_\_\_\_\_ (6) (Manufacturer's Serial No.) \_\_\_\_\_ (7) (CRN)  
(National Bd. No.) (Drawing No.) (Drawing prepared by) (Year built)

5. ASME Code, Section XII \_\_\_\_\_ (11) \_\_\_\_\_ (12) \_\_\_\_\_ (4) \_\_\_\_\_ (13) \_\_\_\_\_ (52)  
(Edition and Addenda (if applicable) (date)) (Code Case No.) Class Capacity

6. Shell: (a) No. of course(s) \_\_\_\_\_ (14) (b) Overall length \_\_\_\_\_ (15)

No.	Course(s)		Material Spec./Grade or Type	Thickness		Long. Joint (Cat. A)			Circum. Joint (Cat A, B & C)			Heat Treatment	
	Diameter	Length		Min.	Corr.	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp	Time
	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)

7. Heads: (a) \_\_\_\_\_ (18) \_\_\_\_\_ (25) (b) \_\_\_\_\_  
(Material Spec. No., Grade or Type) (H.T. — Time & Temp.) (Material Spec. No., Grade or Type) (H.T. — Time & Temp.)

	Location (Top, Bottom, Ends)	Thickness		Radius		Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Eff.
(a)		(26)	(20)	(27)	(28)							(29)		
(b)		(32)												

If removable, bolts used (describe other fastenings) \_\_\_\_\_ (30)  
(Material Spec. No., Grade, Size, No.)

8. MAWP \_\_\_\_\_ (31) \_\_\_\_\_ (52) at max. temp. \_\_\_\_\_ (32) \_\_\_\_\_ (33) \_\_\_\_\_ (52) at \_\_\_\_\_  
(internal) (external) (internal) (external)

9. Impact test \_\_\_\_\_ (34) at test temperature of \_\_\_\_\_ (34)  
[indicate yes or no and the component(s) impact tested]

10. Hydro., pneu., or comb. test press. \_\_\_\_\_ (35) Proof test \_\_\_\_\_ (36)

11. Nozzles, inspection and safety valve openings:

Purpose (Inlet, Outlet, Drain, etc.)	No.	Diameter or Size	Flange Type	Material		Nozzle Thickness		Reinforcement Material	How Attached		Location (Insp. Open.)	
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange		
(37)		(38)	(39)	(40)	(41)	(42)	(43)	(44)	(45)	(44)	(45)	(46)

12. Supports: Skirt \_\_\_\_\_ (47) Lugs \_\_\_\_\_ (47) Legs \_\_\_\_\_ (47) Others \_\_\_\_\_ (47) Attached \_\_\_\_\_ (47)  
(Yes or no) (No.) (No.) (Describe) (Where and how)

13. Remarks \_\_\_\_\_

\_\_\_\_\_ (35) \_\_\_\_\_ (36) \_\_\_\_\_ (49)

(54) **CERTIFICATE OF SHOP COMPLIANCE**  
 We certify that the statements made in this report are correct and that all details of material, construction, and workmanship of this pressure vessel part conform to the ASME Code for Transport Tanks, Section XII, Class 3.  
 T Certificate of Authorization No. \_\_\_\_\_ Expires \_\_\_\_\_  
 Date \_\_\_\_\_ Name \_\_\_\_\_ (Manufacturer) Signed \_\_\_\_\_ (Representative)

(55) **CERTIFICATE OF SHOP INSPECTION**  
 I, the undersigned, holding a valid credential issued by the National Board of Boiler and Pressure Vessel Inspectors and/or Competent Authority of \_\_\_\_\_ and employed by \_\_\_\_\_ of \_\_\_\_\_ have inspected the pressure vessel part described in this Manufacturer's Data Report on \_\_\_\_\_, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel part in accordance with ASME Code, Section XII, Class 3. By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the pressure vessel part described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.  
 Date \_\_\_\_\_ Signed \_\_\_\_\_ (Certified Individual)

**Table 1  
Guide for Completing Forms**

References to Circled Numbers in the Forms	Description
(1)	Name and street address of manufacturer as listed on ASME Certificate of Authorization.
(2)	Name and address of purchaser.
(3)	Identify Competent Authority and regulation complied with.
(4)	U.S. DOT Specification/U.N. Specification.
(5)	Description of vessel part (i.e., shell, two-piece head).
(6)	Manufacturer's serial number.
(7)	Canadian registration number, where applicable.
(8)	Indicate drawing number(s), including applicable revision number, that cover general assembly and list of materials. For Canadian registered vessels, the number of the drawing approved by the provincial authorities.
(9)	Organization that prepared drawing, if other than the Manufacturer listed in (1).
(10)	Where applicable, the National Board number from the Manufacturer's Series of National Board numbers sequentially without skips or gaps. National Board numbers shall not be used for Owner-inspected vessels.
(11)	ASME Code, Section XII, Edition (e.g., 2004) and Addenda (e.g., A03, etc., if applicable) used for construction.
(12)	All Code Case numbers and revisions used for construction must be listed. Where more space is needed, use "Remarks" section or list on a supplemental page.
(13)	Indicate vessel capacity.
(14)	Total number of courses or sections between end closures (heads) required to make one shell. In the "No." blocks in the table below, under "Courses," indicate the number of courses with identical information.
(15)	Length of the shell (courses), excluding heads.
(16)	Indicate the dimensions of the course(s) as follows: <i>(a)</i> cylindricals as inside or outside diameter <i>(b)</i> transition as inside our outside diameter at the largest and smallest ends <i>(c)</i> squares or rectangles as the largest width and height <i>(d)</i> all other shapes define as appropriate or attach a sketch or drawing Where more space is needed, use "Remarks" section or list on a supplemental page.
(17)	Length of the shell (courses), excluding heads.
(18)	Show the complete ASME material specification number and grade as listed in the appropriate stress allowance table in Section IV (e.g., "SA-285C"). Exception: A specification number for a material not identical to an ASME Specification may be shown only if such material has been approved for Section IV construction by an ASME interpretation case ruling and provided the applicable case number is also shown.
(19)	Thickness is the minimum required by the design or statute.
(20)	State corrosion allowance (see TD-130).
(21)	Type of longitudinal joint (e.g., Type 1, 2, 3, 4, 5, or 6) per Table TW-130.4. In case of brazing, explain type of joint. If seamless, indicate joint type as S, and E for electric resistance welded.
(22)	Category A (longitudinal) welds — identify degree of examination (radiographic or if applicable, ultrasonic) employed: full, spot, or none (see TE-230.1). Also identify the joint efficiency associated with the weld from Table TW-130.4. Where more space is needed, use "Remarks" section, supplemental page, or RT map, as applicable. In the case of parts, there is no need to identify the joint efficiency associated with these welds. [See (29) for heads of welded construction joints.]
(23)	Type of circumferential joint (e.g., Type 1, 2, 3, 4, 5, or 6) per Table TW-130.4. In the case of brazing, explain type of joint. For multiple course vessel, the Category B welds in the shell and head-to-shell joint (Category A, B, C) shall be listed bottom to top or left to right as shown on drawing listed in (8).
(24)	Categories A, B, and C (circumferential) welds — identify degree of examination (radiographic or if applicable, ultrasonic) employed: full, spot, or none (see TE-230.1) or spot radiography in accordance with TE-230.1(a)(4). Where more space is needed, use "Remarks" section, supplemental page, or RT map, as applicable. In the case of parts, there is no need to identify the joint efficiency associated with these welds.
(25)	When heat treatment is performed by the Manufacturer, such as postweld heat treatment, annealing, or normalizing, give the holding temperature and time. Explain any special cooling procedure under "Remarks."
(26)	Specified minimum thickness of the head after forming. It includes corrosion allowance.
(27)	Indicate the crown radius (inside or outside) for torispherical heads.
(28)	Indicate the knuckle radius (inside or outside) for torispherical heads.
(29)	For heads of welded construction joints, indicate the following: <i>(a)</i> type of joint in the head (Category A), e.g., Type 1, 2, 3, etc., per Table TW-130.4; in the case of brazing, explain the type of joint. <i>(b)</i> identify degree of examination (radiographic or if applicable, ultrasonic) employed: full, spot, or none. Where more space is needed, use "Remarks" section, supplemental page, RT map, as applicable.
(30)	Bolts used to secure removable head or heads of vessel. Indicate the number, size, material specification (grade/type).
(31)	Show maximum allowable working pressure (internal or external) for which vessel is constructed. See TD-160.
(32)	Show maximum temperature permitted for vessel at MAWP. See (31).
(33)	Indicate the minimum design metal temperature (MDMT).

**Table 1**  
**Guide for Completing Forms (Cont'd)**

References to Circled Numbers in the Forms	Description
(34)	Indicate if impact testing was conducted (yes or no) and the component(s) that were impact tested and the impact test temperature. Where more space is needed, use "Remarks" section or list on a supplemental page. If no, indicate applicable paragraph(s) [such as TM-240.1, TM-240.3, TM-240.4(a), TM-240.4(b), TM-240.4(c), TM-250.5, and TM-250.7].
(35)	Indicate the type of test used (pneumatic, hydrostatic, or combination test, as applicable) and specify test pressure at the top of the vessel in the test position. Indicate under "Remarks" if the vessel was tested in vertical position.
(36)	When proof test is required by Code rules, indicate type of test (see Article TT-3), proof test pressure, and acceptance date by the Inspector. Subsequent Data Reports shall indicate under "Remarks" the test date, type, and acceptance date by the Inspector.
(37)	Nozzles, inspection, and safety valve openings; list all openings, regardless of size and use. Where more space is needed, list them on a supplemental page.
(38)	Indicate nozzles by the size (NPS) and inspection openings by inside dimensions in inches.
(39)	Data entries with description acceptable to the Inspector. For flange type, an abbreviation may be used to define any generic name. Some typical abbreviations: Flanged fabricated nozzle: Cl. 150 flg. Long weld neck flange: Cl. 300 lwn. Weld end fabricated nozzle: w.e. Lap joint flange: Cl. 150 lap jnt.
(40)	Show the material for the nozzle neck.
(41)	Show the material for the flange.
(42)	Nominal thickness applies to nozzle neck thickness.
(43)	Show the complete ASME specification number and grade of the actual material used for the reinforcement material (pad). Material is to be as designated in Section XII. EXCEPTIONS: A specification number for a material not identified to an ASME specification may be shown only if such material meets the criteria in the Code and in conjunction with the Foreword of this Section. When material is accepted through a Code Case, the applicable Case number shall be shown.
(44)	Data entries with description acceptable to the Inspector.
(45)	Categories C and D welds — identify degree of examination (radiographic or if applicable, ultrasonic) employed: full, spot, or none (see TE-230.1). Also identify the joint efficiency associated with the weld from Table TW-130.4.
(46)	"Location" applies to inspection openings only.
(47)	Describe: (a) type of support (skirt, lugs, etc.) (b) location of support (top, bottom, side, etc.) (c) method of attachment (bolted, welded, etc.)
(48)	To be completed when one or more parts of the vessel are furnished by others and certified on Data Report T-2A, B, or C. The part manufacturer's name and serial number should be indicated.
(49)	For additional comments including any Code restrictions on the vessel, or any unusual requirements that have been met, such as those in TG-100.2(c), TF-710(f)(1), etc., or in other notes to this Table. Indicate stiffening rings when used.
(50)	Fill in information identical to that shown on the Data Report Form to which this sheet is supplementary. Indicate the type of Certificate of Authorization, number, expiration date, and signature of the company representative.
(51)	Fill in information for which there was insufficient space on the Data Report Form as indicated by the notation "See attached T-3 Form" on the Data Report. Identify the applicable Data Report item number.
(52)	Indicate data, if known.
(53)	Indicate the extent, if any, of the design function performed.
(54)	Certificate of Shop Compliance block is to show the name of the Manufacturer as shown on his ASME Code Certificate of Authorization. This should be signed in accordance with the organizational authority defined in the Quality Control System.
(55)	Certificate of Shop Inspection block is to be completed by the Manufacturer and signed by the Inspector who performs the inspection.
(56)	The Inspector's National Board credential number must be shown.

Approval Date: November 7, 2011

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2706**  
**Use of SB-584 (UNS C87500) Copper Alloy Sand Castings in the Manufacture of Nonstandard Pressure Parts for Hot Water Heating Boilers and Potable Water Heaters**  
**Section IV**

*Inquiry:* Under what conditions may UNS C87500 copper alloy sand castings, conforming to the requirements of SB-584, be used in the construction of hot water heating boilers and potable water heaters of Section IV pressure vessels?

*Reply:* It is the opinion of the Committee that UNS C87500 copper alloy sand castings, conforming to the requirements of SB-584, may be used in the construction of hot water heating boilers and potable water heaters of Section IV pressure vessels, provided the following requirements are met:

- (a) The maximum allowable stress values shall be those listed in [Tables 1](#) and [1M](#).
- (b) All other applicable parts of Section IV shall apply.
- (c) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.



Approval Date: November 7, 2011

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2707**  
**Use of SA-240/SA-240M UNS S41003 Plate in the**  
**Construction of Boilers**  
**Section IV**

*Inquiry:* Under what conditions may SA-240/SA-240M UNS S41003 plate be used in the construction of Section IV boilers?

*Reply:* It is the opinion of the Committee that SA-240/SA-240M UNS S41003 plate may be used for Section IV construction, provided the following requirements are met:

(a) The material shall conform to the requirements of SA-240/SA-240M UNS S41003.

(b) For external pressure design, Fig. CS-2 in Section II, Part D shall be used.

(c) For welding procedure and performance qualifications, the material shall be classified as P-No. 7, Group 1 in accordance with Section IX.

(d) The maximum design temperature shall be 500°F (260°C).

(e) After any thermal cutting, the cut face shall be ground or machined to a bright finish.

(f) Material shall be welded with a filler metal that produces a low carbon content austenitic chromium-nickel weld deposit (e.g., 309L).

(g) For gas metal arc welding processes using a solid wire or metal cored wire, the shielding gas shall have a maximum CO<sub>2</sub> content of 5%.

(h) The heat input during welding shall be controlled between 12.5 kJ/in. and 38 kJ/in. (0.5 kJ/mm and 1.5 kJ/mm).

(i) The interpass temperature shall not exceed 212°F (100°C).

(j) The preheating temperature shall be above 70°F (20°C).

(k) Maximum allowable stress values shall be as shown in Table 1 and Table 1M.

(l) Maximum allowable thickness shall not exceed 1/2 in. (12 mm).

(m) All other requirements of Section IV shall apply.

(n) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi
100	13.2
200	13.2
300	13.2
400	12.9
500	12.4

**Table 1M**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Values, MPa
40	91.0
100	91.0
150	91.0
200	89.0
250	86.2
300 [Note (1)]	83.4

NOTE:

(1) Maximum use temperature is 260°C. The value at 300°C is furnished for interpolation only.

Approval Date: November 7, 2011

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2708**  
**Use of SA-240/SA-240M UNS S43035 (Grade 439) and**  
**UNS S43932 Less Than  $\frac{1}{4}$  in. (6 mm) in Thickness for the**  
**Construction of Water Boilers Intended for Working**  
**Pressures Up to 160 psi (1 100 kPa) Under Part HF**  
**Section IV**

*Inquiry:* Under what conditions may boilers be constructed of UNS S43035 (Grade 439) and UNS S43932 materials that are less than  $\frac{1}{4}$  in. (6 mm) thick, with a maximum working pressure higher than the 80 psi (550 kPa) established by HF-301.1(c)(1)?

*Reply:* It is the opinion of the Committee that boilers may be constructed of UNS S43035 (Grade 439) and UNS S43932 materials under SA-240/SA-240M that are less than  $\frac{1}{4}$  in. (6 mm) in thickness and designed for

pressures greater than 80 psi (550 kPa), in accordance with the requirements of Section IV, Part HF, provided the following conditions are met:

(a) The materials shall be used to construct only hot water heating boilers and hot water supply boilers for operation at pressures not exceeding 160 psi (1 100 kPa) and water temperatures not exceeding 210°F (99°C).

(b) The materials shall not be exposed to primary products of combustion.

(c) The material thickness shall not be less than 0.065 in. (1.7 mm).

(d) All other requirements of Section IV shall be met in the construction of boilers or parts thereof.

(e) This Case number shall be shown on the Manufacturer's Data Report.

NOTE: This steel may develop embrittlement after service at moderately elevated temperatures; see Appendix A, A-340 and A-360, Section II, Part D.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: November 7, 2011

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2709**  
**UNS S43035 SA-268 Grade TP439 Welded Tubing**  
**Section IV**

*Inquiry:* Under what conditions may welded SA-268 Grade TP439 tubing be used in the construction of hot water heating boilers and hot water supply boilers or water heaters?

*Reply:* It is the opinion of the Committee that SA-268 Grade TP439 may be used in the welded construction of hot water heating boilers and hot water supply boilers or water heaters, provided the following requirements are met:

(a) The allowable stress values for SA-268 Grade TP439 shall be as listed in [Tables 1](#) and [1M](#) for the construction of hot water heating boilers (Part HF).

(b) The allowable stress values for SA-268 Grade TP439 shall be as listed in [Tables 2](#) and [2M](#) for the construction of water heaters (Part HLW).

(c) Welding procedure and performance qualifications shall be conducted in accordance with Section IX.

(d) For external pressure, Fig. CS-2 of Section II, Part D shall be used.

(e) For the purposes of welding procedure and performance qualification, this material shall be considered P-No. 7 Group 2.

(f) PWHT is not required nor recommended.

(g) The maximum design temperature shall be 500°F (260°C).

(h) All other requirements of Section IV shall be met.

(i) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values for**  
**SA-268 Grade TP439 (Part HF)**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi
100	10.2
200	10.2
300	9.8
400	9.6
500	9.4

**Table 2M**  
**Maximum Allowable Stress Values for**  
**SA-268 Grade TP439 (Part HLW)**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Values, MPa
40	88.0
100	87.8
150	84.8
200	82.7
250	81.2
275	80.3

GENERAL NOTE: The maximum use temperature shall be 260°C. Datum for 275°C is provided for interpolation purposes only.

**Table 1M**  
**Maximum Allowable Stress Values for**  
**SA-268 Grade TP439 (Part HF)**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Values, MPa
40	70.4
100	70.2
150	67.8
200	66.1
250	64.9
275	64.3

GENERAL NOTE: The maximum use temperature shall be 260°C. Datum for 275°C is provided for interpolation purposes only.

**Table 2**  
**Maximum Allowable Stress Values for**  
**SA-268 Grade TP439 (Part HLW)**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi
100	12.8
200	12.8
300	12.3
400	12.0
500	11.7

Approval Date: January 7, 2013

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2710-1**  
**Application of the ASME Certification Mark**  
**Section I; Section IV; Section X; Section XII**

*Inquiry:* In the 2011 Addenda to the 2010 Edition of the ASME Boiler and Pressure Vessel Code, the ASME Code Symbols shown below:

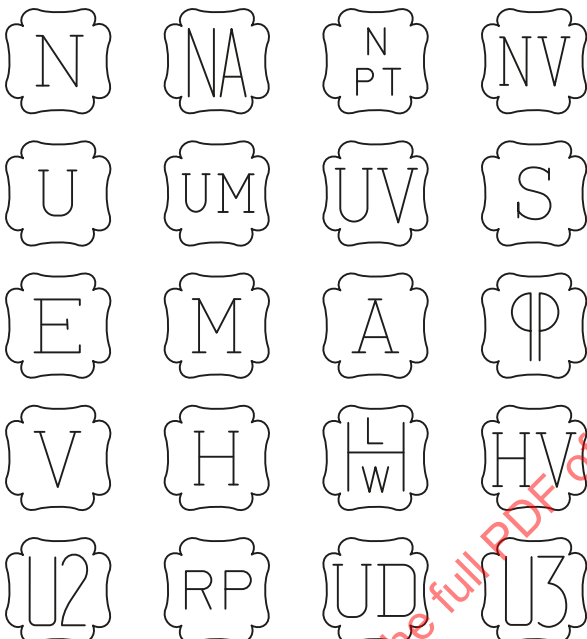
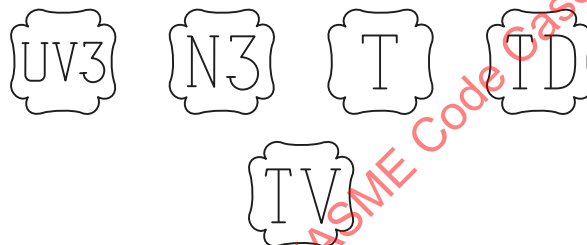
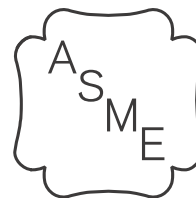


Table continued



were replaced by the single ASME Certification Mark shown below:



which must be accompanied by the appropriate Designator required by the Code of construction. May a Certificate Holder continue to use one of the ASME Code Symbols listed in the 2010 Edition beyond the six-month period after which revisions to the Code published in the 2011 Addenda become mandatory?

*Reply:* It is the opinion of the Committee that the ASME Code Symbols listed in the 2010 Edition may be used until December 31, 2013.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: September 30, 2018

(19)

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2711-1**  
**Use of AS 1548-2008 Grades PT430N/PT430NR,**  
**PT460N/PT460NR, PT490N/PT490NR for Class 2**  
**Section VIII, Division 2**

*Inquiry:* May the steel grades PT430N/PT430NR, PT460N/PT460NR, PT490N/PT490NR, conforming to the Australian Standard AS 1548-2008<sup>1</sup> be used for the manufacture of pressure vessels to Section VIII, Division 2, Class 2?

*Reply:* It is the opinion of the Committee that the grades specified in the Inquiry and conforming to AS 1548-2008 may be used in Section VIII, Division 2, Class 2 construction, provided the following requirements are met:

(a) The maximum allowable stress values shall be as given in Tables 1 and 1M. The maximum design temperature is 1,000°F (538°C).

(b) Grades PT430 and PT460 shall be considered as P-No.1 Group 1; Grade PT490 shall be considered as P-No.1 Group 2.

(c) For the purpose of impact test requirements for Section VIII, Division 2, Class 2 use, PT430NR and PT460NR shall be considered Curve B; PT430N and PT460N shall be considered Curve D; PT490N and PT490NR shall be considered Curve A shown in Figures 3.7, 3.7M, 3.8, and 3.8M.

(d) For external pressure applications, use Fig. CS-2 of Section II, Part D.

(e) This Case number shall be shown on the Manufacturer's Data Report.

<sup>1</sup> See Section II, Part A, Nonmandatory Appendix A for ordering information to obtain a copy of AS 1548-2008.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values**

Maximum Allowable Stress Values, ksi			
For Metal Temperatures Not Exceeding, °F	PT430N, PT430NR	PT460N, PT460NR	PT490N, PT490NR
-20 to 100	24.2	25.6	29.6
150	22.1	24.4	28.9
200	21.4	23.9	28.2
250	21.0	23.6	27.7
300	20.7	23.2	27.3
400	20.1	22.4	26.5
500	19.3	21.3	25.3
600	18.2	20.1	23.9
650	17.5	19.4	23.0
700	16.9	18.7	22.2
750	13.9	13.9	13.9
800	11.4	11.4	11.4
850	8.7	8.7	8.7
900	5.9	5.9	5.9
950	4.0	4.0	4.0
1000	2.5	2.5	2.5

**Table 1M**  
**Maximum Allowable Stress Values**

Maximum Allowable Stress Values, MPa			
For Metal Temperatures Not Exceeding, °C	PT430N, PT430NR	PT460N, PT460NR	PT490N, PT490NR
-30 to 40	167	177	204
65	153	168	200
100	147	164	194
125	144	162	191
150	142	160	188
175	141	158	186
200	139	155	183
225	137	152	180
250	134	149	176
300	128	141	168
325	124	137	163
350	120	133	157
375	114	114	114
400	95.0	95.0	95.0
425	79.6	79.6	79.6
450	63.2	63.2	63.2
475	45.3	45.3	45.3
500	31.7	31.7	31.7
525	21.9	21.9	21.9
550 [Note (1)]	12.7	12.7	12.7

## NOTE:

- (1) These values are provided for interpolation purposes only.  
The maximum use temperature is 538°C.

Approval Date: July 9, 2014

*Code Cases will remain available for use until annulled by the applicable Standards Committee.***Case 2712-1  
Spherical Intermediate Head or End Closure Without  
Straight Flange  
Section VIII, Division 1**

*Inquiry:* Under what conditions is it permissible to attach a spherical head segment to a cylindrical shell section to form an intermediate head or end closure, as shown in [Figure 1](#), for Section VIII, Division 1 construction?

*Reply:* It is the opinion of the Committee that it is permissible to attach a spherical head segment to a cylindrical shell section to form an intermediate head or end closure, as shown in [Figure 1](#), for Section VIII, Division 1 construction, provided the following requirements are met:

(a) Head thickness shall be calculated in accordance with Section VIII, Division 1, Mandatory Appendix 1, 1-6 (g)(1)(-a) and (-b) with  $P$  being the maximum pressure acting on either side. For pressure on the convex side of the head, Case 2286 may be used to determine the head thickness as an alternative to Mandatory Appendix 1, section 1-6. For differential pressure design, see UG-19(a). The maximum intermediate head dish radius,  $L$ , shall be limited to the shell inside diameter.

(b) The stresses in the area of the head to shell joint shall be evaluated by elastic method in accordance with Parts 5.2.2 and 5.3.2 of Section VIII, Division 2. Section VIII, Division 1 allowable stresses shall be used. The cyclic loading conditions shall be evaluated or exempted per Part 5.5 of Section VIII, Division 2.

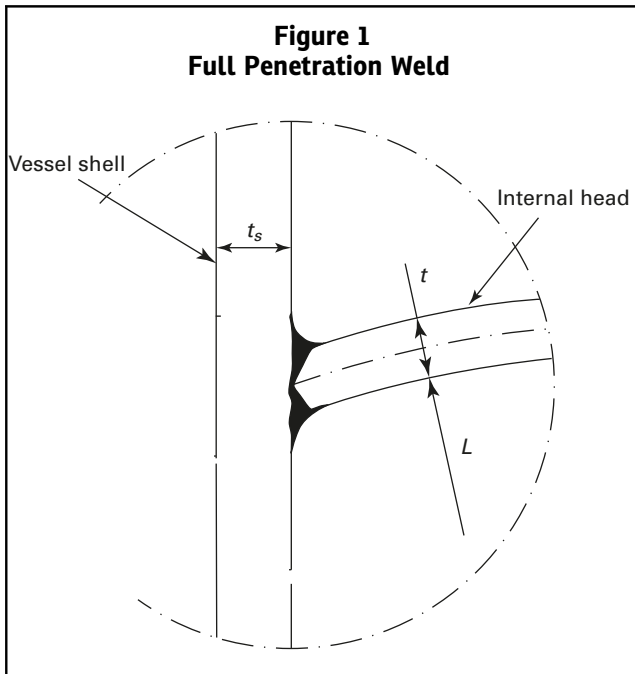
(c) The weld shall be a full penetration through the head thickness (see [Figure 1](#)).

(d) When the shell base material is formed from plate, the region 9 in. (230 mm) or  $(Rt_s)^{1/2}$ , whichever is greater, above and below the weld centerline, shall be ultrasonically examined in accordance with SA-578, and the Level C acceptance criteria shall apply.  $R$  and  $t_s$  are the shell radius and thickness, respectively. For all shell product forms, the completed weld shall be ultrasonically examined after any postweld heat treatment (PWHT) in accordance with Mandatory Appendix 12 of Section VIII, Division 1.

(e) After welding and any PWHT, the weld joint shall be examined by magnetic particle examination in accordance with Mandatory Appendix 6 or by liquid penetrant examination in accordance with Mandatory Appendix 8.

(f) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.



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Approval Date: February 13, 2012

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2715**  
**Use of Glass Bull's-Eye Water Level Indicators on**  
**Electric Boilers**  
**Section I**

*Inquiry:* Under what conditions may an electric boiler be constructed and certified under Section I rules using glass bull's-eye water level indicators in lieu of externally mounted water gage glasses per the requirements of PEB-13?

*Reply:* It is the opinion of the Committee that an electric boiler may be constructed and certified under Section I rules using glass bull's-eye water level indicators in lieu of externally mounted gage glasses per the requirements of PEB-13 under the following conditions:

(a) The maximum allowable working pressure (MAWP) of the boiler shall not exceed 200 psig (1.5 MPa).

(b) The outside diameter of the boiler shell shall not exceed 16 in. (400 mm), and the volume of the boiler shell shall not exceed 5 ft<sup>3</sup> (0.14 m<sup>3</sup>).

(c) The viewing port in the bull's-eye water level indicator assembly shall be made of glass compliant with ASTM E438.

(d) The viewing area of the window shall have a maximum diameter of 2<sup>3</sup>/<sub>16</sub> in. (55 mm).

(e) The bull's-eye water level indicator assembly shall be manufactured by a process that encases the entire thickness and circumference of the glass element in a metallic enclosure, creating a calculated compressive radial prestress not less than 18,000 psi (120 MPa).

(f) The glass bull's-eye water level indicator shall be located to provide a visible water level indication not less than 1 in. (25 mm) above the lowest permissible water level recommended by the boiler Manufacturer.

(g) When more than one water level indicator is necessary to ensure a complete visible range of water level indications from the low water cutoff level to the normal operating water level for all operating and transient conditions, the water level indicators shall be located adjacent to one another and shall be arranged to ensure a minimum of 1 in. (25 mm) in overlapping water level indication.

(h) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: March 21, 2012

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2717**  
**Cast Titanium Aluminum Vanadium Iron Alloy, SB-367,**  
**Grade C-38 (Ti 4Al-2.5V-1.5Fe) UNS R54250**  
**Section VIII, Division 1**

*Inquiry:* May cast titanium SB-367 Grade C-38 (Ti 4Al-2.5V-1.5Fe) be used in Section VIII, Division 1 construction?

*Reply:* It is the opinion of the Committee that SB-367 cast titanium Grade C-38 (Ti 4Al-2.5V-1.5Fe) alloy may be used in Section VIII, Division 1 construction, provided the following requirements are met:

- (a) Supplementary Requirement S5 requiring hot isostatic pressing is mandatory.
- (b) Supplementary Requirement S6 requiring tension testing is mandatory.

(c) The maximum allowable stress values shall be as shown in [Table 1](#) or [1M](#). The maximum design temperature shall not exceed 600°F (316°C).

(d) The charts for determining thickness for those components under external pressure are shown in [Figures 1](#) and [1M](#), and corresponding tabular values are shown in [Table 2](#).

(e) Yield and tensile strength values are shown in [Tables 3](#) and [3M](#). The maximum tensile strength shall be 130 ksi (895 MPa).

(f) Separate welding procedure and performance qualification shall be conducted in accordance with Section IX.

(g) All other rules for Section VIII, Division 1, Part UNF applicable to titanium shall be met.

(h) This Case number shall be shown on the documentation and marking of the material, and recorded on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Allowable Stress Values, ksi <a href="#">[Note (1)]</a>
100	37.1
150	37.1
200	36.3
250	34.6
300	33.1
350	31.6
400	30.2
450	28.9
500	27.8
550	26.7
600	25.8

NOTE:

- (1) Casting quality factors in accordance with UG-24 shall be applied to these numbers.

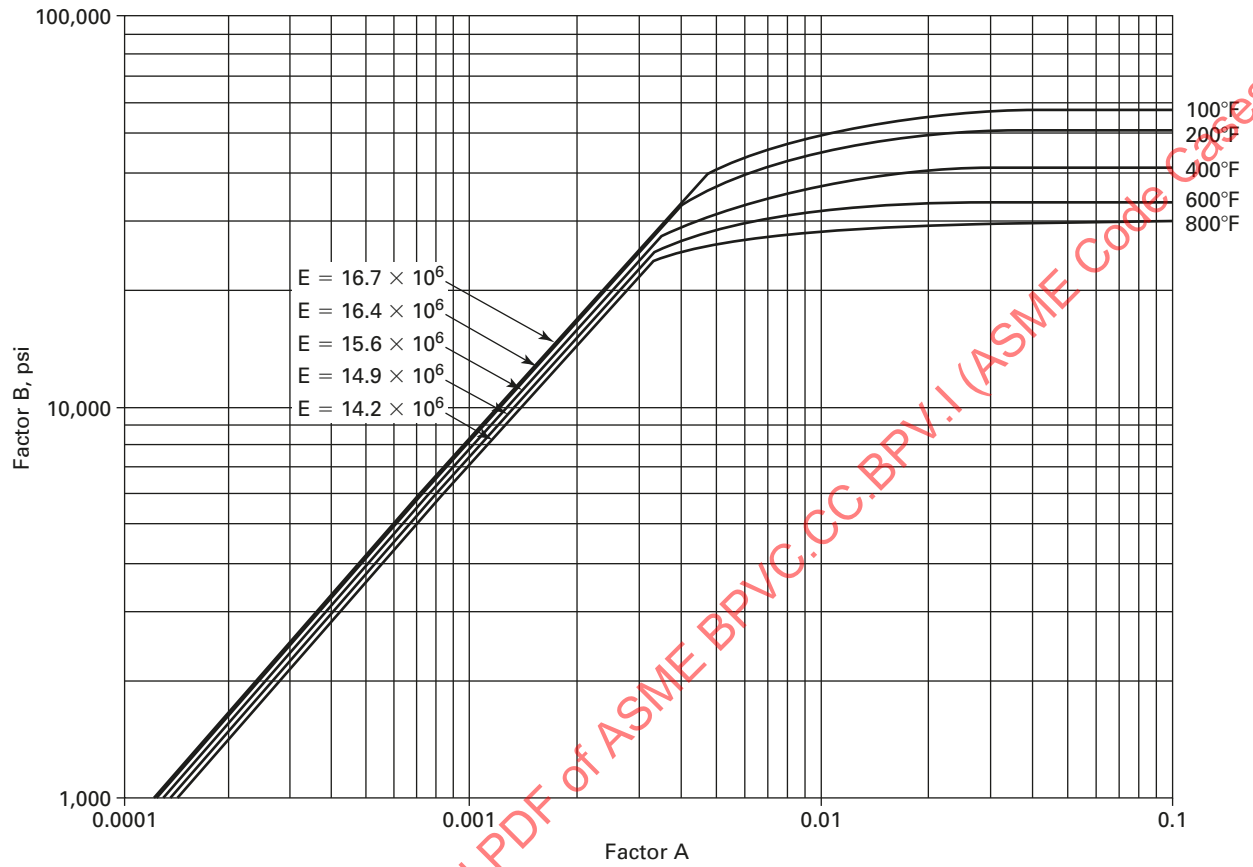
**Table 1M**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Allowable Stress Values, MPa <a href="#">[Note (1)]</a>
40	256
65	256
100	247
125	237
150	228
175	218
200	210
225	202
250	194
275	187
300	181
325 <a href="#">[Note (2)]</a>	176

NOTES:

- (1) Casting quality factors in accordance with UG-24 shall be applied to these numbers.  
 (2) The maximum use temperature shall be 316°C. Value for 325°C temperature is provided for interpolation purposes.

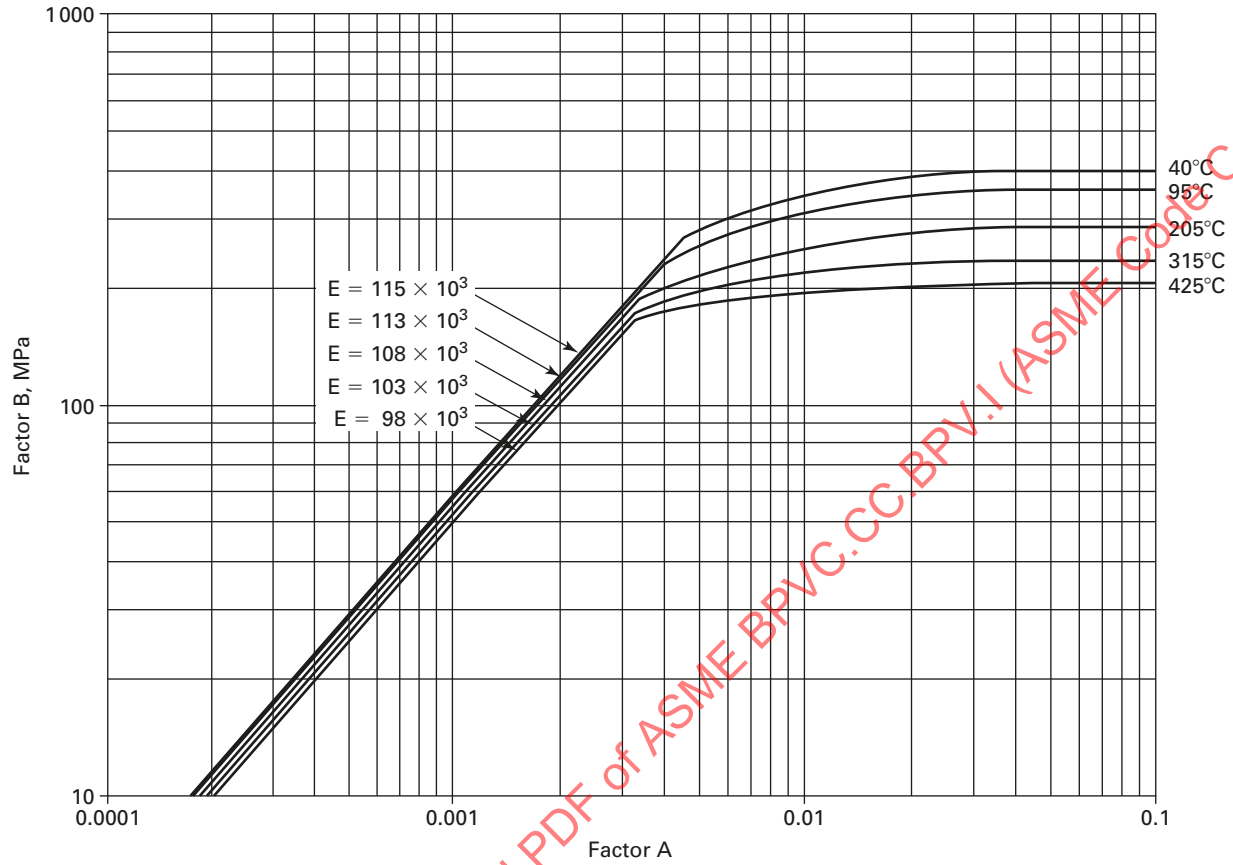
**Figure 1**  
**Chart for Determining Shell Thickness of Components under External Pressure Developed for Titanium Grade 38, Ti 4Al-2.5V-1.5Fe**



GENERAL NOTE: When unidirectionally produced bar is utilized for stiffening rings, Factor A, elastic or inelastic, shall be multiplied by 1.1 to account for reduced stiffness.

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**Figure 1M**  
**Chart for Determining Shell Thickness of Components under External Pressure Developed for Titanium Grade 38, Ti 4Al-2.5V-1.5Fe**



GENERAL NOTE: When unidirectionally produced bar is utilized for stiffening rings, Factor A, elastic or inelastic, shall be multiplied by 1.1 to account for reduced stiffness.

**Table 2**  
**Tabular Values for Figure 1 And Figure 1M**

Temperature, °F	A	B, psi	Temperature °C	A	B, MPa
100	1.00E-05	8.35E+01	40	1.00E-05	5.76E-01
	1.20E-04	1.00E+03		1.74E-04	1.00E+01
	4.67E-03	3.90E+04		4.67E-03	2.69E+02
	7.26E-03	4.60E+04		7.26E-03	3.17E+02
	1.05E-02	5.00E+04		1.05E-02	3.45E+02
	1.83E-02	5.48E+04		1.83E-02	3.78E+02
	3.83E-02	5.75E+04		3.83E-02	3.96E+02
	1.00E-01	5.75E+04		1.00E-01	3.96E+02
200	1.00E-05	8.20E+01	95	1.00E-05	5.65E-01
	1.22E-04	1.00E+03		1.77E-04	1.00E+01
	4.09E-03	3.35E+04		4.09E-03	2.31E+02
	5.97E-03	3.90E+04		5.97E-03	2.69E+02
	1.01E-02	4.50E+04		1.01E-02	3.10E+02
	2.44E-02	5.00E+04		2.44E-02	3.45E+02
	4.11E-02	5.14E+04		4.11E-02	3.54E+02
	1.00E-01	5.14E+04		1.00E-01	3.54E+02
400	1.00E-05	7.80E+01	205	1.00E-05	5.38E-01
	1.28E-04	1.00E+03		1.85E-04	1.00E+01
	3.53E-03	2.75E+04		3.53E-03	1.90E+02
	6.57E-03	3.35E+04		6.57E-03	2.31E+00
	1.17E-02	3.75E+04		1.17E-02	2.59E+00
	2.00E-02	4.00E+04		2.00E-02	2.76E+00
	3.00E-02	4.11E+04		3.00E-02	2.83E+02
	1.00E-01	4.11E+04		1.00E-01	2.83E+02
600	1.00E-05	7.45E+01	315	1.00E-05	5.14E-01
	1.34E-04	1.00E+03		1.94E-04	1.00E+01
	3.36E-03	2.50E+04		3.36E-03	1.72E+02
	4.78E-03	2.79E+04		4.78E-03	1.92E+02
	1.23E-02	3.25E+04		1.23E-02	2.24E+02
	4.50E-02	3.41E+04		4.50E-02	2.35E+02
	1.00E-01	3.41E+04		1.00E-01	2.35E+02
	1.00E-05	7.10E+01		425	1.00E-05
1.41E-04	1.00E+03	2.04E-04	1.00E+01		
3.38E-03	2.40E+04	3.38E-03	1.65E+02		
3.88E-03	2.50E+04	3.88E-03	1.72E+02		
8.82E-03	2.80E+04	8.82E-03	1.93E+02		
5.45E-02	3.00E+04	5.45E-02	2.07E+02		
1.00E-01	3.00E+04	1.00E-01	2.07E+02		

**Table 3**  
**Yield and Tensile Strength Values**

Temperature, °F	Yield, ksi	Tensile, ksi
75	115	130
100	115	130
150	103	130
200	95.6	127
250	89.3	121
300	83.6	116
350	78.5	111
400	74.0	106
450	70.0	101
500	66.5	97.2
550	63.4	93.5
600	60.8	90.2
650	58.6	87.4
700	56.8	85.1
750	55.4	83.3
800	54.2	81.9

GENERAL NOTE: Maximum use temperature is 600°F.

**Table 3M**  
**Yield and Tensile Strength Values**

Temperature, °C	Yield, MPa	Tensile, MPa
21	793	896
40	793	896
65	708	896
100	648	865
125	610	830
150	575	796
175	544	764
200	515	734
225	489	706
250	467	680
275	447	656
300	429	634
325	414	615
350	401	599
375	390	585
400	381	574
425	374	565
450	369	560

GENERAL NOTE: Maximum use temperature is 316°C.

Approval Date: March 21, 2012

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2718**  
**Alternative Minimum Test Temperature for Hydrostatic Testing**  
**Section VIII, Division 2**

*Inquiry:* Under what conditions may a Manufacturer apply the required hydrostatic test to a complete Section VIII, Division 2 pressure vessel at a metal temperature colder than 30°F (17°C) above the minimum design metal temperature (MDMT) stamped on the nameplate as required by para. 8.2.4(a)?

*Reply:* It is the opinion of the Committee that the required hydrostatic test may be applied to a complete Section VIII, Division 2 pressure vessel at a metal

temperature colder than 30°F (17°C) above the MDMT stamped on the nameplate as required by para. 8.2.4(a), under the following conditions:

(a) The base metals, weld metals, and heat affected zones (HAZ) of all components listed in 3.10.1.1 are qualified by impact testing at test temperatures colder than the stamped MDMT of the vessel, or meet the requirements for exemption from impact testing for an MDMT colder than the stamped MDMT of the vessel under the rules of Division 2.

(b) The metal temperature during the hydrostatic test shall be maintained at least 30°F (17°C) warmer than the warmest impact test or exemption temperature determined in para. (a).

(c) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: April 4, 2012

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2719**  
**Use of EN 10088-2 Gr. X6CrNiMoTi 17-12-2 Sheet, Plate, and Strip in the Construction of Boilers**  
**Section IV**

*Inquiry:* Under what conditions may EN 10088-2 Gr. X6CrNiMoTi 17-12-2 sheet, plate, and strip be used in the construction of Section IV boilers?

*Reply:* It is the opinion of the Committee that EN 10088-2 Gr. X6CrNiMoTi 17-12-2 sheet, plate, and strip may be used for Section IV construction, provided the following:

(a) *Extent of Testing.* The tensile tests at room temperature for strips and sheets cut from strips in rolling width less than 600 mm shall be performed on one test sample from each coil.

(b) For external pressure design, use Figure HA-2 of Section II, Part D.

(c) Maximum allowable stress value shall be as shown in Tables 1 and 1M.

(d) *Resurfacing by Welding.* If repairs are authorized by the purchaser, the following requirements have to be fulfilled:

(1) Preparation for repair welding shall include inspection to ensure complete removal of the defect.

(2) Repairs shall be made utilizing welding procedures qualified in accordance with Section IX, and repair welding shall be done by welders or welding operators meeting the qualification requirements of Section IX.

(e) All other requirements of Section IV shall apply.

(f) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values**

For Metal Temperatures Not Exceeding, °F	Maximum Allowable Stress Values, ksi		
	$t \leq \frac{5}{16}$ in.	$\frac{5}{16}$ in. $< t \leq \frac{1}{2}$ in.	$\frac{1}{2}$ in. $< t \leq 3$ in.
100	15.7	15.7	15.1
150	15.7	15.7	15.1
200	15.7	15.7	15.1
250	15.4	15.4	14.9
300	15.2	15.2	14.7
350	15.1	15.1	14.5
400	15.0	15.0	14.5
450	15.0	14.6	14.4
500	15.0	14.1	14.1

**Table 1M**  
**Maximum Allowable Stress Values**

For Metal Temperatures Not Exceeding, °C	Maximum Allowable Stress Values, MPa		
	$t \leq 8$ mm	$8$ mm $< t \leq 13$ mm	$13$ mm $< t \leq 75$ mm
40	108	108	104
65	108	108	104
100	108	108	104
125	106	106	102
150	105	105	101
175	104	104	100
200	104	104	100
225	103	102	100
250	103	98.2	98.2
275 [Note (1)]	103	95.1	95.1

## NOTE:

(1) The maximum use temperature shall be 260°C. Data for 275°C temperature is provided for interpolation purposes.

Approval Date: April 4, 2012

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2720**  
**Use of EN 10025-2 Gr. S235JR Plate in the Construction of Boilers**  
**Section IV**

*Inquiry:* Under what conditions may EN 10025-2 Gr. S235JR plate be used in the construction of Section IV boilers?

*Reply:* It is the opinion of the Committee that EN 10025-2 Gr. S235JR plate may be used for Section IV construction, provided the following:

(a) The maximum copper content in the heat analysis shall be limited to 0.40%.

(b) For external pressure design, use Figure CS-2 of Section II, Part D.

(c) Maximum allowable stress value shall be 10.4 ksi (72.0 MPa).

(d) The maximum thickness shall be 4 in. (100 mm).

(e) *Resurfacing by Welding.* If resurfacing by welding is acceptable by agreement with the purchaser, the following requirements have to be fulfilled:

(1) Preparation for repair welding shall include inspection to ensure complete removal of the defect.

(2) Repairs shall be made utilizing welding procedures qualified in accordance with Section IX, and repair welding shall be done by welders or welding operators meeting the qualification requirements of Section IX.

(f) All other requirements of Section IV shall apply.

(g) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: April 4, 2012

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2721**  
**Use of EN 10217-1 Gr. P235TR2 Tubes in the**  
**Construction of Boilers**  
**Section IV**

*Inquiry:* Under what conditions may EN 10217-1 Gr. P235TR2 tubes be used in the construction of Section IV boilers?

*Reply:* It is the opinion of the Committee that EN 10217-1 Gr. P235TR2 tubes may be used for Section IV construction, provided the following:

- (a) The tubes shall be made using the high frequency welding (HFW) process only.
- (b) For external pressure design, use Figure CS-2 of Section II, Part D.

(c) Maximum allowable stress value shall be 8.8 ksi (61.2 MPa). This stress value includes a joint factor of 0.85.

(d) The maximum thickness shall be  $1\frac{9}{16}$  in. (40 mm).

(e) *Resurfacing by Welding.* Repair welding is not permitted without specific approval by the purchaser. If repairs are authorized by the purchaser, the following requirements have to be fulfilled:

(1) Preparation for repair welding shall include inspection to ensure complete removal of the defect.

(2) Repairs shall be made utilizing welding procedures qualified in accordance with Section IX, and repair welding shall be done by welders or welding operators meeting the qualification requirements of Section IX.

(f) All other requirements of Section IV shall apply.

(g) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: October 25, 2012

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2722-1**  
**Use of SA-240/SA-240M, Alloys 439 and UNS S43932,**  
**and SA-268, alloy TP439 Up to 210°F (99°C) in Heating**  
**Boiler Construction**  
**Section IV**

*Inquiry:* May SA-240/SA-240M, alloys 439 and UNS S43932, and SA-268, alloy TP439 (UNS S43035) be used in Section IV heating boiler construction for water temperatures up to 210°F (99°C)?

*Reply:* It is the opinion of the Committee that SA-240/SA-240M, Alloys 439 and UNS S43932, and SA-268, alloy TP439 (UNS S43035) may be used in Section IV heating

boiler construction for water temperatures up to 210°F (99°C), provided the following additional requirements are met:

(a) Maximum material thickness shall not exceed  $\frac{3}{8}$  in. (9.53 mm).

(b) Maximum allowable stress values shall be as listed in Tables HF-300.1 and HF-300.1M, except that the maximum allowable water temperature shall be 210°F (99°C).

(c) This Case number shall be shown on the applicable Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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**Case 2723**  
**UNS S31635 Tubing for Construction of Water Heaters**  
**Section IV**

*Inquiry:* Under what conditions may UNS S31635 austenitic stainless steel in SA-213/SA-213M TP316Ti be used in the construction of water heaters?

*Reply:* It is the opinion of the Committee that UNS S31635 austenitic stainless steel in SA-213/SA-213M TP316Ti may be used in the construction of water heaters, provided the following requirements are met:

(a) The allowable stress values for the tubing in accordance with SA-213/SA-213M TP316Ti shall be as listed in [Tables 1](#) and [1M](#).

(b) For the purpose of welding procedure and performance qualification, this material shall be considered P-No. 8, Group 1.

(c) For external pressure, Figure HA-2 of Section II, Part D shall be used.

(d) The maximum design temperature shall be 500°F (260°C).

(e) The water temperature shall not exceed 210°F (99°C).

(f) The water heaters shall not be used for comfort heating applications.

(g) All other requirements of Section IV shall be met.

(h) This Case number shall be shown on the Manufacturer's Data Report.

**Table 1**  
**Maximum Allowable Stress Values for**  
**SA-213/SA-213M TP316Ti**

For Metal Temperatures Not Exceeding, °F	Maximum Allowable Stress Values, ksi
100	18.8
150	18.7
200	17.7
250	16.7
300	15.9
400	14.3
500	13.2

GENERAL NOTE: This material may utilize the minimum thickness exemption as shown in HF-301.1(c).

**Table 1M**  
**Maximum Allowable Stress Values for**  
**SA-213/SA-213M TP316Ti**

For Metal Temperatures Not Exceeding, °C	Maximum Allowable Stress Values, MPa
40	129
100	120
150	109
200	99.3
225	95.3
250	92.0
275 [Note (1)]	89.3

GENERAL NOTE: This material may utilize the minimum thickness exemption as shown in HF-301.1(c).

NOTE:

(1) The maximum use temperature shall be 260°C. Datum for 275°C temperature is provided for interpolation purposes.

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**Case 2724**  
**Use of ER310 Filler Metals to Weld UNS S43035, Grades 439 and TP439 Materials to Austenitic Grades 304, 304L, 316, 316L, and 316Ti for the Construction of Heating Boilers**  
**Section IV**

*Inquiry:* Under what conditions may ER310 filler metals be used to weld SA-240/SA-240M, Grade 439 and SA-268, Grade TP439 materials to the following: SA-240/SA-240M, Grades 304, 304L, 316, 316L, 316Ti; SA-213/SA-213M, Grades TP304, TP304L, 316; and SA-249, Grades TP304, TP304L, TP316, and TP316L for the construction of heating boilers under Section IV, Part HF?

*Reply:* It is the opinion of the Committee that ER310 filler metals may be used to weld Grades 439/TP439, P-No. 7 materials to Grades 304/TP304, 304L/TP304L, 316/TP316, 316L/TP316L and 316Ti, P-No. 8 materials in Section IV, Part HF construction, provided the following conditions are met:

- (a) SFA-5.9, ER310 filler metal shall be used.
- (b) All Notes to Table HF-300.1 pertaining to the materials of construction will apply except Note (15).
- (c) This Case number shall be shown on the Manufacturer's Data Report.

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**Case 2725**  
**Polymer Material for Heating Boiler Components**  
**Section IV**

*Inquiry:* May ASTM D4349-1996 (2010), grades PPE410G30A40346 and PPE210G30A50553 polymers be used for the construction of boiler components in Section IV?

*Reply:* It is the opinion of the Committee that ASTM D4349-1996 (2010), grades PPE410G30A40346 and PPE210G30A50553 polymers may be used for the construction of Section IV boiler components, provided the following requirements are met.

## 1 GENERAL REQUIREMENTS

(a) The polymer materials shall be in compliance with ASTM D4349-96 (2010) and shall be limited to the polymers with a classification designation of PPE410G30A40346 and PPE210G30A50553.

(b) The polymer materials shall be certified by the materials manufacturer, and a report of test results shall be furnished to the boiler manufacturer for each lot<sup>1</sup> of material.

(c) The material shall not be used for heat transfer purposes and shall not be exposed to direct flame. The material may be exposed to the products of combustion, but the maximum flue gas temperature shall not exceed 212°F (100°C).

(d) The boiler shall be limited to hot water heating service.

(e) The maximum heat input shall be limited to 256,000 Btu/hr (75 kW).

(f) The maximum allowable working pressure shall not exceed 50 psi (345 kPa).

(g) The maximum material design and water temperature shall not exceed 210°F (99°C).

(h) The maximum water temperature shall be stamped on the ASME nameplate and documented on the Manufacturer's Data Report.

(i) The maximum water volume of the polymer parts shall not exceed 1.85 gal (7 L).

(j) The polymer material shall not be repaired.

(k) The polymer parts shall have a permanently attached label or marking stating, "Repair of the polymer parts is prohibited."

(l) The polymer parts shall be permanently marked in a manner to provide traceability to the material manufacturer's report of test results and to the injection molding machine.

(m) The injection molding process shall be controlled by a written procedure in which all of the following process variables shall be considered essential:

- melting temperature
  - nozzle
  - front
  - middle
  - rear
- mold temperature
- drying time (average)
- drying time (maximum)
- moisture content (% , maximum)
- back pressure
- screw speed
- ratio of shot size to cylinder size
- weight of finished molded part

(n) A change of any of the essential variables in (m) shall require requalification of the written procedure per the test procedure specified in section 2.

(o) The Authorized Inspector (AI) shall monitor the injection molding process to ensure compliance with the written procedure. The AI shall verify that the manufacturer has performed all steps in sections 1, 2, and 3.

(p) Material used for qualification testing shall not be used on Code stamped boilers.

(q) The use of regrind material is prohibited.

(r) This Case number shall be shown on the Manufacturer's Data Report.

(s) The Manufacturer's quality control system shall address use of polymers for injection molded parts.

(t) Joining to other parts shall be only by mechanical methods. Fusion bonding is not allowed.

<sup>1</sup> The term "lot" is a continuous production run of finished polymer material in pellet or granular form that has been assigned a unique identification number and issued a certificate of compliance by the polymer manufacturer.

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(u) After using mold release agents, the first five parts shall be scrapped.

(v) Adding colorant to the polymer is prohibited.

(w) The polymer shall not have line of sight to the flame to prevent degradation as a result of UV radiation.

(x) All finished products (boiler) using these polymer parts shall be subject to a hydrostatic test per HG-510.

(y) All other requirements of Section IV shall apply.

(z) The production of the polymer parts may be sub-contracted, but the production of these parts shall be witnessed by a representative of the boiler Manufacturer (Stamp Holder) and the boiler Manufacturer's AI. The design qualification of the polymer parts per section 2 of this Case shall remain the responsibility of the boiler Manufacturer.

## 2 DESIGN QUALIFICATION

The qualification of the polymer part design shall be by testing of one or more full-size prototype parts by the following test sequence:

(a) The weight of the prototype parts shall be measured to an accuracy of 1.25%.

(b) The weight of the part shall be within the range specified in the injection molding procedure.

(c) The part shall be examined for conformance with dimensions and tolerances shown on the design drawings.

(d) *Water Cycling Pressure Test.* Pressure shall be raised from atmospheric pressure to MAWP and back 100,000 times at maximum design temperature.

(e) *Water Cycling Temperature Test.* The water temperature shall be raised from 59°F (15°C) to the maximum design temperature and back 100,000 times at the MAWP.

(f) After successful completion of the cyclic tests specified in (d) and (e), the same prototype parts shall then be subjected to a design qualification pressure test. This pressure test shall be conducted using water at the maximum design temperature. The test pressure applied shall be a minimum of 6 times the MAWP of the part and shall be raised from zero to this pressure in no less than 1 min and held for 5 min. Test to failure is not required. If the prototype part exhibits any leakage, cracking, or bursts during the application of pressure, or during the required hold time, the prototype shall be considered to have failed and requalification shall be required.

$$P = B / 6$$

where

$B$  = bursting test pressure, psi (kPa)

$P$  = design pressure, psi (kPa)

= MAWP, psi (kPa)

(g) The AI shall verify the cyclic pressure and temperature tests and shall witness and accept the design pressure test.

(h) The specified weight of each part shall be reported in the proof test report.

(i) Classification and acceptance level of imperfections shall be according to Table 1.

## 3 PRODUCTION OF POLYMER PARTS

### 3.1 GENERAL REQUIREMENTS

(a) Production of polymer parts may begin when the injection molding parameters [see 1(m)] are stable and within tolerance as defined in the injection molding procedure. The parameters shall be recorded at the beginning of production. Further, the injection molding machine shall be monitored during production, and the parameters [see 1(m)] shall be recorded once per hour minimum for review by the AI.

(b) The first ten parts produced are to be used for start-up purposes only. These ten parts shall not be considered part of the production batch and shall be scrapped. The following parts shall be monitored as defined in 3.2.

(c) Each production part shall be weighed by a scale calibrated to an accuracy of  $1/10$  of the tolerance range, and the weight of parts shall not be less than 98.75% of the weight of the prototype unit.

### 3.2 INSPECTION OF PRODUCTS

There are two acceptable methods for inspection of the products: a 100% inspection as described in (a) or statistical methods described in (b). For the statistical methods, there are two alternatives described: Statistical Process Control (SPC) [see (b)(1)] or two sample T-test method [see (b)(2)].

(a) *Inspection at 100%*

(1) Each polymer part shall be examined internally and externally for imperfections. Classification and acceptance level of imperfections shall be according to Table 1.

(2) The first ten parts in a production batch<sup>2</sup> shall be examined for conformance per the design drawings. Any dimension outside the specified limit shall be cause for rejection.

(3) Every tenth part after the first ten parts in a production batch shall be examined for conformance with dimensions and tolerances shown on the design drawings. Any dimension outside the specification limits shall be cause for rejection of that part and the previous parts in the production batch. The previously rejected parts in the production batch shall be thoroughly examined, and shall meet all requirements of this Code Case, or shall be scrapped. The injection molding process shall be re-qualified before production is resumed.

<sup>2</sup> The term "production batch" is a continuous production run of molded parts from each individual injection molding machine.

(4) At least one part per 1,000 parts shall be subjected to the requirements identified in 2(b) through 2(i). The parts to be used for these tests shall be selected at random by the Authorized Inspector. If the part(s) fail any of these tests, the complete batch shall be scrapped, including the remainder of the parts. The production process shall be requalified per section 2.

(b) *Inspection by Statistical Control Methods*

(1) *Statistical Process Control (SPC)*

(-a) The Manufacturer shall use ASTM E2281-08a, Standard Practice for Process and Measurement Capability Indices, to evaluate process capability and performance.

(-b) The Manufacturer shall comply with ASTM E2587-07e1, Standard Practice for Use of Control Charts in Statistical Process Control, and demonstrate the following items:

(-1) critical variables defined on design drawings of the part; as a minimum the outer dimensions of length, height, and width

(-2) part weight

(-3) visual inspection of the part according to

Table 1

(-c) The Manufacturer shall comply with the following:

(-1) minimum  $C_p$  value of 1.67

(-2) minimum  $C_{pk}$  value of 1.33

(-d) If the  $C_p$  and/or  $C_{pk}$  values go below the minimum values stated in (-c), then each part in the production batch shall be thoroughly examined, and shall meet

all requirements of this Code Case, or shall be scrapped. The injection molding process shall be requalified before production is resumed.

(2) *The Two Sample T-Test Method*

(-a) The Manufacturer shall establish a control sample such that all parts within the sample are acceptable. The control sample shall be 100 parts, minimum.

(-b) The T-test shall be based on critical variables such as the outer dimensions of length, height, and width. As a minimum, the weight of the polymer part shall be used for the T-test.

(-c) The T-test shall be performed:

(-1) at the beginning and end of each production batch<sup>2</sup>

(-2) at initial production for each lot<sup>1</sup> of polymer material

(-3) each production sample shall consist of a minimum sample size of 20 production parts.

(-4) each production sample shall be compared to the control sample.

(-5) the calculated  $t$  value shall be less than or equal to the tabulated  $t$  value at  $p = 0.01$

(-6) if the calculated  $t$  value is greater than the tabulated  $t$  value, then each part in the production batch shall be thoroughly examined, and shall meet all requirements of this Case, or shall be scrapped. The injection molding process shall be requalified before production is resumed.

<sup>2</sup> The term "production batch" is a continuous production run of molded parts from each individual injection molding machine.

<sup>1</sup> The term "lot" is a continuous production run of finished polymer material in pellet or granular form that has been assigned a unique identification number and issued a certificate of compliance by the polymer manufacturer.

**Table 1**  
**Visual Acceptance Criteria**

Defect	Definition	Maximum Size
Black spots, brown streaks	Dark spots or streaks	None permitted
Blister	Hollows on or in the parts	Pressure side: none permitted; Nonpressure side: maximum diameter, $\frac{1}{16}$ in. (1.5 mm); maximum density 1 per 1 ft <sup>2</sup> (1 per 0.1 m <sup>2</sup> ), none less than 2 in. (50 mm) apart
Bubbles	Air entrapped in the parts	Maximum diameter: $\frac{1}{16}$ in. (1.5 mm), maximum density: 4 per 1 in. <sup>2</sup> (4 per 650 mm <sup>2</sup> ); maximum diameter: $\frac{1}{16}$ in. (1.5 mm), maximum density 10 per 1 in. <sup>2</sup> (10 per 650 mm <sup>2</sup> )
Burn marks, dieseling	Charred or dark plastic caused by trapped gas	None permitted
Cracking, crazing	Any visible	None permitted
Delamination	Single surface layers flake off parts	None permitted
Discoloration	Similar to burn marks but generally not as dark or severe	Acceptable
Flow, halo, blush marks	Marks seen on the part due to flow of molten plastic across the molding surface	Acceptable
Gels	Bubbles or blisters on or in the part due to poor melt quality	None permitted
Jetting	Undeveloped frontal flow	None permitted

Approval Date: May 24, 2012

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2726**  
**Hydrostatic and Pneumatic Testing of Mass-Produced Pressure Vessels With an Intermediate Isolation Valve Between Indicating Gage and Pressure Vessel**  
**Section VIII, Division 1**

*Inquiry:* When is it permissible during hydrostatic or pneumatic testing to place an intermediate isolation valve between an indicating gage required in UG-102(a) and a pressure vessel constructed to the requirements of UG-90(c)(2) and Appendix 35 of Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that it is permissible during hydrostatic or pneumatic testing of mass-produced vessels constructed in accordance with UG-90(c)(2) and Appendix 35 of Section VIII, Division 1 to place an intermediate isolation valve between the pressure vessel and the indicating gage required by UG-102(a) when the following conditions are met:

(a) The pressure vessel is tested in a test enclosure, and the test enclosure may not provide adequate access to perform inspection in accordance with 35-6(f).

(b) The intermediate isolation valve is required to maintain pressure in the vessel at a value of test pressure divided by 1.3 while the vessel is moved from the test enclosure to a location where inspection for leakage is performed.

(c) There shall be administrative procedures or valve operation controls to ensure that the intermediate isolation valve is maintained to its full, open position assuring that the pressure vessel is tested to the prescribed test pressure.

(d) The manufacturer's pressure test operating procedures shall describe the following:

(1) requirements, operator actions and check points for performing the pressure test and leakage inspection.

(2) the intermediate isolation valve setup and operating positions. If electric or pneumatic controlled valves are used in the test cell, an explanation of the indicating lights, valve positions, and valve fail open/closed positions shall be provided.

(e) The indicating gage required by UG-102(a) shall not be isolated from the source of pressure by the intermediate isolation valve.

(f) This Case number shall be noted on the Manufacturer's Data Report for the vessel.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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(19)

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**Case 2727-1**  
**22Cr-5Ni-3Mo-N (UNS S31803) Use to 600°F (316°C) for Class 2**  
**Section VIII, Division 2**

*Inquiry:* May 22Cr-5Ni-3Mo-N (UNS S31803) forgings, plate, seamless and welded tube, and seamless and welded pipe in accordance with SA-182, SA-240, SA-789, and SA-790, respectively, be used in Section VIII, Division 2, Class 2 welded construction at temperatures up to and including 600°F (316°C)?

*Reply:* It is the opinion of the Committee that 22Cr-5Ni-3Mo-N (UNS S31803) forgings, plate, seamless and welded tube, and seamless and welded pipe in accordance with SA-182, SA-240, SA-789, and SA-790, respectively, may be used in Section VIII, Division 2, Class 2 welded construction at temperatures up to and including 600°F (316°C), provided the following additional requirements are met:

(a) The rules for austenitic-ferritic duplex stainless steels in Section VIII, Division 2, Class 2 shall apply.

(b) The maximum allowable stress values shall be as given in Tables 1 and 1M. The maximum design temperature shall not exceed 600°F (316°C). For welded tube or pipe, a joint efficiency factor of 0.85 shall be used.

(c) This steel may be expected to develop embrittlement after service at moderately elevated temperature; see Appendix A, A-340 and A-360.

(d) This Case number shall be shown on the Manufacturer's Data Report.

<b>Table 1</b>	
<b>Maximum Allowable Stress Values</b>	
For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress, ksi
500	33.1
600	31.9

<b>Table 1M</b>	
<b>Maximum Allowable Stress Values</b>	
For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress, MPa
250	229
275	226
300	223
325 [Note (1)]	219

NOTE:  
(1) This value is provided for interpolation purposes only; the maximum design temperature shall be per (b) of the Reply.

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(19)

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**Case 2728-1**  
**Use of SB-564 Nickel-Iron-Chromium-**  
**Molybdenum-Copper Alloy UNS N08825 Forgings for**  
**Class 2**  
**Section VIII, Division 2**

*Inquiry:* Under what conditions may SB-564 nickel-iron-chromium-molybdenum-copper alloy, UNS N08825 forgings be used in Section VIII, Division 2, Class 2 construction?

*Reply:* It is the opinion of the Committee that SB-564 nickel-iron-chromium-molybdenum-copper alloy UNS N08825 forgings may be used in Section VIII, Division 2, Class 2 construction, provided the following additional requirements are met:

(a) Section II, Part D, Table 5B maximum allowable stress values shall be those for SB-424, UNS N08825.

(b) All other Section VIII, Division 2, Class 2 requirements for UNS N08825 shall apply.

(c) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2729-1**  
**Fabrication of Class I Vessels With Metallic Nozzles Not Meeting Minimum Wall Thickness Requirements**  
**Section X**

*Inquiry:* Is it permissible to fabricate Section X, Class I vessels with metallic nozzles that do not meet the minimum wall thickness requirements of UG-45, Section VIII, Division 1 as required by RG-100(c) and RM-211, Section X?

*Reply:* It is the opinion of the Committee that Section X, Class I vessels may be fabricated with metallic nozzles that do not meet the minimum wall thickness requirements of UG-45, Section VIII, Division 1 as required by RG-100(c) and RM-211, Section X subject to the following:

(a) The minimum wall thickness of nozzle necks shall be determined as follows:

(1) For access openings and openings used only for inspection:

$$t_r = t_a$$

(2) For other nozzles:

$t_a$  = minimum neck thickness required for internal and external pressure using UG-27 and UG-28 of Section VIII, Division 1 (plus corrosion allowance), as applicable. The effects of external forces and moments from supplemental loads (see UG-22, Section VIII, Division 1) shall be considered. Shear stresses shall not exceed 70% of the allowable tensile stress for nozzle material.

$t_{b1}$  = thickness given in Table UG-45 of Section VIII, Division 1 plus the thickness added for corrosion allowance

$$t_r = \max. (t_a, t_{b1})$$

(b) The minimum nozzle wall thickness for piping connections using a groove in the nozzle end to restrain the piping shall be determined as follows:

$t_{b2}$  = minimum neck thickness required for internal and external pressure using UG-27 and UG-28 of Section VIII, Division 1. The effects of external forces and moments from supplemental loads (see UG-22, Section VIII, Division 1) shall be considered. Shear stresses shall not exceed 70% of the allowable tensile stress for nozzle material.

$t_{b3}$  = minimum nozzle wall thickness at the bottom of the groove shall not be less than the thickness shown in Table 1

$$t_{rg} = \max. (t_{b2}, t_{b3}). \text{ See Figure 1.}$$

(c) Grooved nozzle ends for piping connections are prohibited except for the pipe sizes shown in Table 1.

(d) When grooved nozzle ends are used for pipe sizes shown in Table 1, the inside corner radius at the bottom of the groove shall be 0.015 in. (0.381 mm) minimum to 0.030 in. (0.762 mm) maximum.

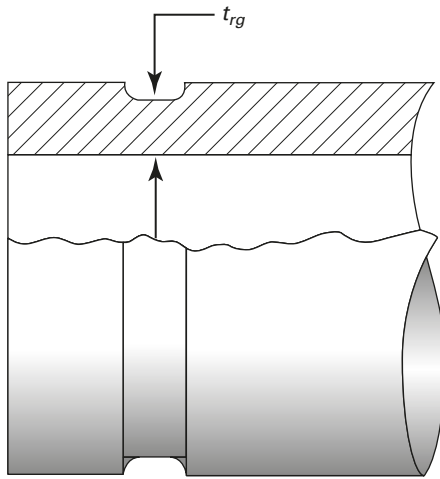
(e) The maximum allowable nozzle design stress shall be 25.1 ksi (173 MPa).

(f) The maximum internal design pressure shall be 1,200 psi (8.27 MPa).

(g) This Case number shall be shown on the Fabricator's Data Report.

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**Figure 1**  
**Minimum Nozzle Wall Thickness for Piping**  
**Connection Using a Groove in the Nozzle End**



**Table 1**  
**Minimum Groove Wall Thickness**

Nominal Pipe Size, in. (DN)	Minimum Groove Wall Thickness, $t_{b3}$ , in. (mm)
$\frac{3}{4}$ (20)	0.033 (0.838)
1 (25)	0.044 (1.118)
$1\frac{1}{2}$ (40)	0.055 (1.397)
2 (50)	0.055 (1.397)
$2\frac{1}{2}$ (65)	0.083 (2.108)
3 (80)	0.093 (2.362)
4 (100)	0.106 (2.692)

Approval Date: June 28, 2012

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2730**  
**Allowable Stresses and Design Stress Intensities for Bolting Materials Listed in Both Tables 3 and 4 of Section II, Part D**  
**Section VIII, Division 2**

*Inquiry:* Under what conditions is it permissible to use allowable stresses for bolting materials listed in Table 3 of Section II, Part D in lieu of the design stress intensity values listed in Table 4 of Section II, Part D for pressure vessels constructed in accordance with Section VIII, Division 2, Part 5?

*Reply:* It is the opinion of the Committee that the allowable stresses for bolting materials listed in Table 3 of Section II, Part D may be used in lieu of the design stress intensity values listed in Table 4 of Section II, Part D for pressure vessels constructed in accordance with Section VIII, Division 2, Part 5 under the following conditions:

(a) The bolting material shall have the same specification, grade, and minimum specified yield and tensile strengths listed in both Table 3 and Table 4 of Section II, Part D.

(b) The material and size of the bolts shall be identified on the Manufacturer's Data Report in the Remarks section.

(c) This Case number shall be shown on the Manufacturer's Data Report and marked on the nameplate.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: May 16, 2012

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2731**  
**Exemption From Mandatory Requirement for Fusible Plug in Hand-Fired Boilers**  
**Section I**

*Inquiry:* Until such time as the revision to Section I removing the mandatory requirement for a fusible plug in hand-fired boilers in PFT-52 is published, is it permissible to manufacture hand fired boilers without a fusible plug?

*Reply:* It is the opinion of the Committee that it is permissible to manufacture hand fired boilers without a fusible plug as required by PFT-52, provided all other applicable requirements of Section I are met, and this Case number is recorded on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: August 1, 2018

*Code Cases will remain available for use until annulled by the applicable Standards Committee.***Case 2733-3****F-Number Grouping for Ni-Fe-Cr, Classification UNS N08087 Welding Filler Metal  
Section I; Section VIII, Division 1; Section VIII, Division 2;  
Section VIII, Division 3; Section IX**

*Inquiry:* What alternate rules may be applied to grouping UNS N08087, Ni-Fe-Cr welding filler metal meeting the chemical properties of [Table 1](#) but otherwise conforming to AWS A5.14 to reduce the number of welding performance qualifications?

*Reply:* It is the opinion of the Committee that UNS N08087, Ni-Fe-Cr welding electrodes meeting the chemical properties of [Table 1](#) but otherwise conforming to AWS A5.14 may be considered as F-No. 43 for welding performance qualifications only. Separate welding procedure qualifications are required. Welding shall be limited to the GTAW, GMAW, and SAW processes. Further, this material shall be identified as UNS N08087 in the Welding Procedure Specification, Welding Procedure Qualification Record, and Welder Performance Records.

**Table 1  
Chemical Requirements**

Element	Composition, %
C	0.08-0.14
Mn	1.2-1.8
Si	0.05-0.50
P	0.01 max.
S	0.01 max.
Ni	54 max.
Cr	8.0-9.5
Mo	1.8-2.2
Nb	0.90-1.40
B	0.0005-0.002
Al	0.10-0.20
Cu	0.25 max.
N	0.02 max.
Fe	38-42

This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: August 1, 2018

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2734-3****F-Number Grouping for Ni-Fe-Cr, Classification UNS N08087 Welding Electrode  
Section I; Section VIII, Division 1; Section VIII, Division 2;  
Section VIII, Division 3; Section IX**

*Inquiry:* What alternate rules may be applied to grouping UNS N08087, Ni-Fe-Cr welding electrodes meeting the chemical properties of [Table 1](#) and mechanical properties of [Table 2](#) but otherwise conforming to AWS A5.11/A5.11M to reduce the number of welding performance qualifications?

*Reply:* It is the opinion of the Committee that UNS N08087, Ni-Fe-Cr welding electrodes meeting the chemical properties of [Table 1](#) and mechanical properties of [Table 2](#) but otherwise conforming to AWS A5.11/A5.11M may be considered as F-No. 43 for welding performance qualifications only. Separate welding procedure qualifications are required. Further, this material shall be identified as UNS N08087 in the Welding Procedure Specification, Welding Procedure Qualification Record, and Welder Performance Records.

This Case number shall be shown on the Manufacturer's Data Report.

**Table 1  
Chemical Requirements**

Element	Composition, %
C	0.08-0.14
Mn	1.2-1.8
Si	0.05-0.50
P	0.01 max.
S	0.01 max.
Ni	54 max.
Cr	8.0-9.5
Mo	1.8-2.2
Nb	0.90-1.40
B	0.0005-0.002
Al	0.10-0.20
Cu	0.25 max.
N	0.02 max.
Fe	38-42

**Table 2  
Mechanical Property Requirements (Room Temperature)**

Property	Values
Tensile strength, min., ksi (MPa)	80 (560)
Yield strength, 0.2% min., ksi (MPa)	52 (360)
Elongation in 2 in. (50 mm), %	25

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: September 25, 2012

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2735**  
**Use of UNS S82011 Stainless Steel**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions is it permissible in welded construction conforming to the rules of Section VIII, Division 1 to use UNS S82011 wrought ferritic/austenitic stainless steel as seamless and welded pipe and tube, and plate, conforming to the composition requirements of [Table 1](#), the mechanical property requirements of [Table 2](#), and otherwise conforming to the requirements of SA-240, SA-789, and SA-790, as applicable?

*Reply:* It is the opinion of the Committee that the materials described in the Inquiry may be used in Section VIII, Division 1 construction, provided the following requirements are met:

(a) The material shall be furnished in the heat treated condition. The heat treatment shall be performed in the range of 1,850°F to 2,050°F (1 010°C to 1 120°C) with subsequent rapid cooling.

(b) The rules for austenitic-ferritic stainless steels in Section VIII, Division 1, Subsection C, Part UHA shall apply.

(c) The design temperature shall not exceed 650°F (343°C).

(d) The maximum allowable design stress values shall be those listed in [Tables 3](#) or [3M](#). For welded pipe and tube, a joint efficiency factor of 0.85 shall be used.

(e) For external pressure design, use Fig. HA-5 of Section II, Part D.

(f) This material shall be considered P-No. 10H Group 1.

(g) Heat treatment after welding is neither required nor prohibited. However, if heat treatment is applied, the treatment shall be as noted in (a).

(h) Tensile and yield strengths at temperature are shown in [Tables 4](#), [4M](#), [5](#) and [5M](#).

(i) Physical properties shall be taken from Section II, Part D, Subpart 2 using the values from Table TE-1, Group 2 for thermal expansion; Table TCD, Material Group J for thermal conductivity and thermal diffusion; Table TM-1, Material Group H for elastic modulus; and Table PRD, high alloy steels (200 series) for Poisson's ratio and density.

(j) This Case number shall be included in the material documentation and marking and shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Chemical Requirements**

Element	Weight, %
Carbon, max.	0.030
Manganese	2.00–3.00
Phosphorus, max.	0.040
Sulfur, max.	0.020
Silicon, max	1.00
Chromium	20.5–23.5
Nickel	1.00–2.00
Molybdenum	0.10–1.00
Nitrogen	0.15–0.27
Copper, max.	0.50
Iron	Balance

**Table 2**  
**Mechanical Property Requirements**

Material	Tensile Strength, Yield Strength, min.		Elongation, min. (in 2-in. or 50 mm)
	min.	(0.2% Offset)	
Sheet/strip $\leq \frac{3}{16}$ in. ( $\leq 5.0$ mm)	101 ksi (700 MPa)	75 ksi (515 MPa)	30%
Plate $> \frac{3}{16}$ in. ( $> 5.0$ mm)	95 ksi (655 MPa)	65 ksi (450 MPa)	30%
Tube	101 ksi (700 MPa)	75 ksi (515 MPa)	30%
Pipe	95 ksi (655 MPa)	65 ksi (450 MPa)	30%

**Table 3**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Stress Values, ksi [Note (1)]			
	Sheet		Pipe and Tube Wall Thickness $\leq \frac{3}{16}$ in.	Pipe and Tube Wall Thickness $> \frac{3}{16}$ in.
	Sheet	Plate		
100	28.9	27.1	28.9	27.1
200	28.4	26.8	28.4	26.8
300	26.5	25.0	26.5	25.0
400	26.0	24.4	26.0	24.4
500	26.0	24.4	26.0	24.4
600	26.0	24.4	26.0	24.4
650	26.0	24.4	26.0	24.4

NOTE:

(1) The criterion of 3.5 on tensile strength was used in establishing the values.

**Table 3M**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Stress Values, MPa [Note (1)]			
			Pipe and Tube Wall Thickness ≤ 5.00 mm	Pipe and Tube Wall Thickness > 5.00 mm
	Sheet	Plate		
40	199	187	199	187
65	199	187	199	187
100	194	183	194	183
150	183	172	183	172
200	179	168	179	168
250	179	168	179	168
300	179	168	179	168
325	179	168	179	168
350 [Note (2)]	179	168	179	168

GENERAL NOTE: **PRECAUTIONARY NOTE:**

This material may be expected to develop embrittlement after exposure at moderately elevated temperatures. See paras. A-340 and A-360 in Appendix A of Section II, Part D.

NOTES:

- (1) The criterion of 3.5 on tensile strength was used in establishing the values.
- (2) The value at 350°C is for interpolation only. The maximum use temperature is 343°C.

**Table 4**  
**Tensile Strength Values**

For Metal Temperature Not Exceeding, °F	Strength, ksi			
			Pipe and Tube Wall Thickness ≤ <sup>3</sup> / <sub>16</sub> in.	Pipe and Tube Wall Thickness > <sup>3</sup> / <sub>16</sub> in.
	Sheet	Plate		
100	101.0	95.0	101.0	95.0
200	99.5	93.6	99.5	93.6
300	92.9	87.4	92.9	87.4
400	90.9	85.5	90.9	85.5
500	90.9	85.5	90.9	85.5
600	90.9	85.5	90.9	85.5
650	90.9	85.5	90.9	85.5
700	90.9	85.5	90.9	85.5
750	90.9	85.5	90.9	85.5
800	90.2	84.8	90.2	84.8
850	88.6	83.4	88.6	83.4
900	88.3	83.1	88.3	83.1
950	88.3	83.1	88.3	83.1
1000	88.3	83.1	88.3	83.1

**Table 4M**  
**Tensile Strength Values**

For Metal Temperature Not Exceeding, °C	Strength, MPa			
	Sheet	Plate	Pipe and Tube Wall	Pipe and Tube Wall
			Thickness ≤ 5.00 mm	Thickness > 5.00 mm
40	696	655	696	655
65	696	655	696	655
100	679	639	679	639
150	656	617	656	617
200	640	602	640	602
250	630	593	630	593
300	627	590	627	590
325	627	590	627	590
350	627	590	627	590
375	627	590	627	590
400	627	590	627	590
425	622	585	622	585
450	612	576	612	576
475	608	572	608	572
500	608	572	608	572
525	608	572	608	572
550	608	572	608	572

**Table 5**  
**Yield Strength Values**

For Metal Temperature Not Exceeding, °F	Strength, ksi			
	Sheet	Plate	Pipe and Tube Wall	Pipe and Tube Wall
			Thickness ≤ <sup>3</sup> / <sub>16</sub> in.	Thickness > <sup>3</sup> / <sub>16</sub> in.
100	75.0	65.0	75.0	65.0
200	64.4	55.9	64.4	55.9
300	58.1	50.4	58.1	50.4
400	54.1	46.9	54.1	46.9
500	51.9	45.0	51.9	45.0
600	50.4	43.7	50.4	43.7
650	49.6	43.0	49.6	43.0
700	48.6	42.1	48.6	42.1
750	47.3	41.0	47.3	41.0
800	45.7	39.6	45.7	39.6
850	44.1	38.2	44.1	38.2
900	42.5	36.9	42.5	36.9
950	41.4	35.9	41.4	35.9
1000	41.1	35.7	41.1	35.7

**Table 5M**  
**Yield Strength Values**

For Metal Temperature Not Exceeding, °C	Strength, MPa			
	Sheet	Plate	Pipe and Tube Wall	Pipe and Tube Wall
			Thickness ≤ 5.00 mm	Thickness > 5.00 mm
40	517	448	517	448
65	472	409	472	409
100	438	380	438	380
150	400	346	400	346
200	375	325	375	325
250	360	312	360	312
300	350	304	350	304
325	346	300	346	300
350	340	295	340	295
375	334	289	334	289
400	325	282	325	282
425	316	274	316	274
450	306	265	306	265
475	296	256	296	256
500	288	249	288	249
525	283	246	283	246
550	283	246	283	246

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Approval Date: June 23, 2014

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**Case 2736-2**  
**7% Ni Thermo-Mechanical Control Processed Steel**  
**Plate for Cryogenic Applications**  
**Section VIII, Division 1**

*Inquiry:* May thermomechanical control processed (TMCP) 7% Ni-steel plates, meeting the requirements of ASTM A841/A841M-13, Grade G, Class 9 be used for welded construction under the rules of Section VIII, Division 1, Part ULT?

*Reply:* It is the opinion of the Committee that TMCP 7% Ni-steel plates, meeting the requirements of ASTM A841/A841M-13, Grade G, Class 9 may be used for welded construction under the rules of Section VIII, Division 1, provided the following additional requirements are met:

(a) The maximum permitted nominal thickness of plates is 2 in. (50 mm).

(b) For Section VIII, Division 1, the rules of Subsection C, Part ULT shall apply.

(c) The material-specific requirements shall be those for 9% Ni-steel plate, SA-553 Type I, except that the allowable stress values in Tables 2 and 2M of this Case shall be used rather than those in Table ULT-23.

(d) For external pressure, Fig. CS-3 of Section II, Part D, Subpart 3 shall apply.

(e) The yield strength and tensile strength values for use in design shall be as shown in Tables 1 and 1M.

(f) The maximum allowable stress values for the material shall be those given in Tables 2 and 2M. Welded construction allowable stresses apply only to butt joints.

(g) The maximum design temperature shall be 150°F (65°C).

(h) Separate welding procedure and performance qualifications in accordance with Section IX shall be required for this material.

(i) The minimum tensile strength of the reduced tension specimen in accordance with QW-462.1 shall not be less than 100 ksi (690 MPa) or 95 ksi (655 MPa), respectively, at room temperature. The choice of UTS depends on the welding process and filler metal used in the construction.<sup>1</sup>

(j) During fabrication and assembly, other than during welding, the material shall not be exposed to temperatures exceeding the final tempering temperature of 985°F (530°C).

(k) This Case number shall be shown on the Manufacturer's Data Report.

<sup>1</sup> Some nickel-base AWS classification consumables that will usually meet the 100 ksi (690 MPa) or 95 ksi (655 MPa) tensile strength requirements are: F43, SFA-5.11, ENiCrMo-3, UNS W86112; F43, SFA-5.14, ERNiCrMo-3, UNS N96625; F43, SFA-5.11, ENiCrMo-4, UNS W80276; and F43, SFA-5.14, ERNiCrMo-4, UNS N10276.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1  
Yield and Tensile Strength Values**

Metal Temperature, °F	Yield Strength, ksi [Note (1)]	Tensile Strength, ksi [Note (2)]
-320	129	152
-300	122	143
-250	111	131
-200	106	124
-150	102	120
-100	97.4	115
-50	92.8	109
-20 to 100	85.0	100
150	81.8	100

NOTES:

- (1) The tabulated values of yield strength are those that the Committee believes are suitable for use in design calculations. At temperatures other than room temperature, the yield strength values correspond to the yield strength trend curve adjusted to the minimum specified room temperature yield strength. The yield strength values do not correspond exactly to “minimum” or “average,” as those terms are applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 1 require testing for yield strength of production material at temperatures other than at room temperature for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated yield strength values for ASME acceptance/rejection purposes for materials. If some test results at temperatures other than at room temperature on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.
- (2) The tabulated values of tensile strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the tensile strength values tend toward an average or expected value, which may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. The tensile strength values do not correspond exactly to “average” as this term is applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 1 require testing for tensile strength at temperatures other than at room temperature of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile strength values for ASME acceptance/rejection purposes for materials. If some test results at temperatures other than room temperature on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

**Table 1M  
Yield and Tensile Strength Values**

Metal Temperature, °C	Yield Strength, MPa [Note (1)]	Tensile Strength, MPa [Note (2)]
-195	886	1040
-170	793	933
-145	747	879
-120	719	846
-95	695	817
-70	668	786
-45	640	753
-30 to 40	586	690
65	562	690

NOTES:

- (1) The tabulated values of yield strength are those that the Committee believes are suitable for use in design calculations. At temperatures other than room temperature, the yield strength values correspond to the yield strength trend curve adjusted to the minimum specified room temperature yield strength. The yield strength values do not correspond exactly to “minimum” or “average,” as those terms are applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 1 require testing for yield strength of production material at temperatures other than at room temperature for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated yield strength values for ASME acceptance/rejection purposes for materials. If some test results at temperatures other than at room temperature on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.
- (2) The tabulated values of tensile strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the tensile strength values tend toward an average or expected value, which may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. The tensile strength values do not correspond exactly to “average” as this term is applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 1 require testing for tensile strength at temperatures other than at room temperature of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile strength values for ASME acceptance/rejection purposes for materials. If some test results at temperatures other than room temperature on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

**Table 2**  
**Maximum Allowable Stress Values in Tension for Welded and Nonwelded Construction**

Temperature, °F	Nonwelded Construction, ksi	Welded Construction	
		UTS, 100 ksi	UTS, 95 ksi
-320	43.3	38.9	36.9
-300	40.9	37.9	36.1
-250	37.3	36.3	34.6
-200	35.5	35.0	33.3
-150	34.2	33.5	31.8
-100	32.7	32.1	30.5
-50	31.2	31.0	29.5
-20 to 100	28.6	28.6	27.1
150	28.6	28.6	27.1

GENERAL NOTE: Allowable stresses for welded construction below 20°F (30°C) are based on trend curves for high-Ni welding consumables. These values are the same as those in Table ULT-23 for 5%, 8%, and 9% Ni-steels. Allowable stresses for nonwelded construction and for welded construction at 20°F (30°C) and above are based on trend curves for the base metal and use the criteria of Appendix 1 of Section II, Part D, except that the 1.1 factor on the tensile strength trend curve is not used for values below RT. Values at intermediate temperatures may be calculated by linear interpolation.

**Table 2M**  
**Maximum Allowable Stress Values in Tension for Welded and Nonwelded Construction**

Temperature, °C	Nonwelded Construction, MPa	Welded Construction	
		UTS, 690 MPa	UTS, 655 MPa
-195	298	268	254
-170	267	255	243
-145	251	247	235
-120	242	238	226
-95	234	229	217
-70	225	220	210
-45	215	214	203
-30 to 40	197	197	187
65	197	197	187

GENERAL NOTE: Allowable stresses for welded construction below 20°F (30°C) are based on trend curves for high-Ni welding consumables. These values are the same as those in Table ULT-23 for 5%, 8%, and 9% Ni-steels. Allowable stresses for nonwelded construction and for welded construction at 20°F (30°C) and above are based on trend curves for the base metal and use the criteria of Appendix 1 of Section II, Part D, except that the 1.1 factor on the tensile strength trend curve is not used for values below RT. Values at intermediate temperatures may be calculated by linear interpolation.

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(19)

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**Case 2737-2**  
**7% Ni Thermo-Mechanical Control Processed Steel**  
**Plate for Cryogenic Applications for Class 2**  
**Section VIII, Division 2**

*Inquiry:* May thermo-mechanical control processed (TMCP) 7% Ni-steel plates, conforming to the chemical requirements listed in [Table 1](#), the mechanical properties listed in [Table 2](#), and otherwise conforming to the requirements of SA-841 be used for welded construction under the rules of Section VIII, Division 2, Class 2?

*Reply:* It is the opinion of the Committee that TMCP 7% Ni-steel plates, conforming to the chemical requirements listed in [Table 1](#),<sup>1</sup> the mechanical properties listed in [Table 2](#), and otherwise conforming to the requirements of SA-841 may be used for welded construction under the rules of Section VIII, Division 2, Class 2 provided the following additional requirements are met:

(a) The maximum permitted nominal thickness of plates is 2 in. (50 mm).

(b) For external pressure, Fig. CS-3 of Section II, Part D, Subpart 3 shall apply.

(c) The yield strength and tensile strength values for use in design shall be as shown in [Tables 3](#) and [3M](#).

(d) The maximum allowable stress values for the material shall be those given in [Tables 4](#) and [4M](#). Welded construction allowable stresses apply only to butt joints. The maximum design temperature shall be 150°F (65°C).

(e) Moduli of elasticity values shall be those listed in Section II, Part D, Subpart 2, Table TM-1 for Group F.

(f) Mean linear thermal expansion coefficients are as given in [Tables 5](#) and [5M](#).

(g) Nominal coefficients of thermal conductivity and thermal diffusivity are as given in [Tables 6](#) and [6M](#), and [7](#) and [7M](#), respectively.

(h) Poisson's ratio is 0.34.

(i) The density is 0.285 lb/in.<sup>3</sup> (7 900 kg/m<sup>3</sup>).

(j) Separate welding procedure and performance qualifications in accordance with Section IX shall be required for this material.

(k) The minimum tensile strength at room temperature of the reduced tension specimen in accordance with QW-462.1 shall not be less than 100 ksi (690 MPa).<sup>2</sup>

(l) The weld metals for welding this base material shall have one of the following:

(1) a specified minimum yield strength of 62.5 ksi (431 MPa).

(2) one all weld-metal tension test specimen from each lot of consumable shall be tested to determine that the room-temperature yield strength meets 62.5 ksi (431 MPa) minimum. The test specimen shall conform to the dimensional standards of SFA-5.11, para. 12.1.

(m) The material is exempt from production impact tests of the weld metal in accordance with para. 6.6.5.2(b) of Division 2, Class 2.

(n) During fabrication and assembly, other than during welding, the material shall not be exposed to temperatures exceeding 985°F (530°C).

(o) This Case number shall be referenced in the documentation and marking of the material and shown on the Manufacturer's Data Report.

<sup>1</sup> This material is susceptible to magnetization. Use of magnets in handling after heat treatment should be avoided if residual magnetism would be detrimental to subsequent fabrication or service.

<sup>2</sup> Some nickel-base AWS classification consumables that will usually meet the 100 ksi (690 MPa) or 95 ksi (655 MPa) tensile strength requirements are: F43, SFA-5.11, ENiCrMo-3, UNS W86112; F43, SFA-5.14, ERNiCrMo-3, UNS N96625; F43, SFA-5.11, ENiCrMo-4, UNS W80276; and F43, SFA-5.14, ERNiCrMo-4, UNS N10276.

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**Table 1**  
**Chemical Requirements (Heat and Product)**

Element	Weight, %
Carbon, max.	0.13
Silicon	0.04–0.25 [Note (1)]
Manganese	0.60–1.20
Phosphorus, max.	0.015
Sulfur, max.	0.015
Nickel	6.0–7.5
Chromium	0.30–1.00
Molybdenum, max.	0.30
Aluminum, acid sol., min.	0.008 [Note (1)]

## NOTE:

(1) Silicon may be less than 0.04%, provided that soluble aluminum is 0.025% or over.

**Table 2**  
**Mechanical Property Requirements**

Property	Class 9
Tensile Strength, min., ksi (MPa)	100–120 (690–825)
Yield Strength, 0.2%, min., ksi (MPa)	85 (585)
Elongation in 2 in. (50 mm), %	20

**Table 3**  
**Yield and Tensile Strength Values**

Metal Temperature, °F	Yield Strength, ksi [Note (1)]	Tensile Strength, ksi [Note (2)]
-320	129	152
-300	122	143
-250	111	131
-200	106	124
-150	102	120
-100	97.4	115
-50	92.8	109
-20 to 100	85.0	100
150	81.8	100

## NOTES:

- (1) The tabulated values of yield strength are those that the Committee believes are suitable for use in design calculations. At temperatures other than room temperature, the yield strength values correspond to the yield strength trend curve adjusted to the minimum specified room temperature yield strength. The yield strength values do not correspond exactly to "minimum" or "average," as those terms are applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 2 require testing for yield strength of production material for use in Code components at temperatures other than room temperature. It is not intended that results of such tests, if performed, be compared with these tabulated yield strength values for ASME acceptance/rejection purposes for materials. If some test results at temperatures other than room temperature on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.
- (2) The tabulated values of tensile strength are those that the Committee believes are suitable for use in design calculations. At temperatures other than room temperature, the tensile strength values tend toward an average or expected value, which may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. The tensile strength values do not correspond exactly to "average" as this term is applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 2 require testing for tensile strength, at temperatures other than room temperature, of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile strength values for ASME acceptance/rejection purposes for materials. If some test results at temperatures other than room temperature on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

**Table 3M**  
**Yield and Tensile Strength Values**

Metal Temperature, °C	Yield Strength, MPa [Note (1)]	Tensile Strength, MPa [Note (2)]
-195	886	1040
-170	793	933
-145	747	879
-120	719	846
-95	695	817
-70	668	786
-45	640	753
-30 to 40	586	690
65	562	690

## NOTES:

- (1) The tabulated values of yield strength are those that the Committee believes are suitable for use in design calculations. At temperatures other than room temperature, the yield strength values correspond to the yield strength trend curve adjusted to the minimum specified room temperature yield strength. The yield strength values do not correspond exactly to "minimum" or "average," as those terms are applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 2 require testing for yield strength of production material for use in Code components at temperatures other than room temperature. It is not intended that results of such tests, if performed, be compared with these tabulated yield strength values for ASME acceptance/rejection purposes for materials. If some test results at temperatures other than room temperature on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.
- (2) The tabulated values of tensile strength are those that the Committee believes are suitable for use in design calculations. At temperatures other than room temperature, the tensile strength values tend toward an average or expected value, which may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. The tensile strength values do not correspond exactly to "average" as this term is applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 2 require testing for tensile strength, at temperatures other than room temperature, of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile strength values for ASME acceptance/rejection purposes for materials. If some test results at temperatures other than room temperature on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

**Table 4**  
**Maximum Allowable Stress Values in Tension**  
**for Welded and Nonwelded Construction**

Temperature, °F	ksi
-20 to 100	41.7
150	41.7

GENERAL NOTE: Maximum allowable stress values for 100°F may be used at temperatures down to -325°F.

**Table 4M**  
**Maximum Allowable Stress Values in Tension**  
**for Welded and Nonwelded Construction**

Temperature, °C	MPa
-35 to 40	287
65	287

GENERAL NOTE: Maximum allowable stress values for 40°C may be used at temperatures down to -200°C.

**Table 5**  
**Mean Linear Thermal Expansion Coefficients**

Temperature Range, °F	Coefficient, in./in./°F
-320 to RT	$2.8 \times 10^{-6}$
-300 to RT	$3.0 \times 10^{-6}$
-250 to RT	$3.4 \times 10^{-6}$
-200 to RT	$3.9 \times 10^{-6}$
-150 to RT	$4.3 \times 10^{-6}$
-100 to RT	$4.8 \times 10^{-6}$
-50 to RT	$5.2 \times 10^{-6}$
0 to RT	$5.7 \times 10^{-6}$
RT to 100	$6.6 \times 10^{-6}$
RT to 150	$7.0 \times 10^{-6}$

**Table 5M**  
**Mean Linear Thermal Expansion Coefficients**

Temperature Range, °C	Coefficient, in./in./°C
-196 to RT	$5.0 \times 10^{-6}$
-170 to RT	$5.7 \times 10^{-6}$
-150 to RT	$6.3 \times 10^{-6}$
-100 to RT	$7.8 \times 10^{-6}$
-50 to RT	$9.2 \times 10^{-6}$
0 to RT	$10.7 \times 10^{-6}$
RT to 20	$11.3 \times 10^{-6}$
RT to 150	$12.2 \times 10^{-6}$

**Table 6**  
**Thermal Conductivity Coefficients**

Temperature, °F	Coefficient, Btu/hr-ft-°F
-320	12.6
-300	12.9
-250	13.6
-200	14.3
-150	15.0
-100	15.7
-50	16.4
0	17.1
20	17.4
70	18.1

**Table 6M**  
**Thermal Conductivity Coefficients**

Temperature, °C	Coefficient, W/m-°C
-200	22.2
-150	24.3
-100	26.4
-50	28.5
0	30.5
20	31.4
50	32.6

**Table 7**  
**Thermal Diffusivity Coefficients**

Temperature, °F	Coefficient, ft <sup>2</sup> /hr
-320	0.346
-300	0.345
-250	0.344
-200	0.343
-150	0.343
-100	0.342
-50	0.341
0	0.340
20	0.339
70	0.339

**Table 7M**  
**Thermal Diffusivity Coefficients**

Temperature, °C	Coefficient, $\times 10^{-6} \text{ m}^2/\text{sec}$
-200	7.8
-150	8.0
-100	8.2
-50	8.4
0	8.6
20	8.7
50	8.8

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**Approval Date: September 25, 2012**

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**Case 2738  
Manufacturer's Data Reports  
Section VIII, Division 1; Section VIII, Division 2; Section  
VIII, Division 3**

*Inquiry:* Is it permissible for Inspectors to only include their National Board Commission number on Manufacturer's Data Reports in lieu of their National Board

Commission Number and/or Jurisdiction Number as included in the Notes to completion of Manufacturer's Data Reports?

*Reply:* It is the opinion of the Committee that it is permissible for Inspectors to include only their National Board Commission Number regardless of the registration status of the pressure vessel or part.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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**Case 2739**  
**Alternative Diameter-To-Thickness Ratios for Spherical and Formed Heads With Openings**  
**Section VIII, Division 2**

*Inquiry:* Under what conditions is it permissible to use the rules of Section VIII, Division 2 for openings in spherical and formed heads with diameter-to-thickness ( $D/T$ ) ratios greater than the limit of 400, as defined in para. 4.5.2.1?

*Reply:* It is the opinion of the Committee that the rules of para. 4.5 may be used for any ratio of  $D/T$  under the following conditions:

- (a) The opening satisfies all other requirements of para. 4.5.
- (b) The nozzle is one of the following:
  - (1) a radial nozzle located in a spherical shell or formed head designed in accordance with the rules of para. 4.5.10
  - (2) a hillside or perpendicular nozzle in a formed head designed in accordance with the rules of para. 4.5.11
- (c) This Case number shall be identified in the Manufacturer's Data Report.

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**Case 2740-1**  
**25Cr-7Ni-4Mo-N (UNS S32750) Austenitic-Ferritic**  
**Stainless Steel for Class 2**  
**Section VIII, Division 2**

*Inquiry:* May 25Cr-7Ni-4Mo-N (UNS S32750) Type 2507, austenitic-ferritic stainless steel products conforming to the specifications in [Table 1](#) be used for welded construction under the rules of Section VIII, Division 2, Class 2?

*Reply:* It is the opinion of the Committee that the materials described in the Inquiry may be used in the construction of welded pressure vessels conforming to the rules of Section VIII, Division 2, Class 2, provided the following additional requirements are met:

(a) The design temperature shall not exceed 600°F (316°C).

(b) The maximum wall thickness for tube and pipe shall be 1 in. (25 mm).

(c) The maximum allowable stress values shall be as given in [Tables 2](#) and [2M](#).

(d) For external pressure design, Fig. HA-5 of Section II, Part D shall be used.

(e) These materials shall be considered as P-No. 10H, Group 1.

(f) For physical properties, the material shall be considered as 25Cr-7Ni-4Mo-N material.

(g) Impact testing in accordance with the rules in para. 3.11.4 for austenitic-ferritic duplex stainless steels is required.

(h) Heat treatment after forming or fabrication is neither required nor prohibited, but when heat treatment is performed, it shall be performed from 1,880°F to 2,060°F (1025°C to 1125°C) followed by liquid quenching or rapid cooling by other means.

(i) This Case number shall be shown on the Manufacturer's Data Report.

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**Table 1**  
**Product Specifications**

Forgings (Type F53)	SA-182
Plate, sheet, and strip	SA-240
Seamless and welded pipe	SA-790
Seamless and welded tube	SA-789

**Table 2**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi [Note (1)]
100	48.3
150	48.3
200	47.2
250	45.1
300	43.3
350	41.7
400	40.4
450	39.4
500	38.6
550	38.3
600	38.3

GENERAL NOTE: This material may be expected to develop embrittlement after service at moderately elevated temperature; see Section II, Part D, Appendix A, A-340 and A-360.

NOTE:

(1) For SA-789 welded tube and SA-790 welded pipe, a factor of 0.85 shall apply.

**Table 2M**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Values, MPa [Note (1)]
40	333
65	333
100	322
125	310
150	299
175	289
200	280
225	273
250	268
275	265
300	263
325	263 [Note (2)]

GENERAL NOTE: This material may be expected to develop embrittlement after service at moderately elevated temperature; see Section II, Part D, Appendix A, A-340 and A-360.

NOTES:

- (1) For SA-789 welded tube and SA-790 welded pipe, a factor of 0.85 shall apply.
- (2) The maximum design temperature is 316°C; 325°C value is provided for interpolation only.

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**Case 2741**  
**PW-39.2.1, PWHT Requirements for P-No. 4 Material**  
**Welded to Lower P-Number Material**  
**Section I**

*Inquiry:* Changes have been approved for publication in the 2013 Edition of Section I to PW-39.2.1 to allow a reduced PWHT temperature when welding P-No. 4 material to a lower P-Number material. May those changes be applied ahead of publication of the 2013 Edition?

*Reply:* It is the opinion of the Committee that the changes approved for publication in the 2013 Edition of Section I to PW-39.2.1 to allow a reduced PWHT temperature when welding P-No. 4 material to a lower P-No. material may be applied ahead of publication of the 2013 Edition, provided the following requirements are met:

(a) Fillet welds, partial-penetration welds, and full-penetration welds through the tube or pipe thickness, attaching P-No. 4 tube and pipe to headers of lower P-Number material, may be postweld heat-treated at the temperature specified in Table PW-39 for the lower P-Number material, provided the tubes or pipe comply with all the following conditions:

(1) maximum specified chromium content of 3.0%

(2) maximum size of NPS 4 (DN 100)

(3) maximum thickness of  $\frac{1}{2}$  in. (13 mm)

(4) maximum specified carbon content of not more than 0.15%

(b) This Case number shall be shown on the Manufacturer's Data Report.

(c) This Case shall be annulled six months after publication of the Code revisions.

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Approval Date: August 29, 2012

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**Case 2742**  
**Composite Class III Pressure Vessel Lower Cycle**  
**Pressure Limit**  
**Section X**

*Inquiry:* Under what conditions may the lower pressure limit for cycle testing per para. 8-700.5.4.1 be increased?

*Reply:* It is the opinion of the Committee that the lower pressure limit for cycle testing of Section X, Class III vessels per para. 8-700.5.4.1 may be increased under the following conditions:

(a) If a minimum operating pressure is specified in the User Design Specification (UDS) that is greater than 10% of the design pressure, the vessels may be cycled between the minimum operating pressure and the design pressure, rather than between 10% of design pressure and the design pressure, for  $N$  pressure cycles as defined in para. 8-700.5.4.1. The number of full range startup/shutdown cycles shall also be addressed in the UDS, with pressure cycling between 10% of design pressure and the design pressure conducted accordingly.

(b) The minimum operating pressure shall be included on the nameplate in accordance with Part RS of Section X.

(c) This Case number shall be shown on the Fabricator's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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**Case 2743**  
**Composite Class III Pressure Vessel Batch Cycle Testing**  
**Section X**

*Inquiry:* Under what conditions may batch cycle testing be decreased once it is established that the pressure vessel design and materials are not sensitive to fatigue cycling?

*Reply:* It is the opinion of the Committee that the batch cycle testing for Section X, Class III vessels may be decreased once it is established that the pressure vessel design and materials are not sensitive to fatigue cycling under the following conditions:

(a) For the batch cycling test per para. 8-700.3, the number of cycles to be demonstrated per para. 8-700.5.4 may consider the number of fatigue tests,  $n$ , to include prior to qualification and batch tests of the same configuration.

(b) The batch cycling test per para. 8-700.3 is no longer required on every batch once it has been demonstrated that the pressure vessel design and materials are not sensitive to fatigue cycling by passing the batch cycle testing on a total of five vessels with the number of cycles per para. 8-700.5.4 and having no leaks either in the first set of  $N$  cycles, or in the second set of  $N$  cycles (where a leak would otherwise be allowed but not a rupture) for a total of 5.2 times the design service life. However, the batch cycle test must be repeated at least once every 3 yr. If a leak or rupture occurs during a batch test, then batch testing would have to be reinitiated until a new total of five vessels passes the cycle requirements per para. 8-700.5.4 with no leaks.

(c) This Case number shall be shown on the Fabricator's Data Report.

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**Case 2744**  
**Composite Pressure Vessel Analysis**  
**Section X**

*Inquiry:* Under what conditions may mean (average) composite thickness and material properties be used for stress analysis under Section X, para. 8-400.1 rather than minimum thickness and material properties?

*Reply:* It is the opinion of the Committee that mean (average) composite thickness and material properties shall be used for stress analysis when the allowable strength for the laminate has been based on analysis using mean properties. Analysis using mean properties shall be used to determine the minimum thickness required for components.

This Case number shall be shown on the Fabricator's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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**Case 2745-1**  
**Composite Pressure Vessels for High-Pressure Fluids**  
**Section X**

*Inquiry:* Under what conditions may fluids other than hydrogen gas be contained in composite pressure vessels designed and constructed under the rules of Section X for Class III vessels with nonload-sharing liners?

*Reply:* It is the opinion of the Committee that composite pressure vessels with nonload-sharing liners and containing fluids other than compressed hydrogen may be designed and constructed under the rules of Section X, Mandatory Appendix 8, provided the following requirements are met:

(a) Additional fluids allowed are methane, natural gas, helium, nitrogen, water, and hydraulic oils. Use of mixtures of these fluids is permitted. Air is allowed to a maximum design pressure of 3,600 psi (24.8 MPa) and not permitted to mix with hydrocarbons or hydrogen. The maximum operating temperature with air shall be lower than 100°F below the auto-ignition temperature of the liner material at the design pressure, but no greater than the maximum allowed per this Code (see Mandatory Appendix 8, para. 8-400.3). The tank shall be protected

against gunfire. A penetration test in accordance with para. 8-700.5.10 must be run with the contained gas (air). The tank shall be protected from impacts in service. In addition, air shall be filtered for particles before being put in the vessel. The User is responsible for specifying the contained fluids in the Design Specification.

(b) Contained fluids shall be compatible with the composite, liner, and nozzle materials. If compatibility is not already demonstrated, testing must be conducted to confirm compatibility. Confirmation of compatibility shall be reported in the Fabricator's Data Report.

(c) Allowed permeation rates shall be included in the User Design Specification. The fabricator shall confirm permeation rate through testing.

(d) Permeation testing may be conducted with the fluid to be contained, or by using an alternate fluid with adjustment in rate made by considering relative molecular weight or by using relative viscosity, as appropriate.

(e) Additional pressure and bending loads present due to containment of liquids shall be considered in the stress analysis, and changes made to test pressures or procedures as appropriate during qualification testing to accurately assess the maximum design stresses.

(f) This Case number shall be shown on the Fabricator's Data Report.

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**Case 2746**  
**Composite Pressure Vessel Pressurization Rate**  
**Section X**

*Inquiry:* Under what conditions may the pressurization rate be increased for burst testing per para. 8-700.5.3.1?

*Reply:* It is the opinion of the Committee that the pressurization rate may be increased for burst testing per para. 8-700.5.3.1 under the following conditions:

(a) The pressurization rate shall not exceed 200 psi/sec (14 bar/s).

(b) If the pressurization rate exceeds 50 psi/sec (3.5 bar/s) at pressures above 80% of the design burst, either the vessel shall be located between the pressure source and the pressure measurement device, or the test pressure shall be held at the vessel's design burst pressure for 5 sec prior to resuming the test.

(c) This Case number shall be shown on the Fabricator's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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**Approval Date: August 29, 2012**

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**Case 2747**  
**Composite Pressure Vessel Nozzle Design Change**  
**Section X**

*Inquiry:* May a change be made to the nozzle design without conducting a creep test as indicated in Table 8-700.2.1-1?

*Reply:* It is the opinion of the Committee that for new vessel construction, a change to the nozzle design will not change the creep characteristics of the liner or resin, and therefore, a creep test shall not be required, as follows:

(a) A creep test per para. 8-700.5.5 shall not be required for a change to the design of the end nozzle.

(b) This Case number shall be shown on the Fabricator's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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(19)

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**Case 2748-2**  
**Use of SA/EN 10028-2, Grade 20MnMoNi4-5, Quenched and Tempered Steel Plate for Class 2 Section VIII, Division 2**

*Inquiry:* Under what conditions may steel plates manufactured in accordance with SA/EN 10028-2, Grade 20MnMoNi4-5 be used in Section VIII, Division 2, Class 2 construction?

*Reply:* It is the opinion of the Committee that steel plates manufactured in accordance with SA/EN 10028-2, Grade 20MnMoNi4-5 be used in Section VIII, Division 2, Class 2 construction, provided the following additional requirements are met:

(a) The design temperature shall not exceed 750°F (399°C).

(b) For the purpose of impact test requirements, this material shall be considered Curve C material in Figures 3.7, 3.7M, 3.8, and 3.8M of Section VIII, Division 2, Class 2.

(c) Limits on trace elements shall be those specified in Table 1 of SA-20/SA-20M.

(d) The maximum allowable stress values shall be those listed in Tables 1 and 1M.

(e) The yield and tensile strengths shall be as shown in Tables 2 and 2M, and Tables 3 and 3M, respectively.

(f) For physical properties, the material shall be considered Mn-0.5Mo-0.5Ni material.

(g) For external pressure design, the requirements of Figure CS-5 of Section II, Part D shall apply.

(h) This material shall be considered P-No. 3, Group 3.

(i) This material shall be considered Table 3-A.1 material.

(j) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi, for Thickness, <i>t</i> , in.				
	$t \leq 1.5$	$1.5 < t \leq 2.5$	$2.5 < t \leq 4$	$4 < t \leq 6$	$6 < t \leq 10$
100	35.7	35.7	34.4	34.4	33.8
150	35.7	35.7	34.4	34.4	33.8
200	35.7	35.7	34.4	34.4	33.8
250	35.7	35.7	34.4	34.4	33.8
300	35.7	35.7	34.4	34.4	33.8
350	35.7	35.7	34.4	34.4	33.8
400	35.7	35.7	34.4	34.4	33.8
450	35.7	35.7	34.4	34.4	33.8
500	35.7	35.7	34.4	34.4	33.8
550	35.7	35.7	34.4	34.4	32.9
600	35.7	35.7	34.4	34.4	32.5
650	35.7	35.7	34.4	34.4	32.1
700	35.7	35.7	34.4	34.4	31.5
750	35.7	35.4	34.4	33.9	30.8

**Table 1M**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Values, MPa, for Thickness, <i>t</i> , mm				
	$t \leq 40$	$40 < t \leq 60$	$60 < t \leq 100$	$100 < t \leq 150$	$150 < t \leq 250$
40	246	246	238	238	233
65	246	246	238	238	233
100	246	246	238	238	233
125	246	246	238	238	233
150	246	246	238	238	233
175	246	246	238	238	233
200	246	246	238	238	233
225	246	246	238	238	233
250	246	246	238	238	231
275	246	246	238	238	228
300	246	246	238	238	226
325	246	246	238	238	223
350	246	246	238	238	220
375	246	246	238	238	217
400 [Note (1)]	246	244	238	233	212

NOTE:

(1) The maximum design temperature is 399°C; 400°C values are provided for interpolation only.

**Table 2**  
**Yield Strength Values**

For Metal Temperature Not Exceeding, °F	Yield Strength Values, ksi, for Thickness, $t$ , in.				
	$t \leq 1.5$	$1.5 < t \leq 2.5$	$2.5 < t \leq 4$	$4 < t \leq 6$	$6 < t \leq 10$
100	68.2	66.7	65.3	63.8	58.0
150	65.8	64.4	63.0	61.6	56.0
200	64.4	63.0	61.7	60.3	54.8
250	63.1	61.8	60.5	59.1	53.7
300	62.0	60.7	59.4	58.1	52.8
350	61.0	59.7	58.4	57.1	51.9
400	60.2	58.9	57.6	56.3	51.2
450	59.5	58.2	56.9	55.7	50.6
500	58.7	57.5	56.2	55.0	50.0
550	58.1	56.8	55.6	54.3	49.4
600	57.4	56.1	54.9	53.7	48.8
650	56.6	55.4	54.2	53.0	48.1
700	55.6	54.4	53.2	52.0	47.3
750	54.3	53.2	52.0	50.8	46.2

GENERAL NOTE: The tabulated values of yield strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the yield strength values correspond to the yield strength trend curve adjusted to the minimum specified room temperature yield strength. The yield strength values do not correspond exactly to "minimum" or "average" as these terms are applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 2 require elevated temperature testing for yield strengths of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated yield strength values for ASME Code acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

**Table 2M**  
**Yield Strength Values**

For Metal Temperature Not Exceeding, °C	Yield Strength Values, MPa, for Thickness, $t$ , mm				
	$t \leq 40$	$40 < t \leq 60$	$60 < t \leq 100$	$100 < t \leq 150$	$150 < t \leq 250$
40	470	460	450	440	400
65	454	444	434	425	386
100	442	432	423	414	376
125	434	425	416	407	370
150	427	418	409	400	364
175	421	412	403	394	358
200	416	407	398	389	354
225	411	402	393	385	350
250	406	398	389	381	346
275	402	394	385	377	342
300	398	390	381	373	339
325	394	385	377	369	335
350	389	380	372	364	331
375	382	374	366	358	325
400 [Note (1)]	374	366	358	350	318

GENERAL NOTE: The tabulated values of yield strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the yield strength values correspond to the yield strength trend curve adjusted to the minimum specified room temperature yield strength. The yield strength values do not correspond exactly to "minimum" or "average" as these terms are applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 2 require elevated temperature testing for yield strengths of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated yield strength values for ASME Code acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

NOTE:

(1) The maximum design temperature is 399°C; 400°C values are provided for interpolation only.

**Table 3**  
**Tensile Strength Values**

For Metal Temperature Not Exceeding, °F	Tensile Strength Values, ksi, for Thickness, $t$ , in.				
	$t \leq 1.5$	$1.5 < t \leq 2.5$	$2.5 < t \leq 4$	$4 < t \leq 6$	$6 < t \leq 10$
100	85.6	85.6	82.7	82.7	81.2
150	85.6	85.6	82.7	82.7	81.2
200	85.6	85.6	82.7	82.7	81.2
250	85.6	85.6	82.7	82.7	81.2
300	85.6	85.6	82.7	82.7	81.2
350	85.6	85.6	82.7	82.7	81.2
400	85.6	85.6	82.7	82.7	81.2
450	85.6	85.6	82.7	82.7	81.2
500	85.6	85.6	82.7	82.7	81.2
550	85.6	85.6	82.7	82.7	81.2
600	85.6	85.6	82.7	82.7	81.2
650	85.6	85.6	82.7	82.7	81.2
700	85.6	85.6	82.7	82.7	81.2
750	85.6	85.6	82.7	82.7	81.2

GENERAL NOTE: The tabulated values of tensile strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the values of tensile strength tend toward an average or expected value that may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. The tensile strength values do not correspond exactly to "average" as this term is applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 2 require elevated temperature testing for tensile strengths of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile strength values for ASME Code acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

**Table 3M  
Tensile Strength Values**

For Metal Temperature Not Exceeding, °C	Tensile Strength Values, MPa, for Thickness, <i>t</i> , mm				
	<i>t</i> ≤ 40	40 < <i>t</i> ≤ 60	60 < <i>t</i> ≤ 100	100 < <i>t</i> ≤ 150	150 < <i>t</i> ≤ 250
40	590	590	570	570	560
65	590	590	570	570	560
100	590	590	570	570	560
125	590	590	570	570	560
150	590	590	570	570	560
175	590	590	570	570	560
200	590	590	570	570	560
225	590	590	570	570	560
250	590	590	570	570	560
275	590	590	570	570	560
300	590	590	570	570	560
325	590	590	570	570	560
350	590	590	570	570	560
375	590	590	570	570	560
400 [Note (1)]	590	590	570	570	560

GENERAL NOTE: The tabulated values of tensile strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the values of tensile strength tend toward an average or expected value that may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. The tensile strength values do not correspond exactly to "average" as this term is applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 2 require elevated temperature testing for tensile strengths of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile strength values for ASME Code acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

NOTE:

(1) The maximum design temperature is 399°C; 400°C values are provided for interpolation only.

Approval Date: September 30, 2018

(19)

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2749-2**  
**Use of EN 10222-2:1999, Grade 18MnMoNi5-5, Steel**  
**Forgings for Class 2**  
**Section VIII, Division 2**

*Inquiry:* Under what conditions may steel forgings, manufactured in accordance with EN 10222-2:1999, Grade 18MnMoNi5-5 be used in Section VIII, Division 2, Class 2 construction?

*Reply:* It is the opinion of the Committee that forgings, manufactured in accordance with EN 10222-2:1999,<sup>1</sup> Grade 18MnMoNi5-5 be used in Section VIII, Division 2, Class 2 construction, provided the following additional requirements are met:

(a) If resurfacing by welding is acceptable by agreement between the purchaser and the material producer, and in accordance with para. 8.2.3 of EN 10222-1, the following requirements must be fulfilled.

(1) Preparation for repair welding shall include inspection to assure complete removal of the defect.

(2) Repairs shall be made utilizing welding procedures, welders, and welding operators qualified in accordance with Section IX.

(b) The design temperature shall not exceed 750°F (399°C).

(c) For the purpose of impact test requirements, this material shall be considered Curve C material in Figures 3.7, 3.7M, 3.8, and 3.8M of Section VIII, Division 2, Class 2.

(d) Limits on trace elements shall be those specified in Table 1 of SA-20/SA-20M.

(e) The maximum allowable stress values shall be those listed in Tables 1 and 1M.

(f) The yield and tensile strengths shall be as shown in Tables 2 and 2M.

(g) For physical properties, the material shall be considered Mn-0.5Mo-0.5Ni material.

(h) For external pressure design, the requirements of Fig. CS-5 of Section II, Part D shall apply.

(i) This material shall be considered P-No. 3, Group 3.

(j) This material shall be considered Table 3-A.1 material.

(k) This Case number shall be marked on the material, documented on the material test report, and shown on the Manufacturer's Data Report.

<sup>1</sup> See Section II, Part A, Nonmandatory Appendix A for ordering information to obtain an English language copy of EN 10222-2:1999 and its references.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi
100	33.2
150	33.2
200	33.2
250	33.2
300	33.2
350	33.2
400	33.2
450	33.2
500	33.2
550	32.9
600	32.5
650	32.1
700	31.5
750	30.8

**Table 1M**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Values, MPa
40	229
65	229
100	229
125	229
150	229
175	229
200	229
225	229
250	229
275	228
300	226
325	223
350	220
375	217
400	212 [Note (1)]

NOTE:

(1) The maximum design temperature is 399°C; 400°C value is provided for interpolation purposes only.

**Table 2**  
**Yield and Tensile Strength Values**

For Metal Temperature Not Exceeding, °F	Yield Strength Values, ksi [Note (1)]	Tensile Strength Values, ksi [Note (2)]
100	58.0	79.8
150	56.0	79.8
200	54.8	79.8
250	53.7	79.8
300	52.8	79.8
350	51.9	79.8
400	51.2	79.8
450	50.6	79.8
500	50.0	79.8
550	49.4	79.8
600	48.8	79.8
650	48.1	79.8
700	47.3	79.8
750	46.2	79.8

NOTES:

- (1) The tabulated values of yield strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the yield strength values correspond to the yield strength trend curve adjusted to the minimum specified room temperature yield strength. The yield strength values do not correspond exactly to "minimum" or "average" as these terms are applied to a statistical treatment of a homogeneous set of data. Neither the Material Specification nor the rules of Section VIII, Division 2 require elevated temperature testing for yield strengths of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated yield strength values for ASME Code acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.
- (2) The tabulated values of tensile strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the values of tensile strength tend toward an average or expected value that may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. The tensile strength values do not correspond exactly to "average" as this term is applied to a statistical treatment of a homogeneous set of data. Neither the Material Specification nor the rules of Section VIII, Division 2 require elevated temperature testing for tensile strengths of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile strength values for ASME Code acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

**Table 2M**  
**Yield and Tensile Strength Values**

For Metal Temperature Not Exceeding, °C	Yield Strength Values, MPa [Note (1)]	Tensile Strength Values, MPa [Note (2)]
40	400	550
65	386	550
100	376	550
125	370	550
150	364	550
175	358	550
200	354	550
225	350	550
250	346	550
275	342	550
300	339	550
325	335	550
350	331	550
375	325	550
400 [Note (3)]	318	550

## NOTES:

- (1) The tabulated values of yield strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the yield strength values correspond to the yield strength trend curve adjusted to the minimum specified room temperature yield strength. The yield strength values do not correspond exactly to "minimum" or "average" as these terms are applied to a statistical treatment of a homogeneous set of data. Neither the Material Specification nor the rules of Section VIII, Division 2 require elevated temperature testing for yield strengths of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated yield strength values for ASME Code acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.
- (2) The tabulated values of tensile strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the values of tensile strength tend toward an average or expected value that may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. The tensile strength values do not correspond exactly to "average" as this term is applied to a statistical treatment of a homogeneous set of data. Neither the Material Specification nor the rules of Section VIII, Division 2 require elevated temperature testing for tensile strengths of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile strength values for ASME Code acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.
- (3) The maximum design temperature is 399°C; 400°C values are provided for interpolation purposes only

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Approval Date: December 12, 2012

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**Case 2750**  
**Thermo-Mechanical Control Processed 7% Ni Steel**  
**Plate**  
**Section VIII, Division 1**

*Inquiry:* May thermo-mechanical control processed 7% Ni-steel plates, conforming to the chemical requirements listed in [Table 1](#), the mechanical properties listed in [Table 2](#), and otherwise conforming to the requirements of SA-841, be used for welded construction under the rules of Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that thermo-mechanical control processed 7% Ni-steel plates, conforming to the chemical requirements listed in [Table 1](#),<sup>1</sup> the mechanical properties listed in [Table 2](#), and otherwise conforming to the requirements of SA-841 may be used for welded construction under the rules of Section VIII, Division 1, provided the following additional requirements are met:

(a) The maximum permitted nominal thickness of plates is 2 in. (50 mm).

(b) The rules of Subsection C, Part UHT shall apply.

(c) For external pressure, Figure CS-3 of Section II, Part D shall apply.

(d) The yield strength and tensile strength values for use in design shall be those given in [Table 3](#) and [Table 3M](#).

(e) The maximum allowable stress values for the material shall be those given in [Table 4](#) and [Table 4M](#).

(f) The maximum design temperature shall be 150°F (65°C).

(g) Separate welding procedure and performance qualifications in accordance with Section IX shall be required for this material.

(h) During fabrication and assembly, other than during welding, the material shall not be exposed to temperatures exceeding the final tempering temperature of 985°F (530°C).

(i) This Case number shall be included in the marking and referenced in the documentation of the material and shown on the Manufacturer's Data Report.

<sup>1</sup> This material is susceptible to magnetization. Use of magnets in handling after heat treatment should be avoided if residual magnetism would be detrimental to subsequent fabrication or service.

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**Table 1  
Chemical Requirements (Heat and Product)**

Element	Weight, %
Carbon, max.	0.13
Silicon	0.04–0.25 [Note (1)]
Manganese	0.60–1.20
Phosphorus, max.	0.015
Sulfur, max.	0.015
Nickel	6.0–7.5
Chromium	0.30–1.00
Molybdenum, max.	0.30
Aluminum, acid sol., min.	0.008 [Note (1)]

NOTE:

(1) Silicon may be less than 0.04%, provided that soluble aluminum is 0.025% or over.

**Table 2**

Property	Class 9
Tensile Strength, min., ksi (MPa)	100–120 (690– 825)
Yield Strength, 0.2%, min., ksi (MPa)	85 (585)
Elongation in 2 in. (50 mm), %	20

**Table 3  
Yield and Tensile Strength Values**

Metal Temperature, °F	Yield Strength, ksi	Tensile Strength, ksi
	[Note (1)]	[Note (2)]
–20 to 100	85.0	100
150	81.8	100

NOTES:

(1) The tabulated values of yield strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the yield strength values correspond to the yield strength trend curve adjusted to the minimum specified room temperature yield strength. The yield strength values do not correspond exactly to “minimum” or “average,” as those terms are applied to a statistical treatment of homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 1 require testing for yield strength of production material at temperatures above room temperature for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated yield strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

(2) The tabulated values of tensile strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the tensile strength values tend toward an average or expected value, which may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. The tensile strength values do not correspond exactly to “minimum” or “average,” as those terms are applied to a statistical treatment of homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 1 require testing for tensile strength of production material at temperatures above room temperature for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

**Table 3M**  
**Yield and Tensile Strength Values**

Metal Temperature, °C	Yield Strength, MPa [Note (1)]	Tensile Strength, MPa [Note (2)]
-30 to 40	586	690
65	562	690

## NOTES:

- (1) The tabulated values of yield strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the yield strength values correspond to the yield strength trend curve adjusted to the minimum specified room temperature yield strength. The yield strength values do not correspond exactly to "minimum" or "average," as those terms are applied to a statistical treatment of homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 1 require testing for yield strength of production material at temperatures above room temperature for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated yield strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.
- (2) The tabulated values of tensile strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the tensile strength values tend toward an average or expected value, which may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. The tensile strength values do not correspond exactly to "minimum" or "average," as those terms are applied to a statistical treatment of homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 1 require testing for tensile strength of production material at temperatures above room temperature for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

**Table 4M**  
**Maximum Allowable Stress Values in Tension**

Temperature, °C	MPa
-30 to 40	197
65	197

GENERAL NOTE: Allowable stresses for Part UHT construction are based on trend curves for the base metal and use the criteria of Appendix 1. Values at intermediate temperatures may be calculated by linear interpolation.

**Table 4**  
**Maximum Allowable Stress Values in Tension**

Temperature, °F	ksi
-20 to 100	28.6
150	28.6

GENERAL NOTE: Allowable stresses for Part UHT construction are based on trend curves for the base metal and use the criteria of Appendix 1. Values at intermediate temperatures may be calculated by linear interpolation.

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Approval Date: December 12, 2012

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2751**  
**Alternative Rules for Hemispherical Head Attached to Cylindrical Shell Having Integral Backing Ring That Is Part of the Shell**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions can a hemispherical head be attached to a cylindrical shell using an integral backing ring that is part of the shell?

*Reply:* It is the opinion of the Committee that a hemispherical head may be attached to a shell with an integral backing ring that is part of the shell, provided the following conditions are met:

(a) MAWP on the vessel shall not exceed 3,300 psig (22.8 MPa).

(b) Maximum design metal temperature shall not exceed 400°F (205°C).

(c) MDMT stamped on the nameplate shall not be colder than -20°F (-29°C).

(d) The minimum required thickness of the shell,  $t_{shell}$ , and head,  $t_{head}$ , as shown in [Figure 1](#), are per UG-27 and UG-32(f), respectively.

(e) Cyclic loading is not a controlling design requirement (UG-22).

(f) The vessel is not in lethal service (UW-2).

(g) The shell is machined to form an integral backing ring meeting the requirements of [Figure 1](#).

(h) The joint efficiency of the head-to-shell joint shall be 0.90 from Table UW-12 for a Type 2 joint based on full radiographic examination. The limitations in Table UW-12 for the Type 2 joints do not apply.

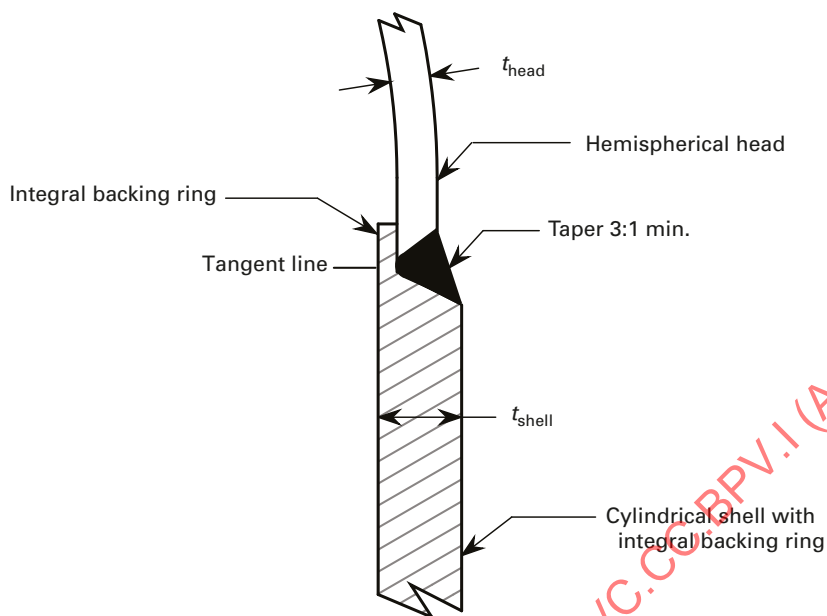
(i) Stress analysis of the head-to-shell joint shall be performed per the requirements of Section VIII, Division 2, Part 5, and the local membrane and local membrane plus bending stresses shall satisfy  $1.0SE$  and  $1.5SE$ , respectively, where  $E$  is the joint efficiency, and  $S$  is the Section VIII, Division 1 allowable stress value.

(j) The weld attaching the shell to the head shall have full radiographic examination and meet the requirements of UW-51.

(k) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Figure 1**  
**Alternative Hemispherical Head to Cylindrical Shell Weld Detail**



Approval Date: December 12, 2012

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2752**  
**22Cr-25Ni-3.5W-3Cu Austenitic Stainless Steel UNS**  
**S31035**  
**Section VIII, Division 1**

*Inquiry:* May solution annealed alloy UNS S31035 seamless pipe with the chemical composition conforming to Table 1, mechanical properties conforming to Table 2, and otherwise conforming to the respective requirements of the specification given in Table 3, and alloy UNS S31035 tubing conforming to SA-213/SA-213M and to Table 1 be used for welded construction up to 1,382°F (750°C) under the rules of Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that solution annealed alloy UNS S31035 seamless pipe and tube as described in the Inquiry may be used in welded construction under the rules of Section VIII, Division 1, provided the following requirements are met:

(a) The material shall be heat treated at a temperature of 2,155°F to 2,280°F (1 180°C to 1 250°C) followed by rapid cooling in air or water.

(b) The rules in Section VIII, Division 1, Subsection C that shall apply are those given in Part UHA for austenitic stainless steels.

(c) For Section VIII, Division 1, the maximum allowable stress values for the material shall be those given in Table 4 and Table 4M. The yield strength values,  $Y-1$ , and tensile strength values,  $U$ , are given in Table 5 and Table 5M.

(d) Separate welding procedure qualification shall be conducted for the material in accordance with Section IX.

(e) For the purposes of performance qualification, the material shall be considered P-No. 45. Pressure-retaining welds of SA-213/SA-213M and seamless SA-312 UNS S31035 tube and pipe shall be limited to circumferential butt welds in tube and pipe of 3½ in. (90 mm) O.D. and smaller. For circumferential butt welds of UNS S31035 to itself, filler metals shall be limited to nickel-based fillers SFA-5.11 class ENiCrFe-2, SFA-5.14 class ERNiCr-3, or SFA-5.14 class ERNiCrCoMo-1.

(f) Heat treatment after welding or fabrication is neither required nor prohibited. If heat treated, the requirements of para. (a) shall apply.

(g) For external pressure design, Figure HA-2 in Section II, Part D shall apply.

(h) This Case number shall be shown on the documentation and marking of the material, and recorded on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1  
 Chemical Requirements**

Element	Composition Limits, %
Carbon	0.04–0.10
Manganese, max.	0.60
Phosphorous, max.	0.025
Sulfur, max.	0.015
Silicon, max.	0.40
Chromium	21.5–23.5
Nickel	23.5–26.5
Tungsten	3.0–4.0
Cobalt	1.0–2.0
Copper	2.5–3.5
Niobium	0.40–0.60
Boron	0.002–0.008
Nitrogen	0.20–0.30

**Table 2  
 Mechanical Test Requirements (Room  
 Temperature)**

Tensile Strength, min. ksi (MPa)	95 (655)
Yield Strength, 0.2% offset, min., ksi (MPa)	45 (310)
Elongation, in 2 in. (50 mm) min., %	40

**Table 3  
 Product Specification**

Seamless pipe	SA-312
---------------	--------

**Table 4  
 Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi	Maximum Allowable Stress Values, ksi [Note (1)]
75	27.1	27.1
100	27.1	27.1
150	26.9	27.1
200	25.5	27.1
250	24.3	26.9
300	23.4	26.3
350	22.6	25.9
400	22.0	25.5
450	21.4	25.2
500	21.0	25.0
550	20.6	24.8
600	20.3	24.7
650	20.0	24.6
700	19.7	24.5
750	19.5	24.4
800	19.2	24.3
850	18.9	24.2
900	18.7	24.0
950	18.4	23.7
1,000	18.2	23.4
1,050	17.9	23.0
1,100	17.7	22.5
1,150	17.5	21.1 [Note (2)]
1,200	16.2 [Note (2)]	16.2 [Note (2)]
1,250	12.1 [Note (2)]	12.1 [Note (2)]
1,300	8.9 [Note (2)]	8.9 [Note (2)]
1,350	6.5 [Note (2)]	6.5 [Note (2)]
1,400	4.9 [Note (2)], [Note (3)]	4.9 [Note (2)], [Note (3)]

NOTES:

- (1) Due to the relatively low yield strength of these materials, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. The stress values in this range exceed 66<sup>2</sup>/<sub>3</sub>% but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.
- (2) These stress values are obtained from time-dependent properties.
- (3) These values are provided for interpolation purposes only. The maximum use temperature is 1,382°F.

**Table 4M**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Values, MPa	Maximum Allowable, Stress Values, MPa [Note (1)]
40	184	184
65	184	184
100	174	184
125	167	184
150	161	181
175	156	179
200	152	176
225	149	174
250	146	173
275	143	172
300	141	171
325	139	170
350	138	170
375	136	169
400	134	168
425	133	168
450	131	167
475	129	166
500	128	164
525	126	163
550	125	160
575	123	158
600	122	154
625	120	140 [Note (2)]
650	111 [Note (2)]	111 [Note (2)]
675	85.1 [Note (2)]	85.1 [Note (2)]
700	64.4 [Note (2)]	64.4 [Note (2)]
725	48.5 [Note (2)]	48.5 [Note (2)]
750	37.1 [Note (2)]	37.1 [Note (2)]

## NOTES:

- (1) Due to the relatively low yield strength of these materials, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. The stress values in this range exceed 66<sup>2</sup>/<sub>3</sub>% but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.
- (2) These stress values are obtained from time-dependent properties.

**Table 5**  
**Yield Strength, Y-1, Values and Tensile  
Strength, U, Values**

For Metal Temperature Not Exceeding, °F	Yield Strength, ksi	Tensile Strength, ksi
75	45.0	95.0
100	45.0	95.0
150	40.4	95.0
200	38.2	95.0
250	36.5	94.1
300	35.0	92.1
350	33.9	90.5
400	32.9	89.3
450	32.2	88.3
500	31.5	87.5
550	31.0	86.9
600	30.5	86.5
650	30.0	86.2
700	29.6	85.8
750	29.2	85.5
800	28.8	85.1
850	28.4	84.6
900	28.0	84.0
950	27.6	83.1
1,000	27.3	82.0
1,050	26.9	80.6
1,100	26.6	78.9
1,150	26.3	76.8
1,200	26.0	74.4
1,250	25.8	71.6
1,300	25.7	68.4
1,350	25.6	64.8
1,400	25.6 [Note (1)]	60.8 [Note (1)]

## NOTE:

- (1) These values are provided for interpolation purposes only. The maximum use temperature is 1,382°F.

**Table 5M**  
**Yield Strength, Y-1, And Tensile Strength, U,**  
**Values**

For Metal			
Temperature Not Exceeding, °C	Yield Strength, MPa	Yield Strength, MPa	Tensile Strength, MPa
40	310		655
65	279		655
100	260		655
125	250		647
150	241		635
175	234		625
200	228		617
225	223		610
250	219		605
275	215		601
300	212		598
325	209		595
350	206		593
375	204		591
400	201		589
425	199		587
450	196		584
475	194		580
500	192		575
525	189		569
550	187		561
575	185		552
600	183		540
625	181		527
650	179		512
675	178		495
700	177		475
725	176		453
750	176		429

Approval Date: December 18, 2012

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2753**  
**22Cr-25Ni-3.5W-3Cu Austenitic Stainless Steel UNS**  
**S31035**  
**Section I**

*Inquiry:* May solution annealed alloy UNS S31035 seamless pipe with the chemical composition conforming to Table 1, mechanical properties conforming to Table 2, and otherwise conforming to the respective requirements of the specification given in Table 3, and alloy UNS S31035 tubing conforming to SA-213/SA-213M and to Table 1 be used for welded construction up to 1,382°F (750°C) in steam-touched service under the rules of Section I?

*Reply:* It is the opinion of the Committee that solution annealed alloy UNS S31035 seamless pipe and tube as described in the Inquiry may be used in welded construction under the rules of Section I, provided the following requirements are met:

(a) The material shall be heat treated at a temperature of 2,155°F to 2,280°F (1 180°C to 1 250°C) followed by rapid cooling in air or water.

(b) The maximum allowable stress values for the material shall be those given in Table 4 and Table 4M.

(c) The rules of PG-19 for 347H (UNS S34709) shall apply for this material except that solution treatment, when required, shall be per (a).

(d) Separate welding procedure qualification shall be conducted for the material in accordance with Section IX.

(e) For the purposes of performance qualification, the material shall be considered P-No. 45.

(f) Pressure retaining welds of SA-213/SA-213M and seamless SA-312 UNS S31035 tube and pipe shall be limited to circumferential butt welds in tube and pipe of 3½ in. (89 mm) O.D. and smaller. For circumferential butt welds of UNS S31035 to itself, filler metals shall be limited to nickel-based fillers SFA-5.11 class ENiCrFe-2, SFA-5.14 class ERNiCr-3, or SFA-5.14 class ERNiCrCoMo-1.

(g) Heat treatment after welding or fabrication is neither required nor prohibited. If heat treated, the requirements of para. (a) shall apply.

(h) The *y*-factor for this material in PG-27.2 shall be the same as alloy 800H.

(i) This Case number shall be referenced in the documentation and marking of the material and shown on the Manufacturer's Data Report.

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**Table 1**  
**Chemical Requirements**

Element	Composition Limits, %
Carbon	0.04–0.10
Manganese, max.	0.60
Phosphorous, max.	0.025
Sulfur, max.	0.015
Silicon, max.	0.40
Chromium	21.5–23.5
Nickel	23.5–26.5
Tungsten	3.0–4.0
Cobalt	1.0–2.0
Copper	2.5–3.5
Niobium	0.40–0.60
Boron	0.002–0.008
Nitrogen	0.20–0.30

**Table 2**  
**Mechanical Test Requirements (Room Temperature)**

Tensile Strength, min. ksi (MPa)	95 (655)
Yield Strength, 0.2% offset, min. ksi (MPa)	45 (310)
Elongation, in 2 in. (50 mm) min., %	40

**Table 3**  
**Product Specification**

Seamless pipe	SA-312
---------------	--------

**Table 4**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi	Maximum Allowable Stress Values, ksi
75	27.1	27.1
100	27.1	27.1
150	26.9	27.1 [Note (1)]
200	25.5	27.1 [Note (1)]
250	24.3	26.9 [Note (1)]
300	23.4	26.3 [Note (1)]
350	22.6	25.9 [Note (1)]
400	22.0	25.5 [Note (1)]
450	21.4	25.2 [Note (1)]
500	21.0	25.0 [Note (1)]
550	20.6	24.8 [Note (1)]
600	20.3	24.7 [Note (1)]
650	20.0	24.6 [Note (1)]
700	19.7	24.5 [Note (1)]
750	19.5	24.4 [Note (1)]
800	19.2	24.3 [Note (1)]
850	18.9	24.2 [Note (1)]
900	18.7	24.0 [Note (1)]
950	18.4	23.7 [Note (1)]
1,000	18.2	23.4 [Note (1)]
1,050	17.9	23.0 [Note (1)]
1,100	17.7	22.5 [Note (1)]
1,150	17.5	21.1 [Note (1)], [Note (2)]
1,200	16.2 [Note (2)]	16.2 [Note (2)]
1,250	12.1 [Note (2)]	12.1 [Note (2)]
1,300	8.9 [Note (2)]	8.9 [Note (2)]
1,350	6.5 [Note (2)]	6.5 [Note (2)]
1,400	4.9 [Note (2)], [Note (3)]	4.9 [Note (2)], [Note (3)]

## NOTES:

- (1) Due to the relatively low yield strength of these materials, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. The stress values in this range exceed  $66\frac{2}{3}\%$  but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.
- (2) These stress values shown are obtained from time-dependent properties.
- (3) These values are provided for interpolation purposes only. The maximum use temperature is 1,382°F.

**Table 4M**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Values, MPa	Maximum Allowable Stress Values, MPa
40	184	184
65	184	184
100	174	184 [Note (1)]
125	167	184 [Note (1)]
150	161	181 [Note (1)]
175	156	179 [Note (1)]
200	152	176 [Note (1)]
225	149	174 [Note (1)]
250	146	173 [Note (1)]
275	143	172 [Note (1)]
300	141	171 [Note (1)]
325	139	170 [Note (1)]
350	138	170 [Note (1)]
375	136	169 [Note (1)]
400	134	168 [Note (1)]
425	133	168 [Note (1)]
450	131	167 [Note (1)]
475	129	166 [Note (1)]
500	128	164 [Note (1)]
525	126	163 [Note (1)]
550	125	160 [Note (1)]
575	123	158 [Note (1)]
600	122	154 [Note (1)]
625	120	140 [Note (1)], [Note (2)]
650	111 [Note (2)]	111 [Note (2)]
675	85.1 [Note (2)]	85.1 [Note (2)]
700	64.4 [Note (2)]	64.4 [Note (2)]
725	48.5 [Note (2)]	48.5 [Note (2)]
750	37.1 [Note (2)]	37.1 [Note (2)]

NOTES:

- (1) Due to the relatively low yield strength of these materials, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. The stress values in this range exceed 66<sup>2</sup>/<sub>3</sub>% but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.
- (2) These stress values shown are obtained from time-dependent properties.

Approval Date: December 12, 2012

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2754**  
**Use of SA-193/SA-193M Grade B16 Bolting in Diameters Larger Than 7 in. (175 mm)**  
**Section VIII, Division 1; Section VIII, Division 2**

*Inquiry:* Under what conditions may SA-193/SA-193M Grade B16 bolting in diameters larger than 7 in. (175 mm) be used in Section VIII, Divisions 1 and 2 (2007 edition and later) construction?

*Reply:* It is the opinion of the Committee that SA-193/SA-193M Grade B16 bolting in diameters larger than 7 in. (175 mm) may be used in Section VIII, Divisions 1 and 2 (2007 edition and later) construction, provided the following additional requirements are met:

(a) The diameter of the bolting shall not exceed 8 in. (200 mm).

(b) The mechanical properties of the bolting shall meet the requirements of SA-193/SA-193M for Grade B16 for over M100 to M180 (over 4 in. to 8 in.), as applicable.

(c) All other requirements for SA-193/SA-193M Grade B16 shall be met.

(d) The design temperature shall not exceed the applicable limits in Section II, Part D.

(e) The allowable stresses shall be per Section II, Part D, Table 3 or 4 for SA-193/SA-193M Grade B16,  $4 < t \leq 7$  in. ( $100 < t \leq 175$  mm), as applicable.

(f) This Case number shall be marked on the material, documented on the material test report, and shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: December 18, 2012

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**Case 2755**  
**Exemption from Preheat and PWHT for Autogenous**  
**Buttwelding of SA-213/SA-213M T22 Seamless Tubing**  
**Section I**

*Inquiry:* Under what conditions may autogenous butt-welds of SA-213/SA-213M T22 material be exempted from the preheat and PWHT requirements of PW-39?

*Reply:* It is the opinion of the Committee that autogenous butt-welds of SA-213/SA-213M T22 material may be considered exempt from the preheat and PWHT requirements of PW-39, provided the following requirements are met:

(a) The welding process shall be limited to automatic, autogenous GTAW.

(b) The tubing size shall be limited to a maximum O.D. of 1.5 in. (38 mm) and a thickness range of 0.095 in. to 0.165 in. (2.4 mm to 4.2 mm).

(c) The welding procedure shall use a multi-pass, staged process as follows:

(1) A minimum preheat of 60°F (16°C) shall be established prior to starting the arc for the first pass.

(2) The first weld pass shall use a lower heat input than the subsequent pass to raise the temperature in the welding zone to a minimum of 300°F (150°C) prior to welding the second pass.

(3) After completion of the first weld pass, a specified wait time shall be determined to limit the maximum inter-pass temperature but also to maintain the minimum pre-heat for the second weld pass.

(4) The heat input shall be sufficiently increased for the second weld pass to completely remelt the material fused during the first weld pass and to achieve penetration and fusion through the full thickness of the tubing.

(5) All temperature limits shall be verified.

(d) The weld procedure and performance qualifications shall be conducted as prescribed in Section IX and include the following:

(1) two separate weld samples, at the minimum and maximum tube O.D. range expected to be applied, must be completely tested.

(2) macrographs and micrographs shall be prepared to verify the complete remelt of the first weld, full penetration and fusion of the second weld pass.

(3) tension tests per QW-150.

(4) root and face guided-bend tests per QW-160.

(5) the interpass temperature shall be limited to 650°F (345°C) maximum.

(6) heat input parameters shall be established for each weld pass and the acceptable wait-time range between weld passes determined based on the measured cooling rate. The acceptable wait-time range between weld passes shall be included in the user's WPS.

(7) the final pass cool down rate shall be limited to ensure the weld cap hardness readings do not exceed 340 HV10 as follows:

(-a) Remove the weld head immediately after weld completion.

(-b) Apply a minimum of 2 in. (50 mm) thick x 6 in. (150 mm) long insulating sleeve, centered at the weld, for a minimum of 30 minutes.

(-c) After cool down, obtain a minimum of five equidistant hardness readings across the entire face of the weld.

(e) All of the welds shall be 100% examined by RT or UT with acceptance criteria per Section I. If UT examination is used, the written procedure shall conform to the requirements of Section V, Article 4, Mandatory Appendix VII.

(f) This Case number shall be identified in the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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**Case 2756**  
**57Ni-22Cr-14W-2Mo-La Alloy (UNS N06230)**  
**Autogenously Welded Tube and Seamless Pipe and Tube**  
**Section I**

*Inquiry:* May solution-annealed alloy UNS N06230 autogenously welded tube and seamless pipe and tube conforming to the specifications listed in [Table 1](#) be used in water service in welded construction for temperatures above 1,000°F (538°C) and up to 1,250°F (677°C) under Section I?

*Reply:* It is the opinion of the Committee that solution-annealed alloy UNS N06230 autogenously welded tube and seamless pipe and tube as described in the Inquiry may be used in water-wetted service in welded construction complying with the rules of Section I, provided the following additional requirements are met:

(a) The maximum allowable stress values for the material shall be those given in Section II, Part D, Table 1B. The metal temperature shall not exceed 1,250°F (677°C).

(b) Welded fabrication shall conform to the applicable requirement of Section I. When welding is performed with filler metal of the same nominal composition as the base metal, only GMAW and GTAW processes are allowed.

(c) Welding procedure and performance qualifications shall be conducted in accordance with Section IX.

(d) All rules regarding weld strength reduction factors in PG-26 shall apply. Values for weld strength reduction factors shall be as listed in [Table 2](#).

(e) When heat treatment is applied, the temperature, time, and method of heat treatment shall be covered by agreement between the user and manufacturer. When this material is formed, the rules of Section I, PG-19 shall apply for alloy UNS N06230. Other than these requirements, any other heat treatment after forming or fabrication is neither required nor prohibited.

(f) For Section I, which requires a temperature-dependent parameter,  $y$  [see PG-27.4, Note (6)], the  $y$  values shall be as shown in PG-27.4.

(g) This Case number shall be referenced in the documentation of the material and recorded on the Manufacturer's Data Report.

**CAUTION: Austenitic alloys are subject to stress corrosion cracking, intergranular attack, pitting, and crevice corrosion when used in boiler applications in aqueous environments. Factors that affect the susceptibility of these materials are applied or residual stress, water chemistry and deposition of solids, and material condition. Susceptibility to attack is enhanced when the material is used in a sensitized condition or with residual cold-work. Concentration of corrosive agents (e.g., chlorides, caustic or reduced sulfur species) can occur under deposits formed on the surface of these materials and can result in severe under-deposit wastage or cracking. For successful operation in water environments, careful attention must be paid to continuous control of water chemistry.**

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**Table 1**  
**Product Specifications**

Seamless pipe and tube	SB-622
Welded tube	SB-626

**Table 2**  
**Weld Strength Reduction Factors**

Temperature		Weld Strength Reduction Factor
°F	°C	
-20 to 100	-4 to 38	0.85
700	371	0.85
750	399	0.85
800	427	0.85
850	454	0.85
900	482	0.85
950	510	0.85
1,000	538	0.85
1,050	566	0.85
1,100	593	0.85
1,150	621	0.82
1,200	649	0.77
1,250	677	0.73

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**Case 2757-1**  
**Alternative Welding Operator Performance Weld**  
**Qualification Test**  
**Section VIII, Division 1; Section VIII, Division 2; Section**  
**VIII, Division 3; Section IX**

*Inquiry:* Under what conditions may a production mockup weld test be used for welding operator performance qualifications when the welding equipment cannot produce a standard test coupon or a production groove weld capable of volumetric examination or mechanical testing required by QW-300, QW-301, QW-302, or QW-305?

*Reply:* It is the opinion of the Committee that a production mockup weld test may be used for welding operator performance qualifications when the welding equipment cannot produce a standard test coupon or a production groove weld capable of volumetric examination or mechanical testing required by QW-300, QW-301, QW-302, or QW-305, provided the following requirements are met:

(a) The production mockup test weld shall be sectioned to provide four weld cross-section surfaces equidistant in the length of the test weld.

(b) One face of each cross-section shall be smoothed and etched with a suitable etchant (QW-470) to give clear definition to the weld metal and heat-affected zone.

(c) Visual inspection of the cross-section of the weld metal and heat-affected zone shall be free of cracks and show complete fusion. For partial penetration designs, linear indications at the root not exceeding  $\frac{1}{32}$  in. (0.8 mm) shall be acceptable.

(d) In addition to the welding operator performance variables of QW-361, the following essential variables shall apply:

(1) change in the equipment from that used for qualification

(2) change from mechanical weld path control to electronic weld path control

(e) Welding operators qualified under these provisions shall be qualified to weld components of like geometry in sizes larger or smaller than the test coupon.

(f) This Case number shall be shown on the Manufacturer's Data Report and the Welding Operator Performance Qualification Record.

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**Case 2758**  
**SA-240/SA-240M, UNS S43035 Plate**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions may ferritic stainless steel UNS S43035 plate conforming to SA-240/SA-240M Type 439 be used in welded construction under the rules of Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that ferritic stainless steel UNS S43035 plate material conforming to SA-240/SA-240M Type 439 may be used in construction of welded pressure vessels under the rules of Section VIII, Division 1, Part UHA, provided the following additional requirements are met:

(a) The Maximum Allowable Stresses and Notes shall be those shown for 18Cr-Ti, seamless tube, SA-268, UNS S43035 material in Section II, Part D, Table 1A.

(b) The maximum use temperature is 600°F (316°C).

(c) For external pressure design, Figure CS-2 of Section II, Part D shall be used.

(d) This material shall be considered P-No. 7, Group No. 2, as shown in Section IX, Table QW/QB-422 and Non-mandatory Appendix D.

(e) Postweld heat treatment is not required if the following requirements are met:

(1) The plate thickness at welded joint does not exceed  $\frac{3}{8}$  in. (10 mm).

(2) For thicknesses over  $\frac{3}{8}$  in. (10 mm) to 1.5 in. (38 mm), a preheat of 450°F (230°C) is maintained during welding, and the joints are completely radiographed.

(f) Impact testing requirements for ferritic stainless steels in UHA-51 shall apply.

(g) This Case number shall be shown on the Manufacturer's Data Report.

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**Case 2759**  
**Use of SA-705/SA-705M, XM-12, Condition H1025 for**  
**Yoke-Supported End Plugs**  
**Section VIII, Division 3**

*Inquiry:* May SA-705/SA-705M, XM-12, condition H1025 material be used for yoke supported end plugs in Section VIII, Division 3 construction?

*Reply:* It is the opinion of the Committee that SA-705/SA-705M, XM-12, condition H1025 material may be used for yoke-supported end plugs in Section VIII, Division 3 construction, provided the following additional requirements are met:

(a) The material shall be in hydrostatic compression during all loading cycles. Hydrostatic compression is assumed to exist if the sum of the three principal stresses is negative (compressive) at all locations within the component.

(b) The material shall have maximum measured yield strength not in excess of 25 ksi (170 MPa) above the specified minimum value.

(c) This Case number shall be shown on the Manufacturer's Data Report.

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**Case 2760**  
**Attaching Tubes to Tubesheets Using Laser Beam**  
**Welding Without Full Penetration**  
**Section IV**

*Inquiry:* Under what conditions may tubes exposed to primary furnace gases be attached using laser beam welding (LBW) to a tubesheet that has tube holes that are neither beveled nor recessed and extend through the tubesheet less than the distance required by Table HW-713?

*Reply:* It is the opinion of the Committee that tubes exposed to primary furnace gases may be attached using laser beam welding (LBW) to a tubesheet that has tube holes that are neither beveled nor recessed and extend through the tubesheet less than the distance required by Table HW-713, provided the following requirements are met:

(a) Each tube shall pass through the tubesheet, and its end shall be at least flush with the tubesheet surface to be welded.

(b) Welding procedure and performance qualification shall be conducted in accordance with Section IX, QW-193. The variables of QW-264 shall apply in addition to those of QW-288. The minimum depth of penetration of the weld shall be 1.25 times the thickness of the tube.

(c) The ability of the welding equipment to achieve the correct penetration shall be verified weekly for each LBW unit. This verification shall be done by sectioning and measuring the depth of penetration of at least one mock-up of a typical production joint.

(d) All other requirements of Section IV shall be met.

(e) This Case number shall be shown on the Manufacturer's Data Report.

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**Case 2761-1**  
**Use of UNS S32205 Ferritic/Austenitic Stainless Steel<sup>1,2,</sup>**  
**<sup>3</sup> Plate, Pipe, and Tube**  
**Section IV**

*Inquiry:* Under what conditions may UNS S32205 ferritic/austenitic stainless steel in SA-240 plate, SA-790 pipe, and SA-789 tube specifications be used in the construction of Section IV hot water heating boilers?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used in the welded construction of Section IV hot water heating boilers, provided the following requirements are met:

(a) The allowable stress for plate, seamless pipe, and seamless tube in accordance with SA-240, SA-789, and SA-790 shall be as listed in Tables 1 and 1M.

(b) The allowable stress for welded pipe and tube in accordance with SA-789 and SA-790 shall be as listed in Tables 2 and 2M.

(c) Welding procedure and performance qualification shall be conducted in accordance with Section IX.

(d) For external pressure, Section II, Part D, Figure HA-5 shall be used.

(e) The maximum design temperature shall be 500°F (260°C).

(f) All other requirements of Section IV shall be met.

(g) This Case number shall be shown on the Manufacturer's Data Report.

<sup>1</sup> This steel may be expected to develop embrittlement after service at moderately elevated temperatures; see Section II, Part D, Nonmandatory Appendix A, A-207 and A-208.

<sup>2</sup> This material may utilize the minimum thickness exceptions of HF-301.1(c) to pressures of 160 psig (1 100 kPa).

<sup>3</sup> Tubing may utilize the thickness requirements of HF-204.3.

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**Table 1**  
**Maximum Allowable Stress Values for SA-240 Plate, Seamless SA-789 Tube, and Seamless SA-790 Pipe**

For Metal Temperatures Not Exceeding, °F	Maximum Allowable Stress Values, ksi
100	19.0
200	19.0
300	18.3
400	17.6
500	17.2

**Table 2M**  
**Maximum Allowable Stress Values for Welded SA-789 Tube, and Welded SA-790 Pipe**

For Metal Temperatures Not Exceeding, °C	Maximum Allowable Stress Values, MPa [Note (1)]
40	111
100	111
150	107
200	104
250	101
275	100 [Note (2)]

**Table 1M**  
**Maximum Allowable Stress Values for SA-240 Plate, Seamless SA-789 Tube, and Seamless SA-790 Pipe**

For Metal Temperatures Not Exceeding, °C	Maximum Allowable Stress Values, MPa
40	131
100	131
150	126
200	122
250	119
275	118 [Note (1)]

NOTE:  
(1) The maximum use temperature shall be 260°C. Datum for 275°C is provided for interpolation purposes.

NOTES:  
(1) For welded pipe and tube, the allowable stress values have been multiplied by a factor of 0.85.  
(2) The maximum use temperature shall be 260°C. Datum for 275°C is provided for interpolation purposes.

**Table 2**  
**Maximum Allowable Stress Values for Welded SA-789 Tube, and Welded SA-790 Pipe**

For Metal Temperatures Not Exceeding, °F	Maximum Allowable Stress Values, ksi [Note (1)]
100	16.2
200	16.2
300	15.6
400	15.0
500	14.6

NOTE:  
(1) For welded pipe and tube, the allowable stress values have been multiplied by a factor of 0.85.

Approval Date: April 15, 2013

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2763**  
**Alloy SUS 430J1L/JIS G 4305:2005 Plates for Part HF**  
**Section IV**

*Inquiry:* Under what conditions may Alloy SUS 430J1L meeting the material requirements of JIS G 4305:2005 be used in the construction of heating boilers per Section IV, Part HF?

*Reply:* It is the opinion of the Committee that SUS 430J1L meeting the material requirements of JIS G 4305:2005 [see General Note (b) of Table 1] may be used in the construction of heating boilers under Section IV Part HF, provided the following requirements are met:

(a) The allowable stress values for the plates in accordance with Alloy SUS 430J1L shall be as listed in [Tables 1 and 1M](#).

(b) The minimum tensile strength shall be 56.5 ksi (390 MPa).

(c) The minimum yield strength shall be 29.5 ksi (205 MPa).

(d) For the purpose of welding procedure and performance qualifications, this material shall be considered P-No. 7, Group 2.

(e) For external pressure, Figure CS-2 of Section II, Part D shall be used.

(f) The maximum design temperature shall be 500°F (260°C).

(g) The water temperature shall not exceed 250°F (125°C).

(h) The maximum allowable working pressure shall not exceed 30 psi (205 kPa).

(i) All other requirements of Section IV shall be met.

(j) This Case number shall be shown on the Manufacturer's Data Report.

**Table 1**  
**Maximum Allowable Stress Values for**  
**JIS G 4305:2005 Gr. SUS 430J1L**

For Metal Temperatures Not Exceeding, °F	Maximum Allowable Stress Values, ksi
100	11.3
150	11.3
200	11.2
250	11.1
300	11.0
400	10.7
500	10.4

## GENERAL NOTES:

- (a) This material may utilize the minimum thickness exemption as shown in HF-301.1 (c).  
 (b) See Nonmandatory Appendix A in order to obtain an English copy of the specification.

**Table 1M**  
**Maximum Allowable Stress Values for**  
**JIS G 4305:2005 Gr. SUS 430J1L**

For Metal Temperatures Not Exceeding, °C	Maximum Allowable Stress Values, MPa
40	78.0
65	77.9
100	77.2
150	75.7
200	73.9
225	73.0
250	72.1
275 [Note (1)]	71.2

## GENERAL NOTES:

- (a) This material may utilize the minimum thickness exemption as shown in HF-301.1 (c).  
 (b) See Nonmandatory Appendix A in order to obtain an English copy of the specification.

## NOTE:

- (1) The maximum use temperature shall be 260°C. Datum for 275°C temperature is provided for interpolation purposes.

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**Case 2764-1**  
**Use of SA-240/SA-240M Types 304L, 316Ti, 316L, 439 (UNS S43035), and UNS S43932 to Construct Water Heating Boilers for a Maximum Pressure of 160 psi (1 100 kPa)**  
**Section IV**

*Inquiry:* Is it permissible to construct hot water heating boilers using SA-240/SA-240M Types 304L, 316Ti, 316L, 439 (UNS S43035), and UNS S43932 under the thickness exceptions of HF-301 but without the 80 psi (550 kPa) working pressure limitation of HF-301.1(c)(1)?

*Reply:* It is the opinion of the Committee that it is permissible to construct closed system, hot water heating boilers in accordance with the thickness exceptions in Section IV, Part HF, HF-301 for use at a maximum pressure of 160 psi (1 100 kPa). This Case number shall be indicated on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: April 15, 2013

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2765**  
**Alloy SUS 430J1L/JIS G 4305:2005 Plates for Part HLW**  
**Section IV**

*Inquiry:* Under what conditions may Alloy SUS 430J1L meeting the material requirements of JIS G 4305:2005 be used in the construction of water heaters per Section IV, Part HLW?

*Reply:* It is the opinion of the Committee that SUS 430J1L meeting the material requirements of JIS G 4305:2005 (see Table 1, General Note) may be used in the construction of water heaters, Section IV, Part HLW provided the following requirements are met:

(a) The allowable stress values for the plates in accordance with Alloy SUS 430J1L shall be as listed in [Tables 1](#) and [1M](#).

(b) The minimum tensile strength shall be 56.5 ksi (390 MPa).

(c) The minimum yield strength shall be 29.5 ksi (205 MPa).

(d) For the purpose of welding procedure and performance qualifications, this material shall be considered P-No. 7, Group 2.

(e) For external pressure, Figure CS-2 of Section II, Part D shall be used.

(f) The maximum design temperature shall be 500°F (260°C).

(g) The water temperature shall not exceed 210°F (99°C).

(h) The maximum allowable working pressure shall not exceed 30 psi (205 kPa).

(i) All other requirements of Section IV shall be met.

(j) This Case number shall be shown on the Manufacturer's Data Report.

**Table 1**  
**Maximum Allowable Stress Values for**  
**JIS G 4305:2005 Gr. SUS 430J1L**

For Metal Temperatures Not Exceeding, °F	Maximum Allowable Stress Values, ksi
100	14.1
150	14.1
200	14.0
250	13.9
300	13.7
400	13.4
500	13.0

GENERAL NOTE: See Nonmandatory Appendix A in order to obtain an English copy of the specification.

**Table 1M**  
**Maximum Allowable Stress Values for**  
**JIS G 4305:2005 Gr. SUS 430J1L**

For Metal Temperatures Not Exceeding, °F	Maximum Allowable Stress Values, ksi
40	97.5
65	97.4
100	96.5
150	94.6
200	92.4
225	91.3
250	90.2
275 [Note (1)]	89.1

GENERAL NOTE: See Nonmandatory Appendix A in order to obtain an English copy of the specification

NOTE:

(1) The maximum use temperature shall be 260°C. Datum for 275°C temperature is provided for interpolation purposes

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**Case 2766**  
**Determination of MAWP for Plate Heat Exchangers**  
**Section VIII, Division 1; Section VIII, Division 2**

*Inquiry:* May the MAWP of plate heat exchangers that contain gasketed plate packs (heat transfer plate packs having gaskets between each heat transfer plate or between each welded pair of heat transfer plates) be determined without performing proof testing or design calculations for the gasketed plate pack?

*Reply:* It is the opinion of the Committee that the MAWP of plate heat exchangers that contain gasketed plate packs may be determined without performing proof testing or design calculations for the gasketed plate pack, provided the following requirements are met:

(a) The MAWP for the plate heat exchanger shall be determined considering all other pressure retaining parts, including the end plates, bolting, and nozzles.

(b) The minimum nominal thickness of single or the combined thickness of double-wall heat transfer plates shall be 0.014 in. (0.35 mm).

(c) The Manufacturer's model number, heat transfer plate material specification, including grade, type, or class as applicable, plate quantity, and nominal thickness shall be shown on the Manufacturer's Data Report. The plate material specification shall comply with UG-4.

(d) The heat exchanger shall not contain a "lethal" substance.

(e) This Code Case shall not be applied to plate heat exchangers containing fully welded or brazed plate packs.

(f) This Case number shall be shown on the Manufacturer's Data Report

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**Case 2767**  
**Use of Welded UNS N02200, N02201, and N04400 Alloy**  
**Pipe and Tube**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions is it permissible in welded construction conforming to the rules of Section VIII, Division 1 to use welded UNS N02200, N02201, or N04400 alloy pipe or tube conforming to the requirements of ASTM B725-05(2009) or ASTM B730-08, as applicable?

*Reply:* It is the opinion of the Committee that the materials described in the Inquiry may be used in Section VIII, Division 1 construction, provided the following requirements are met:

(a) The maximum allowable design stress for UNS N02200 pipe or tube shall be 85% of the stresses shown in Section II, Part D, Table 1B for annealed SB-162 UNS N02200 plate, sheet, and strip.

(b) The maximum allowable design stress for UNS N02201 pipe or tube shall be 85% of the stresses shown in Section II, Part D, Table 1B for annealed SB-162 UNS N02201 plate, sheet, and strip.

(c) The maximum allowable design stress for UNS N04400 pipe or tube shall be 85% of the stresses shown in Section II, Part D, Table 1B for annealed SB-127 UNS N04400 plate.

(d) For external pressure design, use Figure NFN-2 of Section II, Part D for UNS N02200; use Figure NFN-1 of Section II, Part D for UNS N02201; use Figure NFN-3 of Section II, Part D for UNS N04400.

(e) UNS N02200 and N02201 materials shall be considered P-No. 41.

(f) UNS N04400 material shall be considered P-No. 42.

(g) Heat treatment after welding is neither required nor prohibited.

(h) This Case number shall be included in the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2768**  
**Allowing the Use of SB-543 Alloy UNS C70600 Tube**  
**Section IV**

*Inquiry:* Under what conditions may alloy UNS C70600 copper-nickel tube in the W061 welded and annealed temper meeting the material specification SB-543 be used in the construction of water heaters per Part HLW?

*Reply:* It is the opinion of the Committee that alloy UNS C70600 copper-nickel tube in the W061 welded and annealed temper meeting the material specification SB-543 may be used in the construction of water heaters per Part HLW, provided the following requirements are met:

(a) The maximum allowable stress values shall be 0.85 times those for SB-111 UNS C70600 temper O61 as listed in Section IV, Table HF-300.2 and Table HF-300.2M.

(b) Procedure and performance qualifications to be in accordance with Section IX.

(c) For external pressure, Figure NFC-3 of Section II, Part D shall be used.

(d) The water temperature shall not exceed 210°F (99°C).

(e) Physical properties shall be those listed for UNS C70600 in Section II, Part D, Table TE-3, Table TM-3, and Table PRD.

(f) All other requirements of Section IV shall be met.

(g) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: December 18, 2017

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2769-1**  
**Use of SA-240 Types 316Ti, 316L, 439 (UNS S43035), and**  
**UNS S43932 to Construct Water Heating Boilers With**  
**Cylindrical Parts Larger Than 38 in. (950 mm) Outside**  
**Diameter**  
**Section IV**

*Inquiry:* Is it permissible to construct closed system, hot water heating boilers using SA-240 Types 316Ti, 316L, 439 (UNS S43035), and UNS S43932 under the thickness

exceptions of HF-301(c) but without the 38 in. (950 mm) maximum diameter limit of HF-301.1(c)(2) or the pressure limit of HF-301.1(c)(1)?

*Reply:* It is the opinion of the Committee that it is permissible to construct closed system, hot water heating boilers in accordance with the thickness exceptions in HF-301 with cylindrical parts larger than 38 in. (950 mm) outside diameter and pressures up to 160 psi (1 100 kPa). This Case number shall be indicated on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: May 13, 2013

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2770**  
**Grade 91 Steel, 9%Cr-1%Mo (UNS K90901)**  
**Section I**

*Inquiry:* May austenitized and tempered UNS K90901 material that meets the specification requirements of ASTM A989/A989M-11 for hot isostatically-pressed alloy steel powder metallurgy parts for high temperature service be used for Section I components for welded construction?

*Reply:* It is the opinion of the Committee that austenitized and tempered UNS K90901 material conforming to ASTM A989/A989M-11 for hot isostatically-pressed alloy steel powder metallurgy parts may be used for Section I welded construction, provided the following additional requirements are met:

(a) For purposes of welding procedure and performance qualification, this material shall be considered P-No. 15E.

(b) The material shall be austenitized within the temperature range of 1,900°F to 1,975°F (1040°C to 1080°C), followed by air or accelerated cooling, and tempered within the range of 1,350°F to 1,470°F (730°C to 800°C).

(c) The maximum allowable stress values for the material shall be those given in Tables 1 and 1M.

(d) The maximum use temperature is 1,200°F (649°C).

(e) The maximum allowable powder size is 0.019 in. (0.5 mm), and the powder shall be produced by the gas atomization process.

(f) Following atomization, powders shall be stored under a positive nitrogen or argon atmosphere to minimize potential oxidation or contamination.

(g) In addition to a chemical composition analysis of the final blend powder, an analysis of a sample (component or compact) from each lot of parts shall be required.

(h) The material shall be examined using either the magnetic particle or liquid penetrant inspection method per ASTM A989/A989 M-11, Supplementary Requirement S4 or S5.

(i) Weld repairs to the material shall be made with one of the following welding processes and consumables:

(1) SMAW, SFA-5.5/SFA-5.5M E90XX-B9

(2) SAW, SFA-5.23/SFA-5.23M EB9 + neutral flux

(3) GTAW, SFA-5.28/SFA-5.28M ER90S-B9

(4) FCAW, SFA-5.29/SFA-5.29M E91T1-B9

In addition, the Ni + Mn content of all welding consumables shall not exceed 1.0%.

(j) Weld repairs to the material as a part of manufacture shall be made with welding procedures and welders qualified in accordance with Section IX.

(k) Repair by welding shall not exceed 10% of the part surface area and  $3\frac{1}{3}\%$  of wall thickness of the finished part or  $\frac{3}{4}$  in. (19 mm), whichever is less, without prior approval of the purchaser.

(l) If during the manufacturing any portion of the component is heated to a temperature greater than 1,470°F (800°C), then the component shall be reaustenitized and retempered in its entirety in accordance with (b).

(m) Yield strength, tensile strength, external pressure, and physical properties used shall be the same as found in SA-335 for Grade 91.

(n) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi
-20 to 100	24.3
200	24.3
300	24.3
400	24.2
500	24.1
600	23.7
650	23.4
700	22.9
750	22.2
800	21.3
850	20.3
900	19.1
950	17.8
1,000	16.3
1,050	14.0 [Note (1)]
1,100	10.3 [Note (1)]
1,150	7.0 [Note (1)]
1,200	4.3 [Note (1)]

## NOTE:

(1) These stress values are obtained from time dependent properties.

**Table 1M**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Values, MPa
-30 to 40	168
65	168
100	168
125	168
150	168
200	167
250	166
300	164
325	163
350	161
375	157
400	153
425	147
450	141
475	134
500	126
525	117
550	107
575	88.5 [Note (1)]
600	65.0 [Note (1)]
625	45.5 [Note (1)]
650	28.9 [Note (1)][Note (2)]

## NOTES:

(1) These stress values are obtained from time dependent properties.

(2) The maximum use temperature shall be 649°C. Datum for 650°C temperature is provided for interpolation purposes.

Approval Date: June 18, 2013

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2771**  
**SA-738/SA-738M, Grade E Steel Plates**  
**Section VIII, Division 3**

*Inquiry:* Is it permissible to use quenched and tempered SA-738/SA-738M Grade E steel plate in construction of welded pressure vessels conforming to the rules of Section VIII, Division 3?

*Reply:* It is the opinion of the Committee that quenched and tempered steel plate conforming to SA-738/SA-738M, Grade E may be used in the construction of welded pressure vessels conforming to the rules of Section VIII, Division 3, provided the following additional requirements are met:

(a) The maximum thickness of the plate shall be 2 in. (50 mm).

(b) The maximum thickness at welded joints shall not exceed 1¼ in. (32 mm).

(c) The vessel components shall not be used for pressure parts subject to direct firing.

(d) The yield and tensile strength values shall be those shown in Tables 1 and 2, respectively, of this Case.

(e) The reduction of area for the base plate in tensile tests shall be at least 45%.

(f) The physical properties are the same as those for SA-738/SA-738M Grade B.

(g) Except for cutting and welding, heating of the material above 1,100°F (593°C) during fabrication is not permitted. Postweld heat treatment of the material is not required.

(h) Welding procedures and performance qualifications shall be conducted in accordance with Section IX. Separate welding procedure qualifications are required for this material. For performance qualifications this material shall be considered as P-No. 1.

(i) Welding by electroslag or electrogas processes is not permitted.

(j) Materials certification shall be in accordance with KM-101.

(k) This Case number shall be shown on the Manufacturer's Data Report.

**Table 1**  
**Values of Yield Strength**

Specification, Grade	Yield Strength, ksi (MPa), for Metal Temperature of 100°F (40°C)	Yield Strength, ksi (MPa), for Metal Temperature of 150°F (65°C)
SA-738, Grade E	75 (515)	75 (515)

**Table 2**  
**Values of Tensile Strength**

Specification, Grade	Tensile Strength, ksi (MPa), for Metal Temperature of 100°F (40°C)	Tensile Strength, ksi (MPa), for Metal Temperature of 150°F (65°C)
SA-738, Grade E	90 (620)	90 (620)

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Approval Date: June 18, 2013

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**Case 2772**  
**Exceptions to Requirements of Figure UW-13.2,**  
**Sketches (m) and (n)**  
**Section VIII, Division 1**

*Inquiry:* May the  $a$ ,  $b$ , and  $c$  dimensions in Figure UW-13.2, sketches (m) and (n) for flanges calculated as integral type in accordance with Mandatory Appendix 2 be based on the required nozzle thickness rather than the nominal nozzle thickness?

*Reply:* It is the opinion of the Committee that the  $a$ ,  $b$ , and  $c$  dimensions in Figure UW-13.2, sketches (m) and (n) for flanges calculated as integral type in accordance with Mandatory Appendix 2 may be based on the required nozzle thickness rather than the nominal nozzle thickness, provided the following additional requirements are met:

(a) The  $a$  dimension in Figure UW-13.2, sketches (m) and (n) shall not be less than the nominal nozzle thickness,  $t_n$ , plus  $\frac{1}{4}$  in.

(b) The required nozzle thickness,  $t_{r\ n2}$ , shall be used in the calculations in Mandatory Appendix 2 in place of the nominal nozzle thickness,  $t_n$ . The required nozzle thickness,  $t_{r\ n2}$ , shall be equal to or greater than the minimum neck thickness required for internal and external pressure using UG-27 and UG-28 (plus corrosion allowance), as applicable. The effects of external forces and moments from supplemental loads (UG-22) shall be considered (see Figure 1).

(c) The  $g_1$  dimension used in the calculations in Mandatory Appendix 2 shall be equal to 3 times the required thickness,  $3t_{r\ n2}$ .

(d) The  $g_0$  dimension used in the calculations in Mandatory Appendix 2 shall be equal to the required thickness,  $t_{r\ n2}$ .

(e) The  $h$  dimension used in the calculations in Mandatory Appendix 2 shall be equal to  $g_1$  from (c) minus  $g_0$  from (d).

(f) The results of the calculations using the dimensions described in (b), (c), (d), and (e) shall meet all requirements of Section VIII, Division 1, including those in Mandatory Appendix 2, considering all applicable loads.

(g) Additional calculations shall be performed using the nominal nozzle thickness,  $t_n$  but with the  $g_1$  dimension set to the same value as in (c).

(h) The  $g_0$  dimension used in the additional calculations described in (g) shall be equal to the nominal nozzle thickness,  $t_n$ .

(i) The  $h$  dimension used in the additional calculations described in (g) shall be equal to  $g_1$  from (g) minus  $g_0$  from (h).

(j) The results of the calculations using the dimensions described in (g), (h), and (i) shall meet all requirements of Section VIII, Division 1, including those in Mandatory Appendix 2, considering all applicable loads.

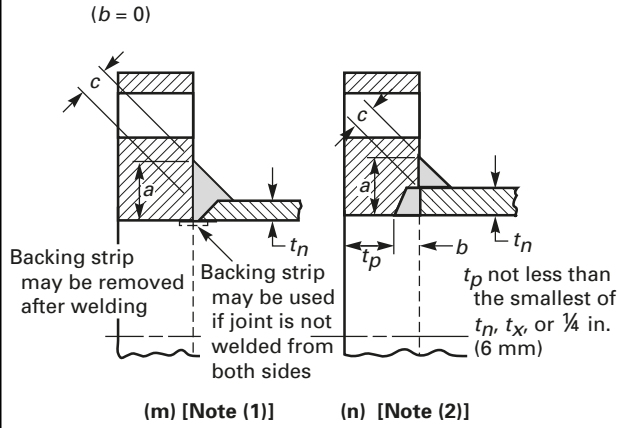
(k) The longitudinal hub stress,  $S_H$ , calculated in accordance with (g) through (i) using the nominal nozzle thickness shall be less than the longitudinal hub stress,  $S_H$ , calculated using the required nozzle thickness in accordance with (b) through (e).

(l) The nominal nozzle thickness,  $t_n$ , shall not be less than the required nozzle thickness,  $t_{r\ n2}$ .

(m) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Figure 1**  
**Typical Bolted Flange Connections**



GENERAL NOTES:

- (a)  $c$ ,  $t_n$ , and  $t_x$  are as defined in 2-3 of Section VIII, Division 1.
- (b)  $t_{r\ n2}$  is as defined in (b) of this Case.

NOTES:

- (1)  $a \geq 3t_{r\ n2}$  and  $\geq t_n + \frac{1}{4}$  in. (6 mm);  $c \geq$  lesser of  $t_{r\ n2}$  or  $t_x$
- (2)  $a + b \geq 3t_{r\ n2}$  and  $\geq t_n + \frac{1}{4}$  in. (6 mm);  $c \geq$  lesser of  $t_{r\ n2}$  or  $t_x$

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Approval Date: August 27, 2013

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2773**  
**Use of Sand Cast Aluminum Alloy EN AC-43000,**  
**AlSi10Mg(a), F Temper**  
**Section IV**

*Inquiry:* Under what conditions may aluminum alloy EN AC-43000, AlSi10Mg(a), F temper, sand castings meeting the requirements of Part HA, used in the construction of heating boilers be exempt from the radii requirements of HA-303?

*Reply:* It is the opinion of the Committee that aluminum alloy EN AC-43000, AlSi10Mg(a), F temper, sand castings used in the construction of heating boilers may be exempt from the radii requirements of HA-303 under the following conditions:

- (a) The material is limited to EN AC-43000, AlSi10Mg(a).
- (b) All other applicable parts of Section IV shall apply.
- (c) This Case number shall be shown on the H-5A Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: September 18, 2013

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2774**  
**Waiver of Weld Joint Examination for Pneumatically Tested Brazed Plate-Type Heat Exchangers That Have Been Previously Hydrostatically Tested**  
**Section VIII, Division 1**

*Inquiry:* When an aluminum-brazed plate-type heat exchanger has been hydrostatically tested at a test pressure in accordance with UG-99, and it will be subsequently pneumatically tested in accordance with UG-100, under what circumstances may the weld joint examination requirements of UW-50 be waived?

*Reply:* It is the opinion of the Committee that when an aluminum-brazed plate-type heat exchanger has been hydrostatically tested at a test pressure in accordance with

UG-99, the weld joint examination requirements of UW-50 prior to pneumatic testing in accordance with UG-100 may be waived, provided all welds that were made after the hydrostatic test have been examined in accordance with UW-50 prior to applying the pneumatic test.

A record of the hydrostatic test shall be documented in the Manufacturer's assembly process control records in such a manner that any welds made after testing can be readily identified; witnessing of the hydrostatic test by the Authorized Inspector is not required.

This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: September 18, 2013

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2775**  
**Use of 57Ni-22Cr-14W-2Mo-La (UNS N06230),**  
**Solution-Annealed Bolting Materials for Pressure**  
**Vessels**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions may 57Ni-22Cr-14W-2Mo-La (UNS N06230), solution-annealed rod, and forging material, conforming to the requirements of SB-564 and SB-572 be used as bolting material in the manufacture of Section VIII, Division 1 pressure vessels?

*Reply:* It is the opinion of the Committee that 57Ni-22Cr-14W-2Mo-La (UNS N06230), solution-annealed rod, and forging material, conforming to the requirements

of SB-564 and SB-572 may be used as bolting material in the manufacture of Section VIII, Division 1 pressure vessels, provided the following requirements are met:

(a) The design temperature shall not exceed 1,650°F (899°C).

(b) The maximum allowable stress values shall be those listed in [Tables 1](#) and [1M](#).

(c) The applicable rules of Section VIII, Division 1, Part UNF for nickel alloys shall be met.

(d) Welding is not permitted.

(e) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.



Approval Date: September 18, 2013

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2776**  
**Use of 52Ni-22Cr-13Co-9Mo (UNS N06617), Annealed**  
**Bolting Materials for Pressure Vessels**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions may 52Ni-22Cr-13Co-9Mo (UNS N06617), annealed rod, bar, and forging material, conforming to the requirements of SB-166 and SB-564 be used as bolting material in the manufacture of Section VIII, Division 1 pressure vessels?

*Reply:* It is the opinion of the Committee that 52Ni-22Cr-13Co-9Mo (UNS N06617), annealed rod, bar, and forging material, conforming to the requirements of

SB-166 and SB-564 may be used as bolting material in the manufacture of Section VIII, Division 1 pressure vessels, provided the following requirements are met:

(a) The design temperature shall not exceed 1,650°F (899°C).

(b) The maximum allowable stress values shall be those listed in [Tables 1](#) and [1M](#).

(c) The applicable rules of Section VIII, Division 1, Part UNF for nickel alloys shall be met.

(d) Welding is not permitted.

(e) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1  
Maximum Allowable Stress Values**

For Metal Temperatures Not Exceeding, °F	Maximum Allowable Stress Values, ksi
100	23.3
200	20.8
300	19.2
400	18.1
500	17.2
600	16.6
650	16.4
700	16.2
750	16.0
800	15.9
850	15.8
900	15.7
950	15.6
1,000	15.5
1,050	15.4
1,100	15.4
1,150	15.3
1,200	15.3
1,250	14.5 [Note (1)]
1,300	11.2 [Note (1)]
1,350	8.7 [Note (1)]
1,400	6.6 [Note (1)]
1,450	5.1 [Note (1)]
1,500	3.9 [Note (1)]
1,550	3.0 [Note (1)]
1,600	2.3 [Note (1)]
1,650	1.8 [Note (1)]

NOTE:

(1) These values are obtained from time-dependent properties.

**Table 1M  
Maximum Allowable Stress Values**

For Metal Temperatures Not Exceeding, °C	Maximum Allowable Stress Values, MPa
40	161
65	152
100	142
125	136
150	132
175	129
200	125
225	122
250	120
275	117
300	115
325	114
350	113
375	111
400	110
425	110
450	109
475	108
500	108
525	107
550	106
575	106
600	106
625	105
650	105
675	101 [Note (1)]
700	81.0 [Note (1)]
725	64.1 [Note (1)]
750	50.4 [Note (1)]
775	39.5 [Note (1)]
800	31.3 [Note (1)]
825	24.6 [Note (1)]
850	19.4 [Note (1)]
875	15.3 [Note (1)]
900 [Note (2)]	12.3 [Note (1)]

NOTES:

(1) These values are obtained from time-dependent properties.

(2) The maximum use temperature is 899°C, and the value at 900°C shall be used for interpolation purposes only.

Approval Date: September 30, 2018

(19)

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2777-1**  
**Use of Resistance Longitudinal Butt Welds for Cylinders**  
**Section VIII, Division 1; Section VIII, Division 2; Section IX**

*Inquiry:* Under what conditions may resistance longitudinal butt welds for cylinders be qualified in accordance with Section IX?

*Reply:* It is the opinion of the Committee that resistance longitudinal butt welds for cylinders may be qualified in accordance with Section IX, provided the following conditions are met:

*(a) Welding Procedure Specification (WPS) Qualification*

*(1)* The base material shall be P-No. 1 with a thickness of 0.054 in. (1.4 mm) minimum to 0.075 in. (1.9 mm) maximum.

*(2)* The welding procedure shall be qualified by preparing a longitudinal butt weld test coupon, observing and recording the values for the essential and nonessential variables from [Table 1](#).

*(3)* The completed test coupon shall be subjected to the mechanical tests required by QW-451.1.

*(4)* The welded test coupon may be flattened prior to testing.

*(5)* As an alternative to QW-196, resistance welding shall be tested as butt joint weld.

*(6)* As an alternative to QW-196.2, resistance butt welds shall be tested in accordance with QW-150 and QW-160.

*(7)* As an alternative to QW-286, resistance butt welds shall be tested in accordance with QW-150 and QW-160.

*(8)* In addition to QW-402.1, a change from a butt weld joint to any other weld joint is not permitted.

*(9)* As an alternative to QW-409.15(a)(6), strip feed rate shall be used.

*(10)* When used for the construction of pressure vessel shells under the rules of Section VIII, Division 1 or 2, the longitudinal ERW weld shall be considered a Type 1 joint whose joint efficiency shall only be improved by a ultrasonic examination performed in accordance with Section VIII, Division 2, para. 7.5.5.

*(b)* As an alternative to QW-384, welder operator qualification for resistance butt welds shall be in accordance with QW-305 and QW-361.

*(c)* This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Resistance Welding Variables for Longitudinal Butt Joints for Cylinders**

Paragraph	Subparagraph	Brief of Variables	Essential	Non-Essential
QW-402	.1	Ø Butt joint	X	...
QW-403	.21	± Coating, plating	X	...
	.22	± T	X	...
QW-407	.1	Ø PWHT	X	...
QW-409	.15(a)(4)	Ø Pressure	X	...
	.15(a)(5)	Ø Current	X	...
	.15(a)(6)	Ø Current time	X	...
	.15(b)	Ø AC to DC	X	...
	.17	Ø Power supply	X	...
	.18	Tip cleaning	...	X
QW-410	.31	Ø Cleaning method	X	...
	.33	Ø Equipment	X	...
	.34	Ø Cooling medium	...	X

Approval Date: September 18, 2013

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2778**  
**Use of UNS S32205 Ferritic/Austenitic Stainless Steel Plate, Sheet, Strip, Pipe, and Tube in the Manufacture of Part HLW Water Heaters and Storage Tanks Section IV**

*Inquiry:* Under what conditions may UNS S32205 ferritic/austenitic stainless steel in SA-240 plate, sheet, strip, SA-790 pipe, and SA-789 tube specifications be used in the construction of unlined Section IV, Part HLW water heaters and storage tanks?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used in the welded construction of Section IV, Part HLW water heaters and storage tanks, provided the following requirements are met:

(a) The allowable stress for plate, seamless pipe, and seamless tube in accordance with SA-240, SA-789, and SA-790 shall be as listed in [Table 1](#) and [Table 1M](#).

(b) The allowable stress for welded pipe and tube in accordance with SA-789 and SA-790 shall be as listed in [Table 2](#) and [Table 2M](#).

(c) Welding procedure and performance qualification shall be conducted in accordance with Section IX.

(d) As an alternative to calculation using the listed stress values, the allowable working pressure of the water or storage tank may be established in accordance with the proof test provision of HLW-500.

(e) For external pressure, Figure HA-5 of Section II, Part D shall be used.

(f) The maximum design temperature shall be 500°F (260°C).

(g) All other requirements of Section IV shall be met.

(h) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values for SA-240 Plate, Sheet, Strip, Seamless SA-790 Pipe, and Seamless SA-789 Tube**

For Metal Temperatures Not Exceeding, °F	Maximum Allowable Stress Values, ksi
100	23.8
200	23.8
300	22.9
400	22.1
500	21.5

**Table 1M**  
**Maximum Allowable Stress Values for SA-240 Plate, Sheet, Strip, Seamless SA-790 Pipe, and Seamless SA-789 Tube**

For Metal Temperatures Not Exceeding, °C	Maximum Allowable Stress Values, MPa
40	164
100	164
150	158
200	152
250	149
275	148 [Note (1)]

NOTE:

(1) The maximum use temperature shall be 260°C. The value at 275°C temperature is provided for interpolation purposes.

**Table 2**  
**Maximum Allowable Stress Values for Welded SA-790 Pipe, and Welded SA-789 Tube**

For Metal Temperatures Not Exceeding, °F	Maximum Allowable Stress Values, ksi
100	20.2
200	20.2
300	19.5
400	18.7
500	18.3

GENERAL NOTE: For welded pipe tube, the allowable stress values have been multiplied by a factor of 0.85.

**Table 2M**  
**Maximum Allowable Stress Values for Welded SA-790 Pipe, and Welded SA-789 Tube**

For Metal Temperatures Not Exceeding, °C	Maximum Allowable Stress Values, MPa
40	139
100	139
150	134
200	130
250	127
275	126 [Note (1)]

GENERAL NOTE: For welded pipe tube, the allowable stress values have been multiplied by a factor of 0.85.

NOTE:

(1) The maximum use temperature shall be 260°C. The value at 275°C temperature is provided for interpolation purposes.

Approval Date: September 18, 2013

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2779**  
**SA/EN10028-2 Grades P235GH, P265GH, P295GH, and**  
**P355GH**  
**Section IV**

*Inquiry:* Under what conditions may Grades P235GH, P265GH, P295GH and P355GH meeting the material requirements of SA/EN10028-2 be used in the construction of heating boilers?

*Reply:* It is the opinion of the Committee that Grades P235GH, P265GH, P295GH and P355GH meeting the material requirements of SA/EN10028-2 may be used in the construction of heating boilers, Part HF, provided the following requirements are met:

(a) The allowable stress values for Grades P235GH, P265GH, P295GH, and P355GH shall be as listed in Table 1 and 1M.

(b) For the purpose of welding procedure and performance qualifications, Grades P235GH, P265GH, P295GH shall be considered P-No. 1, Group 1, and Grade P355GH shall be considered P-No. 1, Group 2.

(c) For external pressure, Section II, Part D, Figure CS-2 shall be used.

(d) The maximum design temperature shall be 500°F (260°C).

(e) The water temperature shall not exceed 250°F (125°C).

(f) All other requirements of Section IV shall be met.

(g) This Case number shall be shown on the Manufacturer's Data Report.

**Table 1**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding °F	Allowable Stress Values, ksi			
	Grade P235GH	Grade P265GH	Grade P295GH	Grade P355GH
-20 to 100	9.9	11.3	12.5	13.6
150	9.9	11.3	12.5	13.6
200	9.9	11.3	12.5	13.6
250	9.9	11.3	12.5	13.6
300	9.9	11.3	12.5	13.6
350	9.9	11.3	12.5	13.6
400	9.9	11.3	12.5	13.6
450	9.9	11.3	12.5	13.6
500	9.9	11.3	12.5	13.6

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1M**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding °C	Allowable Stress Values, MPa			
	Grade P235GH	Grade P265GH	Grade P295GH	Grade P355GH
-30 to 40	68.0	78.0	86.0	94.0
65	68.0	78.0	86.0	94.0
100	68.0	78.0	86.0	94.0
125	68.0	78.0	86.0	94.0
150	68.0	78.0	86.0	94.0
175	68.0	78.0	86.0	94.0
200	68.0	78.0	86.0	94.0
225	68.0	78.0	86.0	94.0
250	68.0	78.0	86.0	94.0
275 [Note (1)]	68.0	78.0	86.0	94.0

NOTE:

(1) The maximum allowable temperature is 260°C. The values 275°C may only be used for interpolation.

Approval Date: June 1, 2015

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2780-1**  
**24Cr-4Ni-3Mn-1.6Mo-0.27N, UNS S82441 Ferritic/  
Austenitic Steel, Alloy Plate, Sheet, and Strip; Bar;  
Seamless and Welded Tube; Seamless and Welded Pipe  
Section VIII, Division 1**

*Inquiry:* Under what conditions may UNS S82441 ferritic/austenitic stainless steel in accordance with A240/A240M-15, ASTM A479/A479M-14, ASTM A789/A789M-14, and ASTM A790/A790M-14a be used in Section VIII, Division 1 welded construction?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used in Section VIII, Division 1 welded construction, provided the following requirements are met:

(a) The physical properties for UNS S82441 are as follows:

- (1) mean linear thermal expansion coefficients, as given in Tables 1 and 1M
- (2) thermal conductivity, as given in Tables 2 and 2M
- (3) density: 0.277 lb/in.<sup>3</sup> (7700 kg/m<sup>3</sup>)
- (4) modulus of elasticity at 68°F (20°C): 29.7 × 10<sup>6</sup> psi (205 × 10<sup>3</sup> MPa)
- (5) Poisson's ratio: 0.3

(b) The yield strength and tensile strength values for use in design shall be as shown in Tables 3 and 3M and Tables 4 and 4M, respectively.

(c) The maximum allowable stress values for the material shall be those given in Tables 5 and 5M and Tables 6 and 6M. The maximum design temperature shall be 600°F (316°C).

(d) The allowable stress values in Tables 5, 5M, 6, and 6M shall be multiplied by 0.85 to determine the allowable stress values for welded tube and welded pipe.

(e) Welding procedure and performance qualifications shall be conducted in accordance with Section IX. This material shall be considered P-No. 10H, Group 1.

(f) Heat treatment after welding is neither required nor prohibited, but if it is performed it shall be an annealing heat treatment as required by the material specifications.

(g) For external pressure design, Figure HA-5 shall be used.

(h) The rules for austenitic/ferritic duplex stainless steels in Section VIII, Division 1, Subsection C, Part UHA shall apply.

(i) This Case number shall be shown on the Manufacturer's Data Report.

Table 1 Mean Linear Thermal Expansion Coefficients	
Temperature Range, °F	Coefficient
RT - 212	7.2 × 10 <sup>-6</sup>
RT - 392	7.5 × 10 <sup>-6</sup>
RT - 572	7.8 × 10 <sup>-6</sup>

Table 1M Mean Linear Thermal Expansion Coefficients	
Temperature Range, °C	Coefficient
RT - 100	13.0 × 10 <sup>-6</sup>
RT - 200	13.5 × 10 <sup>-6</sup>
RT - 300	14.0 × 10 <sup>-6</sup>

Table 2 Thermal Conductivity	
Temperature, °F	Btu/hr-ft-°F
RT (68)	8.4
212	9.2
392	10.4
572	12.1

Table 2M Thermal Conductivity	
Temperature, °C	W/m °C
RT (20)	14.5
100	16
200	18
300	21

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**Table 3**  
**Yield and Tensile Strength Values,  $\geq 0.4$  in.**  
**for ASTM A240/A240M, ASTM A789/A789M,**  
**and ASTM A790/A790M;  $\geq 7/16$  in. for A479/**  
**A479M**

For Metal		
Temperature Not Exceeding, °F	Yield Strength, ksi [Note (1)]	Tensile Strength, ksi [Note (2)]
75	69.5	98.6
100	63.3	98.6
200	53.0	92.9
300	48.6	89.6
400	45.3	87.9
500	44.1	87.9
600	44.1	87.9
650	44.0	87.9
700	39.7	85.4

NOTES:

- (1) The tabulated values of yield strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the yield strength values correspond to the yield strength trend curve adjusted to the minimum specified room temperature yield strength. The yield strength values do not correspond exactly to “minimum” or “average,” as those terms are applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 1 requires elevated temperature testing for yield strength of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated yield strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.
- (2) The tabulated values of tensile strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the tensile strength values tend toward an average or expected value, which may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. The tensile strength values do not correspond exactly to “average” as this term is applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 1 requires elevated temperature testing for tensile strength of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

**Table 3M**  
**Yield and Tensile Strength Values,  $\geq 10$  mm**  
**for ASTM A240/A240M, ASTM A789/A789M,**  
**and ASTM A790/A790M;  $\geq 11$  mm for A479/**  
**A479M**

For Metal		
Temperature Not Exceeding, °C	Yield Strength, MPa [Note (1)]	Tensile Strength, MPa [Note (2)]
21	480	680
40	432	680
65	392	665
100	361	637
125	347	626
150	335	617
175	323	611
200	314	607
225	307	606
250	304	606
275	304	606
300	304	606
325	304	606
350	300	606
375	267	582

NOTES:

- (1) The tabulated values of yield strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the yield strength values correspond to the yield strength trend curve adjusted to the minimum specified room temperature yield strength. The yield strength values do not correspond exactly to “minimum” or “average,” as those terms are applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 1 requires elevated temperature testing for yield strength of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated yield strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.
- (2) The tabulated values of tensile strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the tensile strength values tend toward an average or expected value, which may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. The tensile strength values do not correspond exactly to “average” as this term is applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 1 requires elevated temperature testing for tensile strength of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the

**Table 3M**  
**Yield and Tensile Strength Values, ≥ 10 mm for ASTM A240/A240M, ASTM A789/A789M, and ASTM A790/A790M; ≥ 11 mm for A479/A479M (Cont'd)**

NOTES (CONT'D):

typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

**Table 4**  
**Yield and Tensile Strength Values, < 0.4 in. for ASTM A240/A240M, ASTM A789/A789M, and ASTM A790/A790M; < 7/16 in. for A479/A479M**

For Metal Temperature Not Exceeding, °F	Yield Strength, ksi [Note (1)]	Tensile Strength, ksi [Note (2)]
75	78.3	107
100	71.2	107
200	69.7	101
300	54.7	97.5
400	51.0	95.7
500	49.6	95.7
600	49.6	95.7
650	49.6	95.7
700	44.7	93.0
750	32.2	80.9

NOTES:

(1) The tabulated values of yield strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the yield strength values correspond to the yield strength trend curve adjusted to the minimum specified room temperature yield strength. The yield strength values do not correspond exactly to "minimum" or "average," as those terms are applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 1 requires elevated temperature testing for yield strength of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated yield strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

(2) The tabulated values of tensile strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the tensile strength values tend toward an average or expected value, which may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. The tensile strength values do not correspond exactly to "average" as this term is applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 1 requires

**Table 4**  
**Yield and Tensile Strength Values, < 0.4 in. for ASTM A240/A240M, ASTM A789/A789M, and ASTM A790/A790M; < 7/16 in. for A479/A479M (Cont'd)**

NOTES (CONT'D):

elevated temperature testing for tensile strength of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

**Table 4M**  
**Yield and Tensile Strength Values, < 10 mm for ASTM A240/A240M, ASTM A789/A789M, and ASTM A790/A790M; < 11 mm for A479/A479M**

For Metal Temperature Not Exceeding, °C	Yield Strength, MPa [Note (1)]	Tensile Strength, MPa [Note (2)]
21	540	740
40	486	740
65	441	723
100	406	693
125	390	681
150	376	672
175	364	665
200	353	660
225	345	659
250	342	659
275	342	659
300	342	659
325	342	659
350	337	659
375	300	633
400	217	523

NOTES:

(1) The tabulated values of yield strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the yield strength values correspond to the yield strength trend curve adjusted to the minimum specified room temperature yield strength. The yield strength values do not correspond exactly to "minimum" or "average," as those terms are applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 1 requires elevated temperature testing for yield strength of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated yield strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the

**Table 4M**  
**Yield and Tensile Strength Values, < 10 mm for ASTM A240/A240M, ASTM A789/A789M, and ASTM A790/A790M; < 11 mm for A479/A479M (Cont'd)**

NOTES (CONT'D):

typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

- (2) The tabulated values of tensile strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the tensile strength values tend toward an average or expected value, which may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. The tensile strength values do not correspond exactly to "average" as this term is applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 1 requires elevated temperature testing for tensile strength of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

**Table 5**  
**Maximum Allowable Stress Values, for 70 ksi Y.S./99 ksi T.S.; ≥ 0.4 in. for ASTM A240/A240M, ASTM A789/A789M, and ASTM A790/A790M; ≥ 7/16 in. for ASTM A479/A479M**

For Metal Temperature Not Exceeding, °F		Stress, ksi
75		28.2
100		28.2
200		26.5
300		25.6
400		25.1
500		25.1
550		25.1
600		25.1

GENERAL NOTE: **PRECAUTIONARY NOTE:** This material may be expected to develop embrittlement after exposure at moderately elevated temperatures. See Section II, Part D, Nonmandatory Appendix A, A-207 and A-208.

**Table 5M**  
**Maximum Allowable Stress Values, for 480 MPa Y.S./680 MPa T.S.; ≥ 10 mm for ASTM A240/A240M, ASTM A789/A789M, and ASTM A790/A790M; ≥ 11 mm for ASTM A479/A479M**

For Metal Temperature Not Exceeding, °C		Stress, MPa
21		194
40		184
65		184
100		182
125		179
150		176
175		175
200		173
225		173
250		173
275		173
300		173
325	[Note (1)]	173

GENERAL NOTE: **PRECAUTIONARY NOTE:** This material may be expected to develop embrittlement after exposure at moderately elevated temperatures. See Section II, Part D, Nonmandatory Appendix A, A-207 and A-208.

NOTE:

- (1) The value at 325°C is for interpolation only. The maximum use temperature is 316°C.

**Table 6**  
**Maximum Allowable Stress Values, for 78**  
**ksi Y.S/107 ksi T.S.; < 0.4 in. for ASTM A240/**  
**A240M, ASTM A789/A789M, and ASTM**  
**A790/A790M; < 7/16 in. for ASTM A479/**  
**A479M**

For Metal Temperature Not Exceeding, °F		Stress, ksi
75		30.7
100		30.7
200		28.9
300		27.8
400		27.3
500		27.3
600		27.3

GENERAL NOTE: **PRECAUTIONARY NOTE:** This material may be expected to develop embrittlement after exposure at moderately elevated temperatures. See Section II, Part D, Nonmandatory Appendix A, A-207 and A-208.

**Table 6M**  
**Maximum Allowable Stress Values, for 540**  
**MPa Y.S/740 MPa T.S.; < 10 mm for ASTM**  
**A240/A240M, ASTM A789/A789M, and**  
**ASTM A790/A790M; < 11 mm for ASTM**  
**A479/A479M**

For Metal Temperature Not Exceeding, °C		Stress, MPa
21		211
40		211
65		207
100		198
125		194
150		192
175		190
200		189
225		188
250		188
275		188
300		188
325	[Note (1)]	188

GENERAL NOTE: **PRECAUTIONARY NOTE:** This material may be expected to develop embrittlement after exposure at moderately elevated temperatures. See Section II, Part D, Nonmandatory Appendix A, A-207 and A-208.

NOTE:

(1) The value at 325°C is for interpolation only. The maximum use temperature is 316°C.

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Approval Date: September 30, 2018

(19)

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**Case 2781-1**  
**12Cr-1.5W-1.6Co-B Material**  
**Section I**

*Inquiry:* May 12Cr-1.5W-1.6Co-B seamless tubes conforming to the chemical analysis shown in Table 1, the mechanical properties listed in Table 2, and otherwise conforming to the applicable requirements of SA-213/SA-213M be used for Section I construction?

*Reply:* It is the opinion of the Committee that normalized and tempered seamless 12Cr-1.5W-1.6Co-B tubes as described in the Inquiry may be used for Section I construction, provided the following requirements are met:

(a) The wall thickness of the tubes shall not be greater than 0.5 in. (12.7 mm).

(b) The material shall be austenitized within the temperature range 1,900°F to 1,975°F (1 040°C to 1 080°C) followed by air cooling and tempered within the range 1,400°F to 1,470°F (760°C to 800°C).

(c) The material in the final tempered condition shall not exceed a Brinell Hardness Number of 250 HBW (HRC 25).

(d) The maximum design temperature shall be 1,150°F (621°C).

(e) The maximum allowable stress values for the material shall be those given in Table 3 or Table 3M.

(f) Welding shall be limited to GTAW, GMAW, or SMAW. Separate weld procedure qualification shall apply for this material. For the purpose of performance qualification, the material shall be considered P-No 15F. The performance qualification shall be conducted as prescribed in Section IX.

(g) Exemptions to postweld heat treatment for this material shall be in accordance with the rules for P-No 15E materials in Table PW-39-5. When applicable, the postweld heat treatment shall be performed at 1,365°F to 1,435°F (740°C to 780°C) for a minimum of 1/2 hr.

(h) All cold formed material that is designed for service at a nominal temperature of 1,000°F (540°C) or higher shall be heat treated in accordance with the following rules. Cold bending or forming is defined as any method that produces strain in the material and is performed at a temperature below 1,200°F (650°C). The calculations of cold strains shall be made as described in PG-19.

(1) Heat treatments required by the following subparagraphs shall not be performed locally. The material shall be either heat treated in its entirety, or the cold-strained area (including the transition) shall be cut away from the balance of the tube or component and heat treated separately or replaced.

(2) For all cold swages, flares, and upsets regardless of the dimension and the amount of cold reduction, the material shall be re-austenitized and tempered in accordance with (b).

(3) For design temperatures exceeding 1,000°F (540°C) but less than or equal to 1,115°F (600°C), and cold-forming strains greater than 25%, the material shall be normalized and tempered in accordance with (b).

(4) For design temperatures exceeding 1,115°F (600°C), and cold-forming strains greater than 20%, the material shall be normalized and tempered in accordance with (b).

(5) For design temperatures exceeding 1,000°F (540°C) but less than or equal to 1,115°F (600°C), and cold-forming strains greater than 5% but less than or equal to 25%, the material shall be stress relieved at a temperature between 1,365°F and 1,435°F (740°C and 780°C), with a soaking time of minimum 1 hr, followed by cooling in air or normalized and tempered in accordance with (b).

(6) For design temperatures exceeding 1,115°F (600°C), and cold-forming strains greater than 5% but less than or equal to 20%, the material shall be stress relieved at a temperature between 1,365°F and 1,435°F (740°C and 780°C), with a soaking time of minimum 1 hr, followed by cooling in air or normalized and tempered in accordance with (b).

(i) All material formed at or above 1,200°F (650°C) shall be re-austenitized and tempered in accordance with (b). This heat treatment shall not be performed locally. The material shall be either heat treated in its entirety, or the hot-formed area (including the transition) shall be cut away from the balance of the tube or component and heat treated separately or replaced.

(j) Except as provided in (k), if during manufacturing any portion of the component is heated to a temperature greater than 1,470°F (800°C), then the component shall be re-austenitized and retempered in its entirety in accordance with (b), or the portion of the component heated

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above 1,470°F (800°C), including the heat-affected zone created by the local heating, shall be replaced or shall be removed, renormalized, and tempered and then replaced in the component.

(k) If the allowable stresses to be used are less than or equal to those provided in Section II, Part D, Table 1A for Grade 9 (SA-213 T9) at the design temperature, the requirements of (j) may be waived, provided that the portion of the component heated to a temperature greater than 1,470°F (800°C) is reheat treated within the temperature range 1,400°F to 1,470°F (760°C to 800°C).

(l)  $S_u$  and  $S_y$  values are listed in Table 4 or Table 4M and Table 5 or Table 5M, respectively.

(m) Physical properties are as follows: density: 0.282 lb/in.<sup>3</sup> (7 810kg/m<sup>3</sup>). See Table 6 or Table 6M, Physical Properties.

(n) External pressure design is prohibited.

(o) This Case number shall be referenced in the documentation and marking of the material and shall be shown on the Manufacturer's Data Report.

Element	Composition Limits, %
Carbon	0.10–0.14
Manganese	0.15–0.45
Phosphorus, max.	0.020
Sulphur, max.	0.010
Silicon	0.40–0.60
Chromium	11.00–12.00
Molybdenum	0.20–0.40
Vanadium	0.20–0.30
Nickel	0.10–0.40
Boron	0.003–0.006
Nitrogen	0.030–0.070
Cobalt	1.40–1.80
Aluminum, max.	0.02
Copper, max.	0.25
Tungsten	1.30–1.70
Niobium	0.03–0.08

**Table 2  
Mechanical Properties Requirements**

Minimum Tensile Strength, ksi (MPa)	Minimum Yield Strength, ksi (MPa)	Minimum Elongation in 2 in. (50.8 mm), %
89.9 (620)	65.3 (450)	19

GENERAL NOTES:

(a) For longitudinal strip tests, a deduction from the basic values of 1.00% for each  $\frac{1}{32}$  in. (0.8 mm) decrease in wall thickness below  $\frac{5}{16}$  in. (7.8 mm) shall be made. The following table gives the computed values:

Wall Thickness	Minimum Elongation in 2 in. (50.8 mm), %
$\frac{5}{16}$ (0.312) in. [7.8 mm]	19.0
$\frac{9}{32}$ (0.281) in. [7.1 mm]	18.0
$\frac{1}{4}$ (0.250) in. [6.4 mm]	17.0
$\frac{7}{32}$ (0.219) in. [5.3 mm]	16.0
$\frac{3}{16}$ (0.188) in. [4.8 mm]	15.0
$\frac{5}{32}$ (0.156) in. [4.0 mm]	14.0
$\frac{1}{8}$ (0.125) in. [3.2 mm]	13.0
$\frac{3}{32}$ (0.094) in. [2.4 mm]	12.0
$\frac{1}{16}$ (0.062) in. [1.5 mm]	11.6
0.062 in. to 0.035 in. [0.9 mm to 0.9 mm], excl.	10.9
0.035 in. to 0.022 in. [0.6 mm to 0.9 mm], excl.	10.6
0.022 in. to 0.015 in. [0.4 mm to 0.6 mm], incl.	10.3

(b) Where the wall thickness lies between two values shown in the in-text table above, the minimum elongation value shall be determined by the following equation:

(U.S. Customary Units)

$$E = 32t + 10.00$$

(SI Units)

$$E = 1.25t + 10.00$$

$E$  = elongation in 2 in. (50.8 mm), %

$t$  = actual thickness of specimen, in. (mm)

**Table 3**  
**Maximum Allowable Stress Values**

For Metal Temperatures Not Exceeding, °F	Maximum Allowable Stress Values, ksi
-20 to 100	25.7
200	25.7
300	25.3
400	24.2
500	23.6
600	23.3
650	23.2
700	23.0
750	22.7
800	22.2
850	21.5
900	20.7
950	19.5
1,000	18.2
1,050	15.5
1,100	11.3 [Note (1)]
1,150	7.3 [Note (1)]

NOTE:

(1) These values are obtained from time-dependent properties.

**Table 3M**  
**Maximum Allowable Stress Values**

For Metal Temperatures Not Exceeding, °C	Maximum Allowable Stress Values, MPa
-30 to 40	177
100	177
200	167
300	161
400	156
425	153
450	149
475	144
500	138
525	130 [Note (1)]
550	121 [Note (1)]
575	97 [Note (1)]
600	71 [Note (1)]
625	47 [Note (1)] [Note (2)]

NOTES:

- (1) These values are obtained from time-dependent properties.  
 (2) The maximum use temperature shall be 621°C. Datum for 625°C temperature is provided for interpolation purposes.

**Table 4**  
**Tensile Strength Values,  $S_u$**

For Metal Temperature Not Exceeding, °F	
Exceeding, °F	$S_u$ Values, ksi [Note (1)]
-20 to 100	89.9
200	89.9
300	88.6
400	84.7
500	82.6
600	81.6
650	81.2
700	80.5
750	79.4
800	77.8
850	75.4
900	72.3
950	68.3
1,000	63.6
1,050	58.3
1,100	52.6
1,150	47.0

NOTE:

(1) The tabulated values of tensile strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the values of tensile strength tend toward an average or expected value that may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. The tensile strength values do not correspond exactly to "average" as this term is applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section I require elevated temperature testing for tensile strengths of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile strength values for ASME Code acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

**Table 4M**  
**Tensile Strength Values,  $S_u$**

For Metal Temperature Not Exceeding, °C	
Exceeding, °C	$S_u$ Values, MPa [Note (1)]
-30 to 40	620
65	620
100	620
150	610
200	585
250	571
300	564
325	562
350	559
375	554
400	547
425	537
450	523
475	504
500	481
525	454
550	423
575	389
600	354
625	319 [Note (2)]

NOTES:

(1) The tabulated values of tensile strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the values of tensile strength tend toward an average or expected value that may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. The tensile strength values do not correspond exactly to "average" as this term is applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section I require elevated temperature testing for tensile strengths of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile strength values for ASME Code acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

(2) The maximum use temperature shall be 621°C. Datum for 625°C temperature is provided for interpolation purposes.

**Table 5**  
**Yield Strength Values,  $S_y$**

For Metal Temperature Not Exceeding, °F	
Exceeding, °F	$S_y$ Values, ksi [Note (1)]
-20 to 100	65.3
200	64.6
300	61.7
400	58.9
500	57.2
600	56.5
650	56.3
700	56.0
750	55.6
800	54.9
850	53.7
900	52.1
950	49.9
1,000	47.1
1,050	43.8
1,100	40.0
1,150	36.0

## NOTE:

(1) The tabulated values of yield strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the yield strength values correspond to the yield strength trend curve adjusted to the minimum specified room temperature yield strength. The yield strength values do not correspond exactly to "minimum" or "average," as those terms are applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section I require elevated temperature testing for yield strength of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated yield strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

**Table 5M**  
**Yield Strength Values,  $S_y$**

For Metal Temperature Not Exceeding, °C	
Exceeding, °C	$S_y$ Values, MPa [Note (1)]
-30 to 40	450
65	450
100	444
150	425
200	407
250	396
300	390
325	389
350	388
375	386
400	383
425	379
450	372
475	362
500	350
525	334
550	315
575	293
600	269
625	245 [Note (2)]

## NOTES:

(1) The tabulated values of yield strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the yield strength values correspond to the yield strength trend curve adjusted to the minimum specified room temperature yield strength. The yield strength values do not correspond exactly to "minimum" or "average," as those terms are applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section I require elevated temperature testing for yield strength of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated yield strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

(2) The maximum use temperature shall be 621°C. Datum for 625°C temperature is provided for interpolation purposes.

**Table 6**  
**Physical Properties**

Temperature, °F	Modulus of Elasticity, Tension, 10 <sup>3</sup> ksi	Thermal Conductivity, Btu/ft-hr-°F	Mean CTE, 10 <sup>-6</sup> in./in./°F [Note (1)]
68	31.91	13.0	...
200	31.25	14.3	5.84
400	30.12	15.0	6.06
600	28.78	15.8	6.25
800	27.13	16.2	6.44
1,000	25.25	16.6	6.67
1,150	23.59	16.8	6.79

NOTE:

(1) Mean CTE values are those from 68°F to indicated temperature.

**Table 6M**  
**Physical Properties**

Temperature, °C	Modulus of Elasticity, Tension, 10 <sup>3</sup> MPa	Thermal Conductivity, W/(m-°C)	Mean CTE, 10 <sup>-6</sup> mm/mm/°C [Note (1)]
20	220	24.2	...
100	215	25.2	10.5
200	208	26.2	10.9
300	200	27.1	11.2
400	190	27.9	11.5
500	179	28.5	11.8
600	166	29.1	12.1
650	158	29.3	12.2

NOTE:

(1) Mean CTE values are those from 20°C to indicated temperature.

Approval Date: October 23, 2013

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2782**  
**Cu-13Zn-1.1Ni-Si-Al Alloy Seamless Pipe and Tubing**  
**Section I**

*Inquiry:* May precipitation-hardened Cu-13Zn-1.1Ni-Si-Al alloy (UNS C69100), seamless pipe and tubing conforming to the requirements of ASTM B706-00 (reapproved 2011) be used for nonwelded construction under the rules of Section I?

*Reply:* It is the opinion of the Committee that precipitation-hardened Cu-13Zn-1.1Ni-Si-Al alloy (UNS C69100), seamless pipe and tubing conforming to the requirements of ASTM B706-00 (reapproved 2011) may be used for nonwelded construction under the rules of Section I, provided the following additional requirements are met:

- (a) The pipe and tubing shall be in the precipitation-hardened condition, temper TF00 in ASTM B706.
- (b) The maximum allowable stress values for the material shall be those given in Table 1 or Table 1M. The maximum design temperature shall be 400°F (204°C).
- (c) External pressure design is not permitted.
- (d) This Case number shall be shown on the Manufacturer's Data Report.

<b>Table 1</b>	
<b>Maximum Allowable Stress Values</b>	
For Metal Temperature Not Exceeding, °F	Stress, ksi
100	17.1
150	17.1
200	17.1
250	17.1
300	17.1
350	17.1
400	17.1

<b>Table 1M</b>	
<b>Maximum Allowable Stress Values</b>	
For Metal Temperature Not Exceeding, °C	Stress, MPa
40	118
65	118
100	118
125	118
150	118
175	118
200	118
225 [Note (1)]	117

NOTE:  
(1) The maximum use temperature for this alloy is 400°F (204°C). The value listed at 225°C is provided for interpolation purposes only.

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Approval Date: September 28, 2013

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**Case 2783**  
**Cu-13Zn-1.1Ni-Si-Al Alloy Seamless Tubing**  
**Section VIII, Division 1**

*Inquiry:* May precipitation-hardened Cu-13Zn-1.1Ni-Si-Al alloy (UNS C69100), seamless pipe and tubing conforming to the requirements of ASTM B706-00 (reapproved 2011) be used for nonwelded construction under the rules of Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that precipitation-hardened Cu-13Zn-1.1Ni-Si-Al alloy (UNS C69100), seamless pipe and tubing conforming to the requirements of ASTM B706-00 may be used for nonwelded construction under the rules of Section VIII, Division 1, provided the following additional requirements are met:

(a) The pipe and tubing shall be in the precipitation-hardened condition, temper TF00 in ASTM B706.

(b) Heat treatment shall be age-hardening at 1,110°F ± 25°F (600°C ± 15°C) for 3 hr to 4 hr followed by air cooling.

(c) The physical properties for Cu-13Zn-1.1Ni-Si-Al alloy (UNS C69100) are as follows:

(1) density, 68°F (20°C): 0.307 lb/in.<sup>3</sup> (8 520 kg/m<sup>3</sup>)

(2) thermal conductivity

(-a) 212°F (100°C): 44 Btu/(h·ft·°F) (77 W/m·K)

(-b) 572°F (300°C): 59.5 Btu/(h·ft·°F)

(103 W/m·K)

(3) Coefficient of thermal expansion, 10<sup>-6</sup>/°F: 11 (10<sup>-6</sup>/K: 19)

(d) The yield strength and tensile strength values for use in design shall be as shown in Tables 1 and 1M.

(e) The maximum allowable stress values for the material shall be those given in Tables 2 and 2M. The maximum design temperature shall be 400°F (204°C).

(f) External pressure design is prohibited.

(g) This Case number shall be shown on the Manufacturer's Data Report.

**Table 1**  
**Yield and Tensile Strength Values**

For Metal Temperature Not Exceeding, °F	Yield Strength, ksi [Note (1)]	Tensile Strength, ksi [Note (2)]
100	31.0	60.0
150	30.8	60.0
200	30.8	60.0
250	30.8	60.0
300	30.4	60.0
350	29.8	60.0
400	29.2	60.0

NOTES:

(1) The tabulated values of yield strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the yield strength values correspond to the yield strength trend curve adjusted to the minimum specified room temperature yield strength. The yield strength values do not correspond exactly to "minimum" or "average," as those terms are applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 1 requires elevated temperature testing for yield strength of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated yield strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

(2) The tabulated values of tensile strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the tensile strength values tend toward an average or expected value, which may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. The tensile strength values do not correspond exactly to "average" as this term is applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 1 requires elevated temperature testing for tensile strength of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower

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**Table 1**  
**Yield and Tensile Strength Values (Cont'd)**

NOTES (CONT'D):  
 than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

**Table 1M**  
**Yield and Tensile Strength Values**

For Metal Temperature Not Exceeding, °C	Yield Strength, MPa [Note (1)]	Tensile Strength, MPa [Note (2)]
40	212	414
65	212	414
100	212	414
125	212	414
150	210	414
175	206	414
200	202	414
225	199	409

NOTES:  
 (1) The tabulated values of yield strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the yield strength values correspond to the yield strength trend curve adjusted to the minimum specified room temperature yield strength. The yield strength values do not correspond exactly to "minimum" or "average," as those terms are applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 1 requires elevated temperature testing for yield strength of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated yield strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.  
 (2) The tabulated values of tensile strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the tensile strength values tend toward an average or expected value, which may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. The tensile strength values do not correspond exactly to "average" as this term is applied to a statistical

**Table 1M**  
**Yield and Tensile Strength Values (Cont'd)**

NOTES (CONT'D):  
 treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 1 requires elevated temperature testing for tensile strength of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

**Table 2**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi
100	17.1
150	17.1
200	17.1
250	17.1
300	17.1
350	17.1
400	17.1

**Table 2M**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Values, MPa
40	118
65	118
100	118
125	118
150	118
175	118
200	118
225 [Note (1)]	117

NOTE:  
 (1) The maximum use temperature for this alloy is 400°F (204°C). The value listed at 225°C is provided for interpolation purposes only.

Approval Date: November 1, 2013

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2784**  
**Use of 17Cr-4Ni-4Cu (UNS S17400) Condition H1150D or H1150M**  
**Section VIII, Division 1**

*Inquiry:* May martensitic precipitation hardened stainless steel 17Cr-4Ni-4Cu (UNS S17400) complying with SA-564 Type 630 condition H1150D or H1150M be used for bodies, bonnets, and yokes of pressure-relief devices constructed under Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that martensitic precipitation hardened stainless steel 17Cr-4Ni-4Cu (UNS S17400) complying with SA-564 Type 630 condition H1150D or H1150M may be used for bodies, bonnets, and yokes of pressure-relief devices constructed under Section VIII, Division 1, provided the following additional requirements are met:

(a) The material shall be in the H1150D or H1150M condition.

(b) The yield strength and tensile strength values for use in design shall be as shown in Table 1 and Table 1M, and Table 2 and Table 2M.<sup>1</sup>

(c) The maximum allowable stress values for the material shall be as those given in Table 3 and Table 3M, and Table 4 and Table 4M. The maximum design shall be 700°F (371°C).

(d) For welding, the rules in Article KF-11 on additional fabrication requirements for welding age-hardening stainless steels in Section VIII, Division 3 (2011a addenda) shall apply.

(e) Minimum design metal temperature (MDMT) shall be -50°F (-46°C).

(f) Impact testing is required for UNS S17400 materials in tempers H1150D or H1150M. Impact testing is not required when the maximum obtainable Charpy specimen has a width along the notch less than 0.099 in. (2.5 mm). The minimum lateral expansion opposite the notch shall be no less than 0.015 in. (0.38 mm).

(g) All other requirements of Section VIII, Division 1 shall be met.

(h) This Case number shall be shown on the Manufacturer's Data Report.

<sup>1</sup> The allowable stress values in this Case are based on consensus that using trend curves on 900°F (482°C) (H900 temper) aged material data is conservative for the grades covered by this Case.

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**Table 1**  
**Yield and Tensile Strength Values for**  
**Condition H1150M**

For Metal		
Temperatures Not Exceeding, °F	Yield Strength, ksi [Note (1)]	Tensile Strength, ksi [Note (2)]
100	75	115
150	71.3	...
200	69.4	109
250	67.8	...
300	66.5	105
350	65.2	...
400	64.1	102
450	63.1	...
500	62.1	99.6
550	61.3	...
600	60.6	98.1
650	59.7	97.2
700	58.9	95.9

NOTES:

- (1) The tabulated values of yield strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the yield strength values correspond to the yield strength trend curve adjusted to the minimum specified room temperature yield strength. The yield strength values do not correspond exactly to "minimum" or "average," as those terms are applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 1 require elevated temperature testing for yield strength of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated yield strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.
- (2) The tabulated values of tensile strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the tensile strength values tend toward an average or expected value, which may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. The tensile strength values do not correspond exactly to "average" as this term is applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 1 require elevated temperature testing for tensile strength of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

**Table 1M**  
**Yield and Tensile Strength Values for**  
**Condition H1150M**

For Metal		
Temperatures Not Exceeding, °C	Yield Strength, MPa [Note (1)]	Tensile Strength, MPa [Note (2)]
40	515	795
65	489	795
100	473	795
150	456	795
200	441	774
250	429	760
300	418	749
325	414	744
350	409	737
375	404	728

NOTES:

- (1) The tabulated values of yield strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the yield strength values correspond to the yield strength trend curve adjusted to the minimum specified room temperature yield strength. The yield strength values do not correspond exactly to "minimum" or "average," as those terms are applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 1 require elevated temperature testing for yield strength of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated yield strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.
- (2) The tabulated values of tensile strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the tensile strength values tend toward an average or expected value, which may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. The tensile strength values do not correspond exactly to "average" as this term is applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 1 require elevated temperature testing for tensile strength of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

**Table 2**  
**Yield and Tensile Strength Values for**  
**Condition H1150D**

For Metal		
Temperatures Not Exceeding, °F	Yield Strength, ksi [Note (1)]	Tensile Strength, ksi [Note (2)]
100	105	125
150	99.8	...
200	97.1	119
250	94.9	...
300	93.0	114
350	91.2	...
400	89.7	111
450	88.3	...
500	86.9	108
550	85.8	...
600	84.8	107
650	83.6	106
700	82.4	104

## NOTES:

- (1) The tabulated values of yield strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the yield strength values correspond to the yield strength trend curve adjusted to the minimum specified room temperature yield strength. The yield strength values do not correspond exactly to “minimum” or “average,” as those terms are applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 1 require elevated temperature testing for yield strength of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated yield strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.
- (2) The tabulated values of tensile strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the tensile strength values tend toward an average or expected value, which may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. The tensile strength values do not correspond exactly to “average” as this term is applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 1 require elevated temperature testing for tensile strength of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

**Table 2M**  
**Yield and Tensile Strength Values for**  
**Condition H1150D**

For Metal		
Temperatures Not Exceeding, °C	Yield Strength, MPa [Note (1)]	Tensile Strength, MPa [Note (2)]
40	725	860
65	689	860
100	666	860
150	642	860
200	621	837
250	604	822
300	589	811
325	582	805
350	576	797
375	568	787

## NOTES:

- (1) The tabulated values of yield strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the yield strength values correspond to the yield strength trend curve adjusted to the minimum specified room temperature yield strength. The yield strength values do not correspond exactly to “minimum” or “average,” as those terms are applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 1 require elevated temperature testing for yield strength of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated yield strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.
- (2) The tabulated values of tensile strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the tensile strength values tend toward an average or expected value, which may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. The tensile strength values do not correspond exactly to “average” as this term is applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section VIII, Division 1 require elevated temperature testing for tensile strength of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile strength values for ASME acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

**Table 3**  
**Maximum Allowable Stress Values for**  
**Condition H1150M**

For Metal Temperatures	
Not Exceeding, °F	Stress, ksi
100	32.9
200	32.9
300	32.9
400	31.9
500	31.3
600	30.8
650	30.5
700	30.1

GENERAL NOTE: CAUTION: This material has reduced toughness at room temperature after exposure for about 5,000 hr at or above 600°F.

**Table 4**  
**Maximum Allowable Stress Values for**  
**Condition H1150D**

For Metal Temperatures	
Not Exceeding, °F	Stress, ksi
100	35.7
200	35.7
300	35.7
400	34.7
500	34.0
600	33.5
650	33.2
700	32.8

GENERAL NOTE: CAUTION: This material has reduced toughness at room temperature after exposure for about 5,000 hr at or above 600°F.

**Table 3M**  
**Maximum Allowable Stress Values for**  
**Condition H1150M**

For Metal Temperatures	
Not Exceeding, °C	Stress, MPa
40	227
65	227
100	227
150	227
200	221
250	217
300	214
325	213
350	211
375 [Note (1)]	208

GENERAL NOTE: CAUTION: This material has reduced toughness at room temperature after exposure for about 5,000 hr at or above 600°F.

NOTE:

(1) The value at 375°C is for interpolation only. The maximum use temperature is 371°C.

**Table 4M**  
**Maximum Allowable Stress Values for**  
**Condition H1150D**

For Metal Temperatures	
Not Exceeding, °C	Stress, MPa
40	246
65	246
100	246
150	246
200	239
250	235
300	232
325	230
350	228
375 [Note (1)]	225

GENERAL NOTE: CAUTION: This material has reduced toughness at room temperature after exposure for about 5,000 hr at or above 600°F.

NOTE:

(1) The value at 375°C is for interpolation only. The maximum use temperature is 371°C.

Approval Date: November 1, 2013

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2786**  
**Alloy UNS S30815 Up to 1,700°F (927°C)**  
**Section I; Section VIII, Division 1**

*Inquiry:* May solution annealed 21Cr-11Ni-N alloy (UNS S30815) seamless and welded pipe and tube, plate, forgings and bar be used in Section I and Section VIII, Division 1 welded construction at temperatures above 1,650°F (900°C) up to and including 1,700°F (927°C)?

*Reply:* It is the opinion of the Committee that solution annealed 21Cr-11Ni-N alloy (UNS S30815) in the product forms described in the Inquiry may be used for Section I and Section VIII, Division 1 welded construction at

temperatures above 1,650°F (900°C) up to and including 1,700°F (927°C), provided the following additional requirements are met:

(a) A list of approved SA specifications is shown in [Table 1](#).

(b) The maximum allowable stress values shall be those given in [Table 2](#) and [Table 2M](#).

(c) Allowable stress values in this Case are values obtained from time-dependent properties.

(d) For welding, the material has been assigned P-No. 8, Group 2.

(e) This Case number shall be referenced in documentation and marking of the material and shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1  
 Specifications**

Specification	Item	Identification Symbol or UNS Number
SA-182	Forgings	F 45
SA-213	Seamless tube	UNS S30815
SA-240	Plate, sheet, and strip	UNS S30815
SA-249	Welded tube	UNS S30815
SA-312	Seamless pipe, welded pipe	UNS S30815
SA-479	Bar	UNS S30815

**Table 2  
 Maximum Allowable Stress Values**

For Metal		
Temperature Not Exceeding, °F	Maximum Allowable Stress, ksi	Maximum Allowable Stress (Welded), ksi
1,700	0.58	0.49

GENERAL NOTES:

- (a) Creep fatigue, thermal ratcheting, and environmental effects are increasingly significant failure modes at these temperatures.
- (b) Values for 1,650°F and lower can be found in Section II, Part D (Customary), Table 1A.

**Table 2M  
 Maximum Allowable Stress Values**

For Metal		
Temperature Not Exceeding, °C	Maximum Allowable Stress, MPa	Maximum Allowable Stress (Welded), MPa
925	4.08	3.47
950 [Note (1)]	3.47	2.95

GENERAL NOTES:

- (a) Creep fatigue, thermal ratcheting, and environmental effects are increasingly significant failure modes at these temperatures.
- (b) Values for 900°C and lower can be found in Section II, Part D (Metric), Table 1A.

NOTE:

- (1) The maximum use temperature is 927°C; the value given at 950°C is given for interpolation only.

Approval Date: November 1, 2013

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2787**  
**Multiple Marking of Certified Capacities for**  
**Pressure-Relief Valves**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions may a Manufacturer or Assembler of a pressure-relief valve place more than one certified capacity on the pressure-relief valve or the nameplate and comply with UG-129?

*Reply:* It is the opinion of the Committee that a Manufacturer or Assembler of a pressure-relief valve may place more than one certified capacity on the valve or nameplate provided the following requirements are met:

(a) The pressure-relief valve has been capacity certified by the Manufacturer per the requirements of UG-131 for each of the medias with the following additional requirements:

(1) During the certification of capacity testing required per UG-131, the pressure-relief valve shall be tested first on one of the certified media (steam, air, gas, or water) and then tested on all other media requested by the Manufacturer.

(2) There shall be no adjustments to any of the pressure-relief valves after completion of the testing on the first media.

(3) The measured set pressure for the valve tested on the additional medias shall meet the tolerance requirements of UG-134(d)(1), based on the pressure at which the valve was set to operate in (1), or marked set pressure for sample production valves.

(b) The pressure-relief valve shall meet all requirements of UG-136 for all certified capacities stamped on the valve or nameplate except as follows:

(1) For sample production pressure-relief valves selected for capacity certification or recertification per UG-136(c)(3)(-a) the same requirements per (a) shall apply.

(2) Production testing per UG-136(d)(4) shall be performed using any one of the certified medias to be marked on the valve except steam shall be used when one of the certified media is steam.

(c) This Case number shall be on a plate permanently attached to the pressure-relief valve.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: November 1, 2013

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**Case 2788**  
**SA-240/SA-240M, UNS S43932 Plate**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions may UNS S43932 plate conforming to SA-240/SA-240M be used in welded construction under the rules of Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that UNS S43932 plate material conforming to SA-240/SA-240M may be used in construction of welded pressure vessels under the rules of Part UHA of Section VIII, Division 1, provided the following additional requirements are met:

(a) The maximum allowable stresses and Notes shall be those for 18Cr-Ti, seamless tube, SA-268, UNS S43035 material in Table 1A of Section II, Part D.

(b) The maximum use temperature is 600°F (316°C).

(c) For external pressure design, Figure CS-2 of Section II, Part D shall be used.

(d) Postweld heat treatment is not required if the following requirements are met:

(1) The plate thickness at welded joint does not exceed  $\frac{3}{8}$  in. (10 mm).

(2) For thicknesses over  $\frac{3}{8}$  in. to  $1\frac{1}{2}$  in. (10 mm to 38 mm) preheat of 450°F (230°C) is maintained during welding and the joints are completely radiographed.

(e) All other requirements for ferritic stainless steels in Part UHA shall apply.

(f) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: December 16, 2013

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2789**  
**Laser Measurement for Out-of-Roundness**  
**Section VIII, Division 1**

*Inquiry:* For pressure vessels under external pressure, may a laser measurement system be used in lieu of the segmental circular template as specified in UG-80(b)(2)?

*Reply:* It is the opinion of the Committee that a laser measurement system may be used in lieu of the segmental circular template as specified in UG-80(b)(2) for pressure vessels under external pressure under the following conditions:

(a) Circularity (roundness) is a condition of a surface where all points of the surface intersected by any plane perpendicular to the axis are equidistant from that axis or spine.

(b) The laser measurement system shall be capable of obtaining a measurement that varies from the nominal diameter by no more than  $D/20,000$ .

(c) The laser measurement system shall be performance tested and used within the rated conditions as specified in Form 1 of ASME B89.4.19-2006.

(d) The laser measurements shall be taken a minimum of two times for each area under consideration, and the measurements shall be compared. If the two data sets differ by more than 20% of the tolerance for the item being measured, the item shall be remeasured until two subsequent data sets are within 20% of the tolerance from each other.

(e) The vessel section under consideration shall use either of the following two methods for determining compliance to the out-of-roundness tolerance of UG-80(b)(2):

(1) evaluation of measurements over the same arc lengths as defined in UG-80(b)(2) for a segmental circular template

(2) evaluation of measurements for circularity as defined in (a) using the average diameter of the section and the tolerance provided from Figure UG-80.1

(f) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: November 1, 2013

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2790**  
**Use of Type XM-12, Condition H900 Material With a**  
**Reduced Tensile Strength**  
**Section VIII, Division 3**

*Inquiry:* May Type XM-12, Condition H900 Material with a reduced tensile strength but otherwise meeting all of the requirements of SA-705 Type XM-12, Condition H900 material be used in Section VIII, Division 3 construction?

*Reply:* It is the opinion of the Committee that Type XM-12, Condition H900 Material with a reduced tensile strength but otherwise meeting all of the requirements of SA-705 Type XM-12, Condition H900 material may be used in Section VIII, Division 3 construction provided the following additional requirements are met:

(a) The design temperature shall not exceed 100°F (40°C).

(b) The minimum specified tensile strength shall be 187 ksi (1 290 MPa).

(c) The minimum specified yield strength shall be 170 ksi (1 170 MPa).

(d) All other mechanical properties shall meet the requirements for SA-705, Type XM-12, condition H900 material.

(e) The tensile strength values used in design  $S_u$  shall be obtained from [Table 1](#).

(f) The yield strength values for use in design shall be obtained from Section II, Part D, Table Y-1. The values for SA-705, Type XM-12, condition H900 shall be used.

(g) Mechanical property tests shall be in accordance with Article KM-2 for SA-705, Type XM-12, condition H900 material.

(h) Charpy V-notch testing is required. The results shall be reported to the Manufacturer of the pressure vessel.

(i) This material is permitted only when used as an inner layer in a vessel whose design meets the leak-before-burst criteria of KD-141.

(j) Caution is advised when using this material as it is more susceptible than lower strength materials to environmental stress corrosion cracking and/or embrittlement due to hydrogen exposure. This susceptibility increases as yield strength increases. The designer shall consider these effects and their influences on the vessel. See Section II, Part D, Nonmandatory Appendix A, A-701.

(k) No welding is permitted on this material.

(l) The materials manufacturer shall certify that the material meets all requirements in SA-705 for Type XM-12, Condition H900 material with the exception that the tensile strength meets the requirements of this Case.

(m) This Case number shall be shown on the marking and certification of the material and shown on the Manufacturer's Data Report.

**Table 1**  
**Tensile Strength Values**

Temperature, °F (°C)	Tensile Strength, ksi (MPa)
-20 to 100 (-30 to 40)	187 (1 290)

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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**Approval Date: January 6, 2014**

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2791**  
**Joining of SB-283, UNS C37700 Fittings to SB-75 Tubing**  
**Section IV**

*Inquiry:* Under what conditions may SB-283, UNS C37700 fittings be joined to SB-75 tubing by brazing in Section IV construction?

*Reply:* It is the opinion of the Committee that SB-283, UNS C37700 fittings may be joined to SB-75 tubing by brazing in Section IV construction, provided the following requirements are met:

(a) Brazing procedure and performance qualifications shall be conducted in accordance with Section IX.

(b) All other applicable Code requirements shall be met.

(c) This Case number shall be shown on the Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: January 23, 2014

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2792**  
**57Ni-22Cr-14W-2Mo-La Alloy (UNS N06230) Wrought and Welded Tubing**  
**Section I; Section II, Part B; Section VIII, Division 1**

*Inquiry:* May solution-annealed alloy UNS N06230 wrought and welded tubing tested with a flare test in lieu of a flange test and otherwise conforming to Section II, Part B, SB-626 be used in welded construction under the rules of Section I and Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that solution-annealed alloy UNS N06230 wrought and welded tubing tested with a flare test in lieu of a flange

test and otherwise conforming to Section II, Part B, SB-626 may be used in welded construction under the rules of Section I and Section VIII, Division 1, provided the following additional requirements are met:

(a) The flare test shall be as described in para. 6.3 of SB-751 or para. A2.5.1.5 of SA-370.

(b) Use of welded tubes with a flare angle greater than 30 deg is prohibited.

(c) This Case number shall be referenced in the documentation and marking of the material and shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: March 18, 2014

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**Case 2793**  
**Use of SA-705/SA-705M, Type XM-12, Condition H1025**  
**for Primary Pressure Boundary Components in Contact**  
**With Water or Aqueous Solution**  
**Section VIII, Division 3**

*Inquiry:* May SA-705/SA-705M, Type XM-12, Condition H1025 material be used for external yoke supported plugs and wedges for wire wound pressure vessels in contact with water or an aqueous solution for Section VIII, Division 3 construction?

*Reply:* It is the opinion of the Committee that SA-705/SA-705M, Type XM-12, Condition H1025 material may be used for external yoke supported plugs and wedges for wire wound pressure vessels in contact with water or an aqueous solution in Section VIII, Division 3 construction, provided the following requirements are met:

(a) The plugs shall consist of cylindrical components that provide end closures on cylindrical vessels and that are supported by an external yoke such that the plug is in axial compression.

(b) The wedges shall consist of components that fit between the plugs and the yoke and that transmit the loads from the plug to the yoke in axial compression.

(c) It shall be demonstrated using fracture mechanics analysis that cracks that may initiate at any location within the component where one or more of the principal stresses is tensile, and/or where the sum of the three principal stresses is positive will propagate into a zone where the range of stress intensity is below the threshold for crack growth due to either environmental cracking or fatigue before reaching the critical value for fast fracture.

(d) As an alternative to (c), it may be demonstrated that the component will fail in a leak-before-burst manner considering all credible crack configurations and if personnel can be protected from any harmful effects of the leaking fluid.

(e) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: March 18, 2014

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2794**  
**Solution Annealed Ni-24Fe-23Cr-6Mo-3Cu, UNS N06845, Seamless Pipe and Tube, Plate, Sheet, Strip, Rod, and Bar**  
**Section VIII, Division 1**

*Inquiry:* May solution-annealed Ni-24Fe-23Cr-6Mo-3Cu, UNS N06845, seamless pipe and tube, plate, sheet, strip, rod, and bar conforming to the requirements of the specifications listed in [Table 1](#) be used in welded construction under the rules of Section VIII, Division 1?

*Reply:* It is the opinion of the Committee that solution annealed Ni-24Fe-23Cr-6Mo-3Cu, UNS N06845, seamless pipe and tube, plate, sheet, strip, rod, and bar as described in the Inquiry may be used for welded construction under the rules of Section VIII, Division 1, provided the following additional requirements are met:

(a) The rules of Section VIII, Division 1, Part UNF for nickel alloys shall apply.

(b) The maximum design temperature shall be 842°F (450°C).

(c) The maximum allowable stress values shall be as shown in [Table 2](#) and [2M](#).

(d) The yield and tensile strength values for use in design shall be as shown in [Table 3](#) and [Table 3M](#).

(e) For external pressure, [Figure 1](#) and [1M](#) and the tabular values in [Table 4](#) shall apply. For values of A falling to the left of the applicable material/temperature curve, determine factor B from the tabular values in [Table 4](#) or use the elastic modulus values from [Table 5](#) and [5M](#) in the expression for external pressure in Section VIII, Division 1 that uses E.

(f) Separate weld procedure and performance qualifications conducted in accordance with Section IX shall be required for this material.

(g) Welding of this material to itself is restricted to GTAW with welding consumable ER NiCrCoMo-1.

(h) Heat treatment after welding or fabrication is neither required nor prohibited.

(i) This Case number shall be shown on the Manufacturer's Data Report.

(j) When required, the following physical properties shall apply:

(1) Modulus of elasticity values are as shown in [Table 5](#) and [5M](#).

(2) Mean linear thermal expansion coefficients values are as shown in [Table 6](#) and [6M](#).

(3) Thermal conductivity and thermal diffusivity values are as shown in [Table 7](#) and [7M](#).

(4) The density for the material at room temperature is 0.304 lb/in.<sup>3</sup> (8410 kg/m<sup>3</sup>).

(5) Poisson's ratio is 0.31.

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**Table 1**  
**Material Specifications and Grades**

Material	Specification and UNS Number
Condenser and Heat-Exchanger Tubes	ASTM B163-11 N06845
Seamless Pipe and Tubes	ASTM B423-11 N06845
Plate, Sheet, and Strip	SB-424 N06845
Rod and Bar	ASTM B425-11 N06845

**Table 2**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Stress, ksi	Stress, ksi [Note (1)]
100	26.7	26.7
150	23.2	26.7
200	21.8	26.7
250	20.7	26.7
300	19.8	26.7
350	19.2	25.9
400	18.6	25.2
450	18.2	24.5
500	17.8	24.0
550	17.4	23.5
600	17.1	23.1
650	16.9	22.8
700	16.7	22.5
750	16.5	22.3
800	16.4	22.2
850	16.3 [Note (2)]	22.0 [Note (2)]

## NOTES:

- (1) Section II, Part D, Subpart 1, Table 1B, Note G5 applies to these values.  
 (2) The maximum design temperature is 842°F. This value is provided for interpolation purposes only.

**Table 2M**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Stress, MPa	Stress, MPa [Note (1)]
40	184	184
65	160	184
100	148	184
125	142	184
150	137	184
175	133	179
200	129	174
225	126	170
250	124	167
275	121	164
300	119	161
325	117	159
350	116	157
375	115	155
400	114	154
425	113	153
450	112	152

## NOTE:

- (1) Section II, Part D, Subpart 1, Table 1B, Note G5 applies to these values.

**Table 3**  
**Yield and Tensile Strength Values**

For Metal Temperature Not Exceeding, °F	Yield Strength, ksi [Note (1)]	Tensile Strength, ksi [Note (2)]
100	40.0	100
150	34.8	100
200	32.6	100
250	31.0	99.4
300	29.8	97.0
350	28.8	94.9
400	28.0	93.1
450	27.3	91.5
500	26.7	90.2
550	26.1	89.2
600	25.7	88.3
650	25.3	87.7
700	25.0	87.1
750	24.8	86.6
800	24.6	85.9
850	24.4	85.0
900	24.1	83.6

## NOTES:

- (1) Section II, Part D, Subpart 1, Table Y-1, Note (b) applies to these values.  
 (2) Section II, Part D, Subpart 1, Table U, Note (b) applies to these values.

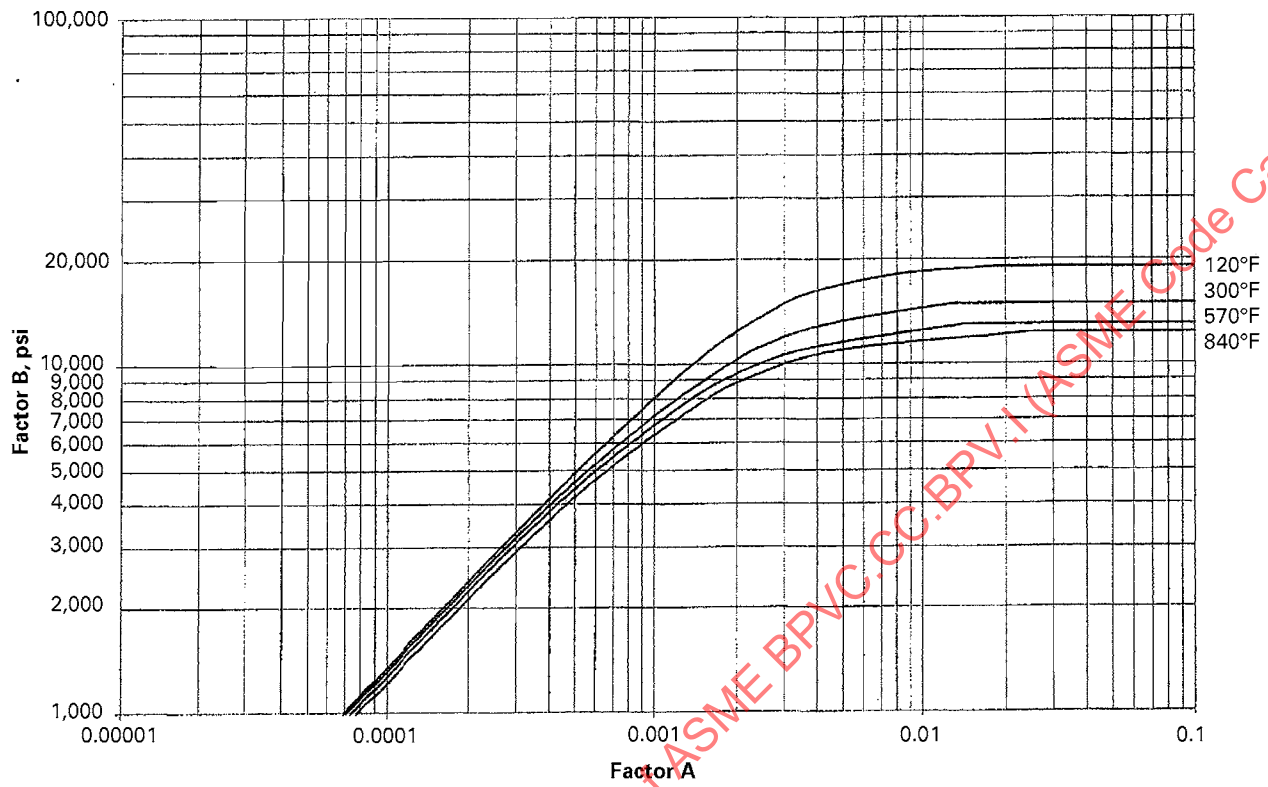
**Table 3M**  
**Yield and Tensile Strength Values**

For Metal Temperature Not Exceeding, °C	Yield Strength, MPa [Note (1)]	Tensile Strength, MPa [Note (2)]
40	276	690
65	240	690
100	222	690
125	212	683
150	205	668
175	199	655
200	194	644
225	189	634
250	185	625
275	182	618
300	179	612
325	176	607
350	174	603
375	172	600
400	171	597
425	170	593
450	169	587

## NOTES:

- (1) Section II, Part D, Subpart 1, Table Y-1, Note (b) applies to these values.  
 (2) Section II, Part D, Subpart 1, Table U, Note (b) applies to these values.

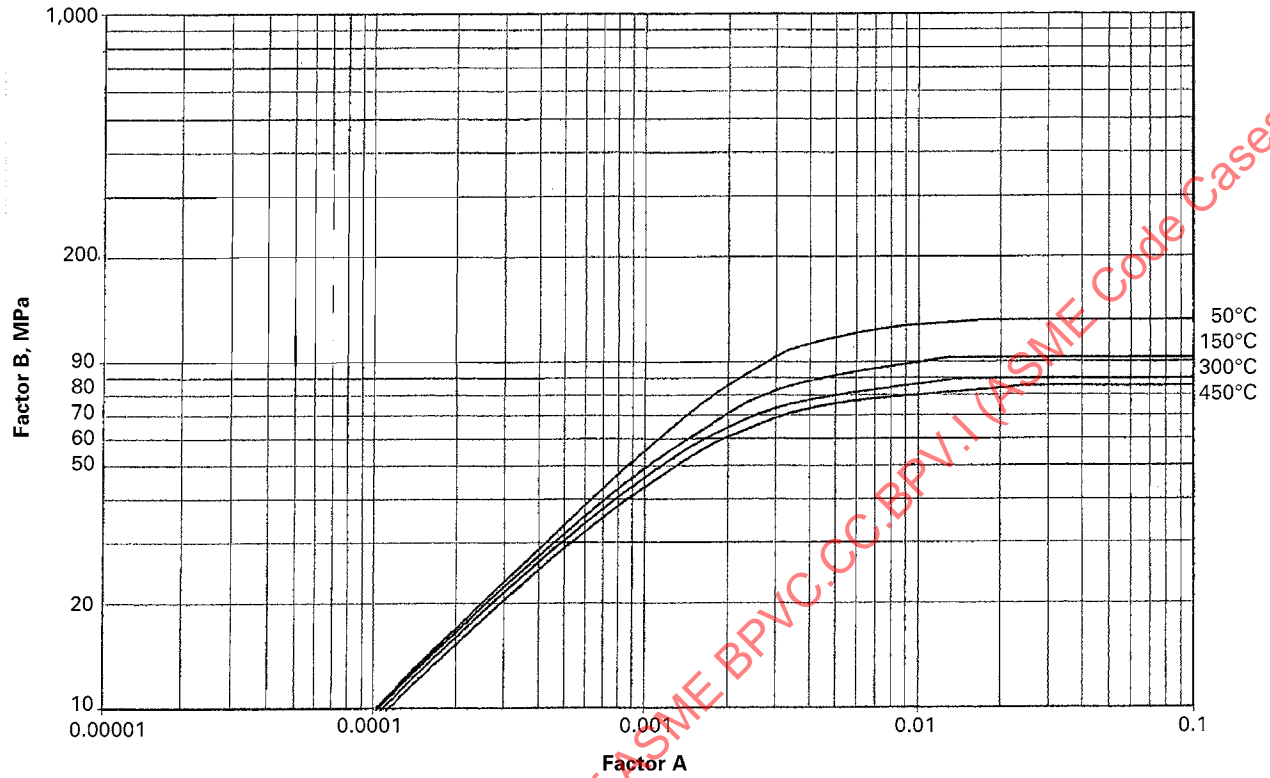
**Figure 1**  
**External Pressure Chart for UNS N06845**



GENERAL NOTE: For Factor A to the left of chart line

Temperature, °F	E, psi × 10 <sup>6</sup>
120	28.6
300	27.9
570	26.7
840	25.4

**Figure 1M**  
**External Pressure Chart for UNS N06845**



GENERAL NOTE: For Factor A to the left of chart line

Temperature, °C	E, MPa × 10 <sup>3</sup>
50	197
150	192
300	185
450	176

**Table 4**  
**Tabular Values for Figure 1 and 1M**

Temperature, °F	A	B, psi	Temperature, °C	A	B, psi
120	1.00 E-05	142	50	1.00 E-05	0.98
	6.99 E-05	1,000		1.02 E-04	10.0
	3.33 E-04	3,600		3.33 E-04	25.0
	8.70 E-04	7,300		8.70 E-04	50.0
	1.58 E-03	10,900		1.58 E-03	75.0
	2.78 E-03	14,500		2.78 E-03	100.0
	4.05 E-03	16,300		4.05 E-03	112.5
	8.06 E-03	18,100		8.06 E-03	125.0
	1.75 E-02	19,000		1.75 E-02	131.0
	1.00 E-01	19,000		1.00 E-01	131.0
300	1.00 E-05	139	150	1.00 E-05	0.96
	7.17 E-05	1,000		1.04 E-04	10.0
	3.50 E-04	3,600		3.50 E-04	25.0
	1.03 E-03	7,300		1.03 E-03	50.0
	1.56 E-03	9,100		1.56 E-03	62.5
	2.50 E-03	11,300		2.50 E-03	78.0
	4.50 E-03	13,100		4.50 E-03	90.0
	1.28 E-02	14,900		1.28 E-02	102.5
	1.00 E-01	14,900		1.00 E-01	102.5
	570	1.00 E-05		133	300
7.46 E-05		1,000	1.08 E-04	10.0	
3.70 E-04		3,600	3.70 E-04	25.0	
1.15 E-03		7,300	1.15 E-03	50.0	
1.80 E-03		9,000	1.80 E-03	62.0	
3.57 E-03		11,000	3.57 E-03	76.0	
1.43 E-02		13,000	1.43 E-02	89.5	
1.00 E-01		13,000	1.00 E-01	89.5	
840		1.00 E-05	128	450	
	7.84 E-05	1,000	1.14 E-04		10.0
	4.00 E-04	3,600	4.00 E-04		25.0
	1.30 E-03	7,300	1.30 E-03		50.0
	2.20 E-03	9,100	2.20 E-03		62.5
	4.70 E-03	10,900	4.70 E-03		75.0
	2.45 E-02	12,300	2.45 E-02		85.0
	1.00 E-01	12,300	1.00 E-01		85.0

**Table 5**  
**Modulus of Elasticity**

Temperature, °F	psi × 10 <sup>6</sup>
RT	28.9
200	28.3
300	27.9
400	27.5
500	27.1
600	26.7
700	26.2
800	25.7
900	25.4
1,000	25.0
1,100	24.6
1,200	24.0
1,300	23.3
1,400	22.7
1,500	22.0

**Table 5M**  
**Modulus of Elasticity**

Temperature, °C	MPa × 10 <sup>3</sup>
25	199
100	195
150	192
200	190
250	188
300	185
350	182
400	179
450	176
500	174
550	172
600	169
650	165
700	161
750	157
800	153
850	148

**Table 6**  
**Mean Linear Thermal Expansion Coefficients**

Temperature Range, °F	Coefficient, in./in./°F
RT-100	7.7 × 10 <sup>-6</sup>
RT-150	7.7 × 10 <sup>-6</sup>
RT-200	7.7 × 10 <sup>-6</sup>
RT-250	7.7 × 10 <sup>-6</sup>
RT-300	7.8 × 10 <sup>-6</sup>
RT-350	7.8 × 10 <sup>-6</sup>
RT-400	7.8 × 10 <sup>-6</sup>
RT-450	7.9 × 10 <sup>-6</sup>
RT-500	7.9 × 10 <sup>-6</sup>
RT-550	8.0 × 10 <sup>-6</sup>
RT-600	8.0 × 10 <sup>-6</sup>
RT-650	8.0 × 10 <sup>-6</sup>
RT-700	8.1 × 10 <sup>-6</sup>
RT-750	8.1 × 10 <sup>-6</sup>
RT-800	8.2 × 10 <sup>-6</sup>
RT-850	8.2 × 10 <sup>-6</sup>
RT-900	8.2 × 10 <sup>-6</sup>
RT-950	8.2 × 10 <sup>-6</sup>
RT-1,000	8.2 × 10 <sup>-6</sup>
RT-1,050	8.2 × 10 <sup>-6</sup>
RT-1,100	8.2 × 10 <sup>-6</sup>
RT-1,150	8.2 × 10 <sup>-6</sup>
RT-1,200	8.3 × 10 <sup>-6</sup>
RT-1,250	8.4 × 10 <sup>-6</sup>
RT-1,300	8.5 × 10 <sup>-6</sup>
RT-1,350	8.6 × 10 <sup>-6</sup>
RT-1,400	8.7 × 10 <sup>-6</sup>
RT-1,450	8.8 × 10 <sup>-6</sup>
RT-1,500	8.8 × 10 <sup>-6</sup>

**Table 6M**  
**Mean Linear Thermal Expansion Coefficients**

Temperature Range, °C	Coefficient, mm/mm/°C
RT-100	$13.9 \times 10^{-6}$
RT-125	$13.9 \times 10^{-6}$
RT-150	$14.0 \times 10^{-6}$
RT-175	$14.0 \times 10^{-6}$
RT-200	$14.1 \times 10^{-6}$
RT-225	$14.2 \times 10^{-6}$
RT-250	$14.3 \times 10^{-6}$
RT-275	$14.3 \times 10^{-6}$
RT-300	$14.4 \times 10^{-6}$
RT-325	$14.5 \times 10^{-6}$
RT-350	$14.5 \times 10^{-6}$
RT-375	$14.6 \times 10^{-6}$
RT-400	$14.6 \times 10^{-6}$
RT-425	$14.7 \times 10^{-6}$
RT-450	$14.7 \times 10^{-6}$
RT-475	$14.8 \times 10^{-6}$
RT-500	$14.8 \times 10^{-6}$
RT-525	$14.8 \times 10^{-6}$
RT-550	$14.8 \times 10^{-6}$
RT-575	$14.7 \times 10^{-6}$
RT-600	$14.7 \times 10^{-6}$
RT-625	$14.8 \times 10^{-6}$
RT-650	$14.9 \times 10^{-6}$
RT-675	$15.1 \times 10^{-6}$
RT-700	$15.3 \times 10^{-6}$
RT-725	$15.5 \times 10^{-6}$
RT-750	$15.6 \times 10^{-6}$
RT-775	$15.7 \times 10^{-6}$
RT-800	$15.8 \times 10^{-6}$

**Table 7**  
**Nominal Coefficients of Thermal Conductivity and Thermal Diffusivity**

Temperature, °F	Thermal Conductivity,	
	Btu/hr-ft × °F	Thermal Diffusivity, ft <sup>2</sup> /hr
70	5.4	0.105
100	5.6	0.108
150	6.0	0.113
200	6.4	0.118
250	6.8	0.124
300	7.0	0.127
350	7.3	0.130
400	7.6	0.134
450	8.1	0.138
500	8.3	0.140
550	8.7	0.144
600	9.0	0.146
650	9.5	0.152
700	9.7	0.154
750	10.0	0.157
800	10.3	0.161
850	10.6	0.165
900	11.0	0.169
950	11.4	0.172
1,000	11.8	0.174
1,050	12.1	0.176
1,100	12.9	0.181
1,150	14.0	0.190
1,200	14.1	0.192
1,250	14.5	0.196
1,300	14.8	0.198
1,350	14.9	0.198
1,400	14.9	0.197
1,450	14.9	0.197
1,500	15.0	0.197
1,550	15.2	0.198

**Table 7M**  
**Nominal Coefficients of Thermal Conductivity and Thermal Diffusivity**

Temperature, °C	Thermal Conductivity, W/m ×	
	°C	Thermal Diffusivity, 10 <sup>-6</sup> m <sup>2</sup> /s
20	9.3	2.70
50	10.0	2.86
75	10.7	3.00
100	11.3	3.12
125	11.8	3.21
150	12.2	3.28
175	12.6	3.35
200	13.0	3.41
225	13.5	3.49
250	14.1	3.57
275	14.7	3.66
300	15.3	3.74
325	15.9	3.83
350	16.4	3.92
375	16.9	4.00
400	17.4	4.09
425	17.9	4.17
450	18.3	4.25
475	18.8	4.33
500	19.4	4.40
525	20.1	4.46
550	20.9	4.52
575	21.7	4.59
600	22.6	4.68
625	23.5	4.79
650	24.3	4.92
675	25.0	5.02
700	25.5	5.10
725	25.7	5.12
750	25.8	5.10
775	25.8	5.12
800	25.8	5.06
825	26.0	5.08
850	26.3	5.11
875	26.6	5.16
900	27.0	5.21
925	27.3	5.26
950	27.6	5.29
975	27.9	5.33
1 000	28.2	5.36

Approval Date: March 18, 2014

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2795**  
**Use of PTFE Tubing Material for Flue Gas Heat Exchanger Tubes**  
**Section VIII, Division 1**

*Inquiry:* May polytetrafluoroethylene (PTFE) be used for flue gas heat exchanger tubes with water as the tube-side fluid and flue gas as the shell-side fluid in Section VIII, Division 1 construction? For the purpose of this Case, flue gas heat exchangers are used downstream of the boiler and electrostatic precipitator in a power plant.

*Reply:* It is the opinion of the Committee that PTFE may be used for flue gas heat exchanger tubes in Section VIII, Division 1 construction, provided the following requirements are met.

## 1 GENERAL REQUIREMENTS

(a) The virgin PTFE material shall have no fillers, additives, or pigments and shall be in compliance with ASTM D4895-10 and shall be limited to the polymer with a classification designation of either Type I Grade 4 Class B, or Type I Grade 3 Class D. The PTFE material shall also have a stretching void index of 50 maximum and a thermal instability index of 7 maximum. The PTFE fine powder material shall be certified by the materials manufacturer, and a certificate of analysis shall be furnished to the vessel manufacturer for each batch of finished material from a production reactor.

(1) The resin manufacturer's certificate of analysis shall include the following as a minimum with the referenced ASTM D4895-10 standard.

(-a) name and address of production plant where the material was made

(-b) reactor batch number (Batch is defined as the finished capacity of the reactor producing the material during one production cycle.)

(-c) certification of conformance with applicable ASTM D4895-10 type, grade, and class

(-d) apparent bulk density

(-e) average particle size diameter

(-f) standard specific gravity of material

(-g) thermal instability index

(-h) stretching void index

(2) The tube manufacturer's certified material test report shall include the following recorded data as a minimum.

(-a) name and address of production plant where tubes were made.

(-b) lot number for each extruder run (An extruder run is the length of tubing produced by the extruder in one production cycle and is given a unique serial number, which is the lot number by the tubing manufacturer.)

(-c) reference to resin manufacturer's batch number from which the tubes were made and ASTM specification, type and grade, and class

(-d) total length of lot

(-e) number of tubes cut from the lot coil and their nominal lengths

(-f) design drawing number and revision showing tube dimensions

(-g) outside diameter and nominal thickness of tubes

(-h) centerline U-bend radius for each tube referenced to tube serial number

(-i) specific gravity of extruder lot per ASTM D792-08

(-j) visual inspection results per Table 1 and dimensions (O.D. and wall thickness) with reference tolerances for each tube

(-k) test pressure per 3(d) after bending and its duration for the lot and certification of acceptable results

(-l) manufacturer's written tubing production procedure number

(-m) extrusion pressure at applicable reduction ratio

(b) The tube side of the completed heat exchanger shall be limited to liquid water service. Any service classified per UW-2(a) is not allowed.

(c) The maximum allowable design pressure for the tube side of the heat exchanger shall be limited to 116 psi (800 kPa) at a maximum temperature of 325°F (163°C).

(d) The PTFE tubing shall not be subject to any differential external pressure. The exchanger shall be installed in a system that controls the operation to ensure the tube

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

design pressure and temperature are not exceeded (e.g., maximum tube temperature exceeded due to loss of water on the tube side).

(e) The shell side of the tubes shall be not be subjected to a flue gas temperature exceeding 383°F (195°C), which shall also be the design temperature of the tube wall and the shell side of the exchanger. The minimum tube design temperature shall be no colder than 40°F (4.4°C). The design pressure of the shell side of the exchanger shall be less than 15 psig (103 kPa).

(f) The maximum nominal outside diameter of the PTFE tubing shall not exceed 0.63 in. (16 mm) with a minimum wall thickness of 0.035 in. (0.89 mm). The tolerance on outside diameter shall be  $\pm 1\%$  and on nominal wall thickness  $+0.012/-0$  in. ( $+0.3/-0$  mm).

(g) The heat exchanger shall be limited to a vertically oriented U-tube type with the U-bends at the bottom of the exchanger, and this service restriction shall be noted in the Remarks section of the Manufacturer's Data Report.

(h) The minimum centerline radius of the U-bends shall be four times the outside diameter of the tubing.

(i) Repairs to the PTFE tubing shall not be permitted.

(j) The PTFE tubing shall be mechanically attached to a metallic tubesheet using qualified procedures and operators per 2(e) and pull-tested per 4(c)

(k) The PTFE tubing shall be marked with an attached identification tag having a unique serial number on an end that will be trimmed off during installation into the tubesheet to provide traceability to the tubing material manufacturer's report of test results as well as the raw material supplier's certificate of analysis. The tubing manufacturer shall provide a map showing the location of each tagged tube into the tubesheet.

(l) The tubing shall be manufactured using paste extrusion process in which a virgin PTFE fine powder is mixed with a volatile hydrocarbon type lubricant pressed using a hydraulic ram into a cylindrical preform shape and fed into an extruder. This process shall be controlled by a written procedure in which all of the following process variables shall be considered essential:

(1) blend preparation

(-a) lubricant type and percentage based on total weight %

(2) extrusion parameters

(-a) tooling size, die and tip, in. (mm)

(-b) reduction ratio (ratio of cross-sectional area of the resin in the extruder barrel to the cross-sectional area of the resin in the die land)

(-c) tooling temperature, °F (°C)

(-d) drying oven temperature, °F (°C)

(-e) sintering oven temperature, °F (°C)

(-f) tube speed, ft/min (m/min)

A change in any of the essential variables shall require requalification of the written procedure per the test procedure specified in sections 2 and 3 below. The procedure shall indicate acceptable ranges for items (1)(-a) and

(2)(-c) through (2)(-f). The tube manufacturer shall also certify that the extruder lot of tubing meets the requirements of this Case.

(m) Tubing used for qualification testing shall not be used on Code-stamped heat exchangers.

(n) The design of the tubing shall take into account published cold flow data for PTFE to ensure the tubes do not permanently lengthen or expand under pressure or their own weight plus the weight of liquid and the differential longitudinal pressure stress in them. To ensure cold flow or creep is not an issue, the total longitudinal stress shall be limited to 600 psi (4.1 MPa) at the design temperature of the tube side of the exchanger. The total longitudinal stress due to pressure and weight shall be determined using the formulas in 5(b).

(o) The use of regrind or recycled material is prohibited.

(p) The completed tube side of the heat exchanger shall be hydrostatically tested per UG-99(b) at 1.3 times the MAWP of the tube side.

NOTE: Since the tube side contains carbon steel components, the lowest stress ratio will be 1.0 at the design temperature.

(q) This Case number shall be shown on the Manufacturer's Data Report and marked on the tubing identification tag, all material test reports, and the Code nameplate.

(r) On Form U-1, line 13 the description of the tubes shall be PTFE per ASTM D4895 with type, grade, and class to which it was manufactured listed.

## 2 DESIGN QUALIFICATION

The maximum allowable working pressure (which shall equal the design pressure) of the PTFE tubing shall be established by the following procedure.

(a) Long-term hydrostatic strength testing shall be conducted in accordance with ISO 9080-12 or ASTM D2837-11. The testing laboratory shall be accredited by the American Association for Laboratory Accreditation (A2LA) in the U.S.A, or shall be accredited by another agency recognized by the local jurisdiction elsewhere. The laboratory shall be qualified per ISO 17025 to perform this type of testing. The testing shall be conducted on a representative sample of a reactor batch of the virgin resin and of the extrusion lot to be used in actual production tubes using air or nitrogen as the test fluid. These tests shall be conducted at ambient, an intermediate temperature and up to 36°F (20°C) above the design temperature for a period of 10,000 hr and use linear regression analysis to extrapolate the long term strength for 50 yr per ISO 9080 or 100,000 hr per ASTM D2837.

The long-term hydrostatic strength at the design temperature obtained shall have a design factor of 0.67 applied resulting in a design strength that does not exceed  $\frac{2}{3}$  of the yield strength. The ratio of the lower confidence limit strength to the long term hydrostatic strength shall be a minimum of 0.9 for each method.

(b) The Authorized Inspector (AI) shall verify that the certified long-term hydrostatic strength test has been completed.

(c) The design qualification tubing shall be visually examined for imperfections prior to having samples subjected to the long-term hydrostatic testing. Classification and acceptance level of imperfections shall be according to Table 1.

(d) The rules of 5(a) of this Case shall be used to calculate the hoop stress in the tube at any pressure.

(e) Mechanical designs for the tube-to-tubesheet joint must have a written joining procedure and have a tube pull out test per 4(c). The tube-to-tubesheet joining procedure shall include procedure specifications, performance qualifications, acceptance criteria, and a procedure for how workers joining tubes to tubesheets shall be qualified. The procedure shall be acceptable to the AI and the user.

### 3 PRODUCTION TUBES

(a) Each tubing extruder run or lot shall be examined by the tube manufacturer externally over its entire length for imperfections. Classification and acceptance level of imperfections shall be according to Table 1. Any defective area found larger than the maximum allowable size shall be removed in its entirety.

(b) A sample of each production extruder lot shall have its specific gravity determined in accordance with ASTM D792-08 and shall have a value of 2.13 to 2.16.

(c) All tubes in a production extruder lot shall be examined for conformance with dimensions and tolerances shown on the design drawings or given in the ASTM D3295-06 Group 03, whichever is more restrictive. Any dimension falling outside the specified limit or the tolerances of this Case shall require the defective section to be rejected, cut out, and not used.

(d) After the tube manufacturer bends the tubes, they shall be subjected to a minimum hydrostatic pressure test of 70% of the burst pressure at the tube manufacturer with water at 70°F ± 5°F (21°C ± 3°C) for a minimum hold time of 15 min. Any failure due to burst, visible deformation, or leakage shall reject that specific tube. Retesting is not permitted.

### 4 PRODUCTION QUALIFICATION

(a) At least one tube per 65,000 ft (20,000 m) or at least one tube per bundle, whichever is less, shall be subject to a cold and hot burst test by the exchanger manufacturer in accordance with the following procedures. These tests shall be witnessed by the AI and certified by the manufacturer.

#### (1) Cold Burst Pressure Test

(-a) Cut five 10 in. ± 1/16 in. (250 mm ± 2 mm) long samples from the test tube.

(-b) Condition the tubes for at least 4 hr at 73°F ± 5°F (23°C ± 2.8°C) prior to testing. The test fluid temperature shall also be at this temperature.

(-c) Measure the wall thickness and outer diameter and record these values on the manufacturer's quality control form.

(-d) Close one end of the tube with a compression plug fitting and install a fill fitting on the other end. Fill the samples with mineral oil or water and plug the fill fitting. Make sure no visible air bubbles are present in the tube.

(-e) Raise the pressure of the fluid at a maximum rate of 145 psig/min (1 MPa/min) to 203 psig (1.4 MPa), and hold for a minimum of 6 min.

(-f) Then raise the pressure at a maximum rate of 29 psi/min (200 kPa/min) until the tube bursts. If the end plug leaks or fails before the tube bursts or leaks, the test is not valid.

(-g) Record the burst pressure at the end of the test as well as all test conditions.

(-h) The burst hoop stress shall have a minimum value of 1,914 psi (13.2 MPa) for any of the samples, which shall be calculated per 5(a).

#### (2) Hot Burst Pressure Test

(-a) Cut five 6 in. ± 1/16 in. (150 mm ± 2 mm) long samples from the test tube.

(-b) Measure the wall thickness and outer diameter and record these values on the manufacturer's quality control form.

(-c) Close one end of the tube with a compression plug fitting.

(-d) Fill each tube to 75% of its volume with water (the rest is air) at a minimum temperature of 60°F (15°C).

(-e) Close the open end of the tube with a plug fitting.

(-f) Install oven thermocouples onto the tubes.

(-g) Heat the tubes in an oven preheated at 320°F ± 4°F (160°C ± 2°C) in a way that they are visible once the door is closed.

(-h) Condition the tubes for 15 min at the preheated temperature.

(-i) Raise the temperature at a maximum rate of 5.4°F/min (3°C/min) until all tubes burst or leak. If the end plug leaks or fails before the tube bursts or leaks the test is not valid.

(-j) Record the temperature during the whole test including rate of temperature rise.

(-k) Note the burst or leak temperature of each tube and record it on the certified test report.

(-l) The steam pressure at burst can be calculated using the steam pressure table of water.

(-m) The burst hoop stress shall be calculated per 5(a) and have a minimum value of 710 psi (4.9 MPa) for any of the samples.

(b) The tubing to be used for these tests shall be selected at random by the AI, and the test results shall be certified by the manufacturer on their material test report.

(c) In addition to meeting the procedure performance qualifications of 2(e) for tube-to-tubesheet joints, and before making production tube-to-tubesheet joints, each worker shall demonstrate to the satisfaction of the AI the ability to achieve complete tube-to-tubesheet joints by successfully assembling six test pieces with a minimum joint pull-out strength that exceeds the strength of the bare tube. The test pieces shall be visually examined to verify a complete joint, sectioned to verify minimum required tube thickness and complete compression of the tube along the entire length of the joint. For each worker's mock-up assembly, a tube pull test shall be done for each size and thickness of tube being used using six tubes in a tubesheet mockup. The tube pull-out test shall establish that the tubes will fail outside the tubesheet before the tube-to-tubesheet joint fails. The results shall be recorded and maintained with the performance qualification record. The results for each worker shall be acceptable to the AI before that worker performs any production tube-to-tubesheet joints.

## 5 TUBE STRESS CALCULATIONS

(a) The hoop stress in the tubing at any pressure [see 2(d), 4(a)(1)(-h), and 4(a)(2)(-m)] shall be calculated based on the following equation for internal pressure.

$$S_h = Pr/t \quad (1)$$

where

- $P$  = internal pressure
- $r$  = maximum inside radius of the tube
- $S_h$  = hoop stress value at pressure  $P$
- $t$  = minimum thickness of the tube

(b) The longitudinal stress in the tubing at pressure  $P$  [see 1(n)] and total longitudinal stress shall be calculated based on the following equations:

$$S_{lp} = Pr/2t \quad (2)$$

where

$S_{lp}$  = longitudinal stress value at pressure  $P$

$$S_l = S_{lp} + W/A \quad (3)$$

where

- $A$  = cross sectional area of the tubing
- $S_l$  = total longitudinal stress due to pressure and weight
- $W$  = weight of suspended tubing below the tubesheet plus the weight of the water contained in the suspended tube

$P$ ,  $r$ , and  $t$  are defined in (a).

## 6 PHYSICAL PROPERTIES

Select physical properties for PTFE to be used for design are as follows:

(a) thermal conductivity = 0.14 Btu/hr-ft-°F (0.25 W/m-K)

(b) linear coefficient of expansion from 77°F to 392°F (25°C to 200°C) =  $8.4 \times 10^{-5}$  in./in. °F ( $15.1 \times 10^{-5}$  mm/mm °C)

## 7 SUMMARY OF CODE CASE REQUIREMENTS

Table 2 provides a summary of the Code Case requirements for material, design, and qualification.

**Table 1**  
**Visual Flaw Acceptance Criteria**

Defect	Definition	Maximum Size, in. (mm)
Black spots, brown streaks	Dark spots or streaks	0.015 (0.4)
Blisters	Hollows on or in the part	0.015 (0.4)
Bubbles	Air entrapped in the part	0.015 (0.4)
Burn marks, dieseling	Charred or dark plastic caused by trapped gas	0.015 (0.4)
Cracking, crazing	Any visible	0.015 (0.4)
Delamination	Single surface layers that flake off the part	0.015 (0.4)
Discoloration	Similar to burn marks but generally not as dark or severe	Acceptable
Flow, halo, blush marks	Marks seen on the part due to flow of molten plastic across the molding surface	0.015 (0.4)
Gels	Bubbles or blisters on or in the part due to poor melt quality	0.015 (0.4)
Jetting	Undeveloped frontal flow	0.015 (0.4)

**Table 2**  
**Summary of Material, Design, and Qualification Requirements**

Requirement	Paragraph	Comment
Material specification	1(a)	Resin raw material
Minimum wall thickness	1(f)	...
Maximum O.D.	1(f)	...
Extrusion process and procedure qualification	1(f)	Qualified procedure required
Tube side design pressure (internal and external)	1(c) and 1(d)	...
Tube side temperature	1(c)	...
Maximum shell side design pressure	1(e)	...
Maximum design temperature of shell side	1(e)	...
Maximum design temperature of tubes	1(e)	...
Tube configuration and orientation	1(g)	Vertical U-tube only
Maximum longitudinal tube stress	1(n)	...
Minimum bend radius	1(h)	...
Tube-to-tubesheet joint	1(j), 2(e), and 4(c)	...
Tube side hydrostatic test pressure	1(p)	...
Design pressure qualification	2(a)	Long term hydrostatic tests
Production qualifications	4(a) and 4(c)	Hot and cold burst tests and pullout tests
Tube stress calculation formulas	5(a) and 5(b)	Hoop and longitudinal Stress
Material physical properties	6(a) and 6(b)	...

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Approval Date: March 18, 2014

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2796**  
**Analysis of Liner(s) for Wire Wound Vessels**  
**Section VIII, Division 3**

*Inquiry:* Under what conditions may yielding of the inner cylinders(s) [liners(s)] be permitted in lieu of the requirements in Section VIII, Division 3, KD-911(c) construction?

*Reply:* It is the opinion of the Committee that yielding of inner cylinders(s) [liners(s)] may be permitted in lieu of the requirements in Section VIII, Division 3, KD-911(c) construction, provided the following requirements are met:

(a) Yielding is permitted only in compression during the wire winding process.

(b) Yielding is not permitted at any value of operating pressure from atmospheric to design pressure at any specified coincident temperature, or at any value of operating pressure from atmospheric to test pressure at the test temperature.

(c) The inner cylinders(s) [liners(s)] shall meet the requirements of KD-230 for elastic-plastic analysis including the requirements of KD-232 for protection against local failure.

(d) Stresses in the wire may be calculated using the requirements in KD-230 or the equations in KD-911.

(e) Deformation of the inner cylinders(s) [liners(s)] shall be calculated using the requirements in KD-230.

(f) This Case Number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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**Case 2797**  
**Material Requirements for Valve Stems for Use With**  
**Power-Actuated Pressure Relief Systems**  
**Section VIII, Division 3**

*Inquiry:* Under what conditions may the materials requirements of Section VIII, Division 3, KR-324 be used for the stems of valves used in conjunction with power-actuated pressure relief systems that meet the requirements of Article KR-6?

*Reply:* It is the opinion of the Committee that materials meeting the requirements of Section VIII, Division 3, KR-324 may be used for the stems of valves used in conjunction with power-actuated pressure relief systems that meet the requirements of Article KR-6, provided the following requirements are met:

(a) Failure of the valve stem shall result in depressurization of the system.

(b) Any fluid that is released as a result of valve stem failure shall be directed away from personnel.

(c) Fluid released shall be nonhazardous.

(d) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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**Approval Date: April 1, 2014**

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**Case 2798**  
**Welding Filler Metals**  
**Section II, Part C**

*Inquiry:* Under what conditions may the welding electrodes and filler metals shown in AWS A5.11/A5.11M:2010, Specification for Nickel and Nickel-Alloy Electrodes for Shielded Metal Arc Welding, which has been approved for publication by ASME without any changes but not yet published, be used?

*Reply:* It is the opinion of the Committee that the welding electrodes and filler metals shown in AWS A5.11/A5.11M:2010, Specification for Nickel and Nickel-Alloy Electrodes for Shielded Metal Arc Welding, may be used under the following conditions:

(a) ENiCrFe-13 and ENiCrMo-22 shall be considered F-No. 43 in Section IX, Table QW-432.

(b) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: June 26, 2018

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2799-1**  
**Induction Kinetic Welding**  
**Section VIII, Division 1; Section VIII, Division 2; Section IX**

*Inquiry:* Under what conditions may a WPS be qualified for using induction kinetic welding to circumferentially butt weld pipe?

*Reply:* It is the opinion of the Committee that a WPS may be qualified for using induction kinetic welding to circumferentially butt weld pipe, provided the following conditions are met:

(a) Welding Procedure Specification (WPS) Qualification

(1) The WPS shall be limited to circumferential butt welding of pipe with the same nominal wall thickness and outside diameter.

(2) The WPS shall be qualified by preparing a qualification weld, observing, and recording the values for the variables from Table 1 with the following three additional essential variables:

(-a) a change in induction coil power greater than 3%

(-b) a change in induction heating time greater than 10%

(-c) a change in the cumulative rotational distance of motion greater than 10%

(3) The completed weld shall be visually examined according to QW-144, and the weld reinforcement shall have a gradual transition from the pipe to the weld on both the outside diameter and inside diameter surface.

(4) The completed test coupon shall be subjected to the mechanical tests required by Table QW-451.1.

(b) The welding operator qualification for induction kinetic welding shall be in accordance with QW-305.

(c) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Welding Variables for Induction Kinetic Welding**

Paragraph	Subparagraph	Brief of Variables	Essential	Supplementary Essential	Nonessential
QW-402, Joints	.12(a)	∅ ±10 deg	X	...	...
	.12(b)	∅ Cross-section > 10%	X	...	...
	.12(c)	∅ O.D. > ±10%	X	...	...
QW-403, Base Metals	.24	∅ Specification, type, or grade	X	...	...
QW-406, Preheat	.7	∅ > 10% Amperage or number of preheat cycles or method, or > 25°F temperature	X	...	...
QW-407, PWHT	.8	∅ PWHT, PWHT cycles, or separate PWHT time or temperature	X	...	...
QW-408, Gas	.22	∅ Shielding gas composition, pressure, or purge time	X	...	...
QW-410, Technique	.17	∅ Type/model of equipment	X	...	...
	.27	∅ Spp. > ±10%	X	...	...
	.31	∅ Cleaning method	X	...	...
	.54	∅ > 10% Upset length or force	X	...	...
	.55	∅ > 10% Distance between clamping dies or preparation of clamping area	X	...	...
	.57	∅ > 10% Forward or reverse speed	X	...	...

Legend:

∅ = Change

Approval Date: April 30, 2014

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2801**  
**Alloy SUS 430J1LTB/JIS G 3463:2006 Tubes for Heating Boilers**  
**Section IV**

*Inquiry:* Under what conditions may alloy SUS 430J1LTB meeting the material requirements of JIS G 3463:2006 be used in the construction of heating boilers per Part HF?

*Reply:* It is the opinion of the Committee that alloy SUS 430J1LTB meeting the material requirements of JIS G 3463:2006<sup>1</sup> may be used in the construction of heating boilers per Part HF, provided the following requirements are met:

(a) The allowable stress values for tubes in accordance with alloy SUS 430J1LTB shall be as listed in [Tables 1](#) and [1M](#).

(b) The minimum specified tensile strength shall be 56.5 ksi (390 MPa).

(c) The minimum specified yield strength shall be 29.5 ksi (205 MPa).

(d) For the purpose of welding procedure and performance qualifications, this material shall be considered P-No. 7, Group 2.

(e) For external pressure, Figure CS-2 of Section II, Part D shall be used.

(f) The maximum design temperature shall be 500°F (260°C).

(g) The water temperature shall not exceed 250°F (125°C).

(h) The maximum allowable working pressure shall not exceed 30 psi (205 kPa).

(i) All other requirements of Section IV shall be met.

(j) This Case number shall be shown on the Manufacturer's Data Report.

<sup>1</sup> See Section II, Part A, Nonmandatory Appendix A in order to obtain an English copy of the specification.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi
100	11.3
150	11.2
200	11.1
250	10.9
300	10.8
400	10.7
500	10.4

## GENERAL NOTES:

- (a) This material may utilize the minimum thickness exemptions shown in HF-301.1(c).
- (b) For welded tubes and pipes, a quality factor of 0.85 shall be applied.

**Table 1M**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Values, MPa
40	78.0
65	78.0
100	75.9
150	74.5
200	73.7
225	73.1
250	72.3
275 [Note (1)]	71.4

## GENERAL NOTES:

- (a) This material may utilize the minimum thickness exemptions shown in HF-301.1(c).
- (b) For welded tubes and pipes, a quality factor of 0.85 shall be applied.

## NOTE:

- (1) The maximum use temperature shall be 260°C. Datum for 275°C temperature is provided for interpolation purposes.

Approval Date: April 30, 2014

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2802**  
**Alloy SUS 430J1LTB/JIS G 3463:2006 Tubes for Water Heaters**  
**Section IV**

*Inquiry:* Under what conditions may alloy SUS 430J1LTB meeting the material requirements of JIS G 3463:2006 be used in the construction of water heaters per Section IV, Part HLW?

*Reply:* It is the opinion of the Committee that alloy SUS 430J1LTB meeting the material requirements of JIS G 3463:2006<sup>1</sup> may be used in the construction of water heaters per Section IV, Part HLW, provided the following requirements are met:

(a) The allowable stress values for tubes in accordance with alloy SUS 430J1LTB shall be as listed in [Tables 1](#) and [1M](#).

(b) The minimum specified tensile strength shall be 56.5 ksi (390 MPa).

(c) The minimum specified yield strength shall be 29.5 ksi (205 MPa).

(d) For the purpose of welding procedure and performance qualifications, this material shall be considered P-No. 7, Group 2.

(e) For external pressure, Figure CS-2 of Section II, Part D shall be used.

(f) The maximum design temperature shall be 500°F (260°C).

(g) The water temperature shall not exceed 210°F (99°C).

(h) The maximum allowable working pressure shall not exceed 30 psi (205 kPa).

(i) All other requirements of Section IV shall be met.

(j) This Case number shall be shown on the Manufacturer's Data Report.

<sup>1</sup> See Section II, Part A, Nonmandatory Appendix A in order to obtain an English copy of the specification.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi
100	14.1
150	14.0
200	13.8
250	13.7
300	13.5
400	13.3
500	13.1

GENERAL NOTE: For welded tubes and pipes, a quality factor of 0.85 shall be applied.

**Table 1M**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Values, MPa
40	97.5
65	97.5
100	94.9
150	93.2
200	92.1
225	91.4
250	90.4
275 [Note (1)]	89.3

GENERAL NOTE: For welded tubes and pipes, a quality factor of 0.85 shall be applied.

NOTE:

(1) The maximum use temperature shall be 260°C. Datum for 275°C temperature is provided for interpolation purposes.

**Approval Date: May 19, 2014**

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2803**  
**Use of Thermometers With Minimum Full-Scale Range**  
**of 50°F to 250°F (10°C to 120°C)**  
**Section IV**

*Inquiry:* May thermometers with a minimum full-scale range of 50°F to 250°F (10°C to 120°C) be used on Section IV boilers?

*Reply:* It is the opinion of the Committee that thermometers with a minimum full-scale range of 50°F to 250°F (10°C to 120°C) may be used on Section IV boilers under the following conditions:

(a) These thermometers shall not be used after December 31, 2015.

(b) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: June 23, 2014

*Code Cases will remain available for use until annulled by the applicable Standards Committee.***Case 2804**  
**Corrected Forming Strain Equation, Table 6.1**  
**Section VIII, Division 2**

*Inquiry:* Is it the intent of Section VIII, Division 2 that the forming strain equation in Table 6.1 use the term  $D_o$  in the denominator applicable for all one-piece double-curved circumferential products?

*Reply:* It is the opinion of the Committee that the current equation for all one-piece double-curved circumferential products in the first row of Table 6.1 is incorrect, and the following corrected equation shall be used:

$$\varepsilon_f = 100 \ln \left( \frac{D_b}{D_f - 2t} \right)$$

where

 $D_b$  = diameter of blank plate or of intermediate product $D_f$  = final outside diameter of component after forming $t$  = nominal thickness of plate, pipe, or tube before forming $\varepsilon_f$  = calculated forming strain

This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: May 14, 2014

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2805**  
**Alternate Rules to PG-26 for Nickel Base Alloys**  
**Section I**

*Inquiry:* What alternate rules to PG-26, Section I may be used for determining the weld strength reduction factors (WSRFs) to be applicable when calculating maximum allowable working pressure (MAWP) or minimum required thickness of components fabricated with longitudinal and spiral (helical) seam welds made from nickel base alloys not listed in PG-26 and used in the creep range?

*Reply:* It is the opinion of the Committee that the rules of PG-26 and Table PG-26 [excluding Note (4)] and described in the Inquiry shall apply, provided the following requirements are met:

(a) Nickel base alloys [see (d)] not listed in PG-26 but listed in Section II, Part D, Table 1B and applicable code cases for Section I components are shown in Table 1 along with assigned WSRFs. These alloys and their assigned WSRFs are covered by the rules in this Case when welded with or without filler.

(b) Autogenous welds (made without weld filler metal) made from nickel base alloys listed in (a) have been assigned a WSRF of 1.00 up to 1,650°F (899°C) when stress allowables are provided in Section II, Part D, Table 1B or applicable code cases, and provided that the product is solution annealed after welding and receives a nondestructive electric examination in accordance with the material specification.

(c) WSRFs shall be applied in the design of cylinders containing longitudinal butt welds and to hemispherical heads or any other spherical sections that comprise segments joined by welding. Longitudinal butt welds shall be interpreted to include spiral (helical) welds per PW-11.2.

(d) Nickel base alloys are defined as metal alloys that contain more nickel by weight percent than any other element.

(e) This Case number shall be shown on the Manufacturer's Data Report.

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**Table 1**  
**WSRFs to Be Applied When Calculating MAWP of Minimum Required Thickness of Components Fabricated with Longitudinal Seam Weld**

Temperature	Nickel Base Alloys														Autogenous Welded Nickel Base Alloys
	N06045	N06600	N06690	N06601	N06025	N10276	N06022	N06230	N06625	N06617 (Except SAW) [Note (1)]	N06617 (SAW) [Note (2)]	N07740			
°F	°C														
700	371	...	...	...	...	...	...	...	...	...	...	...	...	...	...
750	399	...	...	...	...	...	...	...	...	...	...	...	...	...	...
800	427	1.00	1.00	...	...	...	...	...	...	...	...	...	...	...	1.00
850	454	0.95	0.95	1.00	...	...	...	...	...	...	...	...	...	...	1.00
900	482	0.91	0.91	0.95	...	...	...	...	...	...	...	...	...	...	1.00
950	510	0.86	0.86	0.91	1.00	...	...	...	...	...	...	...	...	...	1.00
1,000	538	0.82	0.82	0.86	0.95	1.00	...	...	...	...	...	...	...	...	1.00
1,050	566	0.77	0.77	0.82	0.91	0.95	1.00	...	...	...	...	...	...	...	1.00
1,100	593	0.73	0.73	0.77	0.82	0.86	0.91	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1,150	621	0.68	0.68	0.73	0.77	0.82	0.86	0.91	0.95	1.00	1.00	1.00	1.00	1.00	1.00
1,200	649	0.64	0.64	0.68	0.73	0.77	0.82	0.86	0.91	0.95	1.00	1.00	1.00	1.00	1.00
1,250	677	0.59	0.59	NP	0.68	0.73	0.77	0.82	0.86	0.91	0.95	1.00	1.00	1.00	1.00
1,300	704	0.55	0.55	NP	0.64	0.68	0.73	0.77	0.82	0.86	0.91	0.95	1.00	1.00	1.00
1,350	732	0.50	0.50	NP	0.59	0.64	0.68	0.73	0.77	0.82	0.86	0.91	0.95	1.00	1.00
1,400	760	0.50	0.50	NP	0.55	0.59	0.64	0.68	0.73	0.77	0.82	0.86	0.91	0.95	1.00
1,450	788	0.50	0.50	NP	0.50	0.55	0.59	0.64	0.68	0.73	0.77	0.82	0.86	0.91	0.95
1,500	816	0.50	0.50	NP	0.50	0.50	0.55	0.59	0.64	0.68	0.73	0.77	0.82	0.86	0.91
1,550	843	NP	NP	NP	0.50	0.50	0.50	0.55	0.59	0.64	0.68	0.73	0.77	0.82	0.86
1,600	871	NP	NP	NP	0.50	0.50	0.50	0.50	0.55	0.59	0.64	0.68	0.73	0.77	0.82
1,650	899	NP	NP	NP	0.50	0.50	0.50	0.50	0.50	0.55	0.59	0.64	0.68	0.73	0.77

Legend:

NP = Not permitted

NOTES:

(1) Includes SMAW, GTAW, and GMAW filler metal welds.

(2) SAW filler metal welds.

Approval Date: June 23, 2014

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2806**  
**Rules for Calculating Maximum Permissible Gaps for**  
**Layered Vessels in 4.13.12.3**  
**Section VIII, Division 2**

$$K_c = \left( \frac{4S_a}{3S_m} + 0.25 \right)^{0.5} - 0.5$$

*Inquiry:* May the following equation for  $K_c$  taken from AF-815.2 (2006 Addenda) be used instead of eq. (4.13.7) in 4.13.12.3 of Section VIII, Division 2 (2007 edition through 2013 edition)?

*Reply:* It is the opinion of the Committee that the above equation may be used instead of eq. (4.13.7) in 4.13.12.3, provided that this Case number is shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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(19)

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**Case 2807-1**  
**Exemption From Post-Bending Heat Treatment**  
**Requirements for Carbon and Low-Alloy Steel Tube and**  
**Pipe**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions may bends in tube and pipe of carbon and low-alloy steel that are fabricated by cold forming be exempt from the post-bending heat treatment requirements of UCS-79(d)?

*Reply:* It is the opinion of the Committee that bends in tube and pipe of carbon and low-alloy steel that are fabricated by cold forming may be exempt from the post-bending heat treatment requirements of UCS-79(d), provided the following requirements are met:

(a) For P-No. 1 material, the nominal wall thickness shall not exceed  $\frac{3}{4}$  in. (19.0 mm).

(b) For carbon and low-alloy pipe and tube material in P-No. 3 through P-No. 5A, 5B Grade 1, and 5C Grade 1, an outside diameter is not greater than 4.5 in. (114 mm) and wall thickness not greater than  $\frac{1}{2}$  in. (13.0 mm).

(c) This Case number shall be identified in the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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**Case 2808**  
**UNS S31254 and UNS N08904 Austenitic Stainless Steel**  
**Plate, Sheet, and Strip**  
**Section VIII, Division 2**

*Inquiry:* Is it permissible to use UNS S31254 and UNS N08904 plate, sheet, and strip conforming to the requirements of SA-240 and UNS N08904 plate, sheet, and strip conforming to the requirements of SB-625 for the construction of plate heat exchangers in accordance with Section VIII, Division 2?

*Reply:* It is the opinion of the Committee that plate, sheet, and strip described in the Inquiry may be used in the construction of plate heat exchangers in accordance of Section VIII, Division 2, provided the following requirements are met:

(a) The maximum allowable stress values for UNS S31254 shall be as listed in Tables 1, 1M, 2 and 2M.

(b) The maximum allowable stress values for UNS N08904 shall be as listed in Tables 3 and 3M.

(c) All other applicable requirements of Section VIII, Division 2 shall apply; use austenitic stainless steel rules for UNS S31254 and nickel alloy rules for UNS N08904.

(d) The maximum design temperature shall not exceed 750°F (399°C) for UNS S31254 and 700°F (371°C) for UNS N08904.

(e) This Case number shall be identified in the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values for UNS S31254, Thickness Greater Than  $\frac{3}{16}$  in.**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Value, ksi
-20 to 100	27.1
200	27.1
300	25.8
400	24.6
500	23.7
600	23.2
650	23.1
700	23.0
750	22.9

GENERAL NOTE: The allowable stress values are from Section II, Part D, Table 1A.

**Table 2**  
**Maximum Allowable Stress Values for UNS S31254, Thickness Less Than or Equal to  $\frac{3}{16}$  in.**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Value, ksi
-20 to 100	28.6
200	28.6
300	27.2
400	25.9
500	25.0
600	24.4
650	24.3
700	24.1
750	23.9

GENERAL NOTE: The allowable stress values are from Section II, Part D, Table 1A.

**Table 1M**  
**Maximum Allowable Stress Values for UNS S31254, Thickness Greater Than 5 mm**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Value, MPa
-30 to 40	187
65	187
100	186
125	183
150	178
200	170
250	164
300	161
325	160
350	159
375	158
400 [Note (1)]	158

GENERAL NOTE: The allowable stress values are from Section II, Part D, Table 1A.

NOTE:

(1) The maximum design temperature is 399°C; the 400°C value is for interpolation only.

**Table 2M**  
**Maximum Allowable Stress Values for UNS S31254, Thickness Less Than or Equal to 5 mm**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Value, MPa
-30 to 40	197
65	197
100	197
125	193
150	187
200	179
250	173
300	169
325	168
350	167
375	166
400 [Note (1)]	165

GENERAL NOTE: The allowable stress values are from Section II, Part D, Table 1A.

NOTE:

(1) The maximum design temperature is 399°C; the 400°C value is for interpolation only.

**Table 3**  
**Maximum Allowable Stress Values for UNS**  
**N08904**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Value, ksi
-20 to 100	20.3
200	16.7
300	15.1
400	13.8
500	12.7
600	11.9
650	11.6
700	11.4

GENERAL NOTE: The allowable stress values are from Section II, Part D, Table 1B.

**Table 3M**  
**Maximum Allowable Stress Values for UNS**  
**N08904**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Value, MPa
-30 to 40	140
65	126
100	113
125	108
150	104
175	99.9
200	95.8
225	92.1
250	88.8
275	85.9
300	83.4
325	81.3
350	79.6
375 [Note (1)]	78.4

GENERAL NOTE: The allowable stress values are from Section II, Part D, Table 1B.

NOTE:

(1) The maximum design temperature is 371°C; the 375°C value is for interpolation only.

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**Case 2809**  
**58Ni-29Cr-9Fe Alloy (UNS N06690)**  
**Section I**

*Inquiry:* May cold-drawn and annealed alloy UNS N06690, SB-167 seamless pipe and tube be used in water-wetted service in welded construction under Section I?

*Reply:* It is the opinion of the Committee that cold-drawn and annealed alloy UNS N06690, SB-167 seamless pipe and tube as described in the Inquiry may be used in water-wetted service in welded construction complying with the rules of Section I, provided the following requirements are met:

(a) The maximum allowable stress values for the material shall be those given in Section II, Part D, Table 1B.

(b) Welded fabrication shall conform to the applicable requirement of Section I. When welding is performed with filler metal of the same nominal composition as the base metal, only GMAW and GTAW processes are allowed.

(c) This base metal is assigned to P-No. 43.

(d) When heat treatment is applied, the temperature, time, and method of heat treatment shall be covered by agreement between the user and manufacturer. When

this material is formed, the rules of Section I, PG-19 shall apply for alloy UNS N06690. Other than these requirements, any other heat treatment after forming or fabrication is neither required nor prohibited.

(e) For Section I, which requires a temperature-dependent parameter,  $y$  [see PG-27.4, Note (6)], the  $y$  values shall be as shown in PG-27.4.

(f) This Case number shall be recorded on the Manufacturer's Data Report.

**CAUTION: Austenitic alloys are subject to stress corrosion cracking, intergranular attack, pitting, and crevice corrosion when used in boiler applications in aqueous environments. Factors that affect the susceptibility of these materials are applied or residual stress, water chemistry and deposition of solids, and material condition. Susceptibility to attack is enhanced when the material is used in a sensitized condition or with residual cold work. Concentration of corrosive agents (e.g., chlorides, caustic or reduced sulfur species) can occur under deposits formed on the surface of these materials and can result in severe underdeposit wastage or cracking. For successful operation in water environments, careful attention must be paid to continuous control of water chemistry.**

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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**Case 2810**  
**Use of UNS N08367 Material for Construction**  
**Section I**

*Inquiry:* May annealed austenitic chromium-nickel-molybdenum-iron alloy UNS N08367 wrought sheet, strip, plate, rod and bar, flanges and fittings, and welded pipe and tubing be used for water-wetted service in Section I construction?

*Reply:* It is the opinion of the Committee that annealed austenitic chromium-nickel-molybdenum-iron alloy UNS N08367 wrought sheet, strip, plate, rod and bar, flanges and fittings, and welded pipe and tubing may be used for water-wetted service in Section I construction, provided the following requirements are met:

(a) Allowable product specifications are as shown in Table 1.

(b) The maximum service temperature is limited to 800°F (427°C).

(c) The maximum allowable stress values shall be those shown in Tables 2, 2M, 3, and 3M. Tables 2 and 2M are for SB-366, SB-675, SB-676, SB-688, SB-690, SB-691, SB-804 materials greater than  $\frac{3}{16}$  in. (5 mm) thick and for SB-462 and SB-564 materials. Tables 3 and 3M are for SB-366, SB-675, SB-676, SB-688, SB-690, SB-691, SB-804 materials less than or equal to  $\frac{3}{16}$  in. (5 mm) thick.

(d) The stresses for welded products shall be multiplied by a joint efficiency factor of 0.85.

(e) Welded fabrication shall conform to the applicable requirements of Section I.

(f) This base metal is assigned to P-No. 45.

(g) Welds that are exposed to the effects of corrosion shall be made using filler metal having corrosion resistance comparable to or better than that of the base metal.

(h) Heat treatment after forming or fabrication is neither prohibited nor required, but if performed shall be a full anneal per the material specification.

(i) The required thickness for external pressure shall be determined from Figure NFN-12 of Section II, Part D.

(j) This Case number shall be shown on the Manufacturer's Data Report.

**CAUTION: Austenitic alloys are subject to stress corrosion cracking, intergranular attack, pitting, and crevice corrosion when used in boiler applications in aqueous environments. Factors that affect the susceptibility of these materials are applied or residual stress, water chemistry and deposition of solids, and material condition. Susceptibility to attack is enhanced when the material is used in a sensitized condition or with residual cold work. Concentration of corrosive agents (e.g., chlorides, caustic or reduced sulfur species) can occur under deposits formed on the surface of these materials and can result in severe underdeposit wastage or cracking. For successful operation in water environments, careful attention must be paid to continuous control of water chemistry.**

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1  
Allowable Product Specifications**

Product Form	Specifications
Fittings	SB-366
Forgings	SB-462, SB-564
Plate, sheet, and strip	SB-688
Rod and bar	SB-691
Seamless pipe and tube	SB-690
Welded pipe	SB-675, SB-804
Welded tubing	SB-676

**Table 2  
Maximum Allowable Stress Values for UNS  
N08367, Thickness Greater Than  $\frac{3}{16}$  in.**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi	Maximum Allowable Stress Values, ksi [Note (1)]
-20 to 100	27.1	27.1
200	26.2	27.1
300	23.8	25.7
400	21.9	24.6
500	20.5	23.8
600	19.4	23.3
650	19.0	23.1
700	18.6	22.9
750	18.3	22.8
800	18.0	22.6

NOTE:

(1) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed 66 $\frac{2}{3}$ %, but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.

**Table 2M  
Maximum Allowable Stress Values for UNS  
N08367, Thickness Greater Than 5 mm**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Values, MPa	Maximum Allowable Stress Values, MPa [Note (1)]
-30 to 40	187	187
65	185	187
100	179	186
125	172	182
150	164	177
175	157	173
200	152	170
225	147	167
250	143	165
275	139	163
300	136	161
325	133	160
350	130	159
375	128	158
400	126	157
425	124	156
450[Note (2)]	122	155

NOTES:

- (1) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed 66 $\frac{2}{3}$ %, but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.
- (2) The maximum design temperature is 427°C; the 450°C value is for interpolation only.

**Table 3**  
**Maximum Allowable Stress Values for UNS**  
**N08367, Thickness Less Than or Equal to**  
 $\frac{3}{16}$  in.

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Values, ksi	Maximum Allowable Stress Values, ksi [Note (1)]
-20 to 100	28.6	28.6
200	26.2	28.6
300	23.8	27.0
400	21.9	25.8
500	20.5	25.0
600	19.4	24.5
650	19.0	24.3
700	18.6	24.1
750	18.3	24.0
800	18.0	23.8

## NOTE:

- (1) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed  $66\frac{2}{3}\%$ , but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.

**Table 3M**  
**Maximum Allowable Stress Values for UNS**  
**N08367, Thickness Less Than or Equal to**  
 5 mm

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Values, MPa	Maximum Allowable Stress Values, MPa [Note (1)]
-30 to 40	197	197
65	189	197
100	179	197
125	171	192
150	164	186
175	157	181
200	152	178
225	147	176
250	143	173
275	139	171
300	136	170
325	133	168
350	130	167
375	128	166
400	126	165
425	124	164
450 [Note (2)]	122	163

## NOTES:

- (1) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed  $66\frac{2}{3}\%$ , but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.
- (2) The maximum design temperature is 427°C; the 450°C value is for interpolation only.

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**Case 2811**  
**SA/EN 10025-2 Steel Grades S235J2, S275J2, and**  
**S355J2**  
**Section VIII, Division 1**

*Inquiry:* May steel grades S235J2, S275J2, and S355J2 as specified in SA/EN 10025-2 be used for the fabrication of pressure vessels if all other requirements of Section VIII, Division 1 are met?

*Reply:* It is the opinion of the Committee that the materials described in the Inquiry may be used in the construction of pressure vessels conforming to the rules of Section VIII, Division 1, provided the following requirements are met:

(a) The maximum allowable design stress shall not exceed that shown in Table 1. Yield and tensile strength values used for design up to the maximum use temperature shall be the minimum values at room temperature as required by the specification.

(b) The maximum allowable design temperature shall not exceed 212°F (100°C).

(c) The thickness of the materials shall be limited between 0.20 in. to 0.55 in. (5 mm to 14 mm), inclusive.

(d) The materials shall be used for components under internal pressure only.

(e) Welding procedure and performance qualifications shall be conducted in accordance with Section IX. Grades S235J2 and S275J2 shall be considered as P- No. 1, Group No. 1. Grade S355J2 shall be considered as P-No. 1, Group No. 2 for material thickness less than or equal to 4 in. (100 mm). Grade S355J2 shall be considered as P-No. 1, Group No. 1 for material thickness greater than 4 in. (100 mm).

(f) The materials shall be considered Curve B for the purpose of impact test requirements.

(g) The physical properties shall be those for carbon steels in Section II, Part D, Subpart 2.

(h) All other requirements in Part UCS shall be met.

(i) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F (°C)	Maximum Allowable Stress Values, ksi (MPa)		
	Steel Grade		
	S235J2	S275J2	S355J2
212 (100)	14.9 (103)	17.0 (117)	19.4 (134)

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*Code Cases will remain available for use until annulled by the applicable Standards Committee.***Case 2812  
Pneumatic Testing of Welded Hot Water Heating Boilers  
Section IV**

*Inquiry:* Under what conditions may welded hot water heating boilers constructed in accordance with Section IV be tested pneumatically using the pressure differential method in lieu of the hydrostatic test required in HG-510(c)?

*Reply:* It is the opinion of the Committee that pneumatic testing using the pressure differential method may be used in lieu of hydrostatic test required in HG-510(c), provided the following requirements are met:

(a) The pressure change leak test shall be performed in accordance with the applicable requirements of Section V, Article 10, Mandatory Appendix VI and ASTM E2930.

(b) The volume of the welded boiler shall be no greater than 7 gal (26 L).

(c) No part of the tested item shall be made of cast materials.

(d) The MAWP shall be no greater than 80 psi (552 kPa).

(e) The test pressure shall be the greater of 38 psi or 1.1 times the MAWP.

(f) Heating boilers to be tested shall be compared to a reference vessel of proven leak-tight integrity to measure drop in pressure over time using an electronic control device.

(g) The heating boiler to be tested and the reference vessel shall be dry inside and outside with no visible signs of moisture.

(h) The heating boiler to be tested and the reference vessel shall be maintained at a minimum metal temperature of 60°F (16°C) during the test. In addition, the test boiler, reference vessel, and test air shall be maintained at a temperature that has no more than 5°F (3°C) difference among them.

(i) At a minimum, the written test procedure shall specify the following essential variables:

(1) acceptable air leakage rate that shall be used as a standard accept/reject criteria and that shall assure water tightness

(2) maximum acceptable metal temperature difference between the heating boiler to be tested and the reference vessel prior to testing

(3) volume of the heating boiler to be tested

(4) volume of the reference vessel

(5) time of stabilization

(6) time of test

(7) test pressure

(8) manufacturer and model name of test apparatus

(9) calibration periods

(10) personnel performance qualification

(j) The written test procedure shall be qualified by the Manufacturer and accepted by the AI prior to testing of any heating boilers. At a minimum, the procedure qualification shall meet the requirements referenced in (a). A change to any of the essential variables listed in (i) shall require requalification of the procedure.

(k) Personnel performing the test shall be trained to the written test procedure. Detailed requirements for procedure qualification and personnel qualification shall be included in the Manufacturer's written description of the quality control system.

(l) The test operator shall be isolated from the heating boiler and the reference vessel during the pressurized portion of test. Any observation shall be made from a safe location.

(m) This Code Case does not address all possible safety considerations associated with its use. It is the responsibility of the user of this Code Case to establish appropriate safety and health practices and to determine the applicability of any regulatory requirements or limitations prior to its use.

(n) The welded boiler shall meet all other requirements of Section IV.

(o) This Case number shall be shown on Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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**Case 2813**  
**Laser Marking of Welded Hot Water Heating Boilers**  
**Section IV**

*Inquiry:* Under what conditions may welded hot water heating boilers constructed in accordance with Section IV be marked by a Certificate Holder with the information including the Certification Mark using laser etching directly on the shell in lieu of the nameplate required in HG-530.1(d)?

*Reply:* It is the opinion of the Committee that laser etching used for marking of the information including the Certification Mark may be performed by a Certificate Holder in lieu of the nameplate required in HG-530.1(d), provided the following requirements are met:

(a) Laser marking shall be performed by the Manufacturer of the certified boiler.

(b) The material of the construction shall be limited to stainless steels.

(c) Laser etching shall be limited to welded boilers with the maximum nominal outside diameter equal to 18.9 in. (480 mm) or less.

(d) The arrangement and scope of data marked on the shell shall be in accordance with HG-530.1(a).

(e) The data shall be in characters not less than  $\frac{5}{32}$  in. (4 mm) and shall be readable. The graphic image of the Certification Mark shall conform to the proportions of the official Certification Mark.

(f) The marking process shall leave a permanent and legible mark.

(g) The information marked on the shell shall not be covered by insulation or other material, unless the requirements of HG-530.1(e) are met.

(h) The process controls for laser marking shall be described in the Quality Control System and be acceptable to the Authorized Inspector.

(i) The welded boiler shall meet all other requirements of Section IV.

(j) This Case number shall be shown on Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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**Case 2814**  
**Figure UW-13.4, Illustration (a)**  
**Section VIII, Division 1**

*Inquiry:* In Section VIII, Division 1, Figure UW-13.4, illustration (a), under what conditions is a straight section at the end of the taper of the nozzle allowed?

*Reply:* It is the opinion of the Committee that in Figure UW-13.4, illustration (a), a straight section at the end of the taper of the nozzle is allowed, provided the following conditions are met:

(a) Length of the straight section with the minimum thickness equal to  $t_1$  as defined in Figure UW-13.4, illustration (a) shall not exceed 0.875 in. (22 mm).

(b) The machining of the required taper shall be performed at the inside surface of the nozzle.

(c) The minimum thickness,  $t_1$ , shall not be less than that required by the rules of UG-22, UG-27, UG-28, or Figure UW-13.4.

(d) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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(19)

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**Case 2815-1**  
**Use of SA-336/SA-336M Class F91 for Class 2**  
**Section VIII, Division 2**

*Inquiry:* Under what conditions may SA-336/SA-336M Class F91 be used for Section VIII, Division 2, Class 2 application?

*Reply:* It is the opinion of the Committee that SA-336/SA-336M Class F91 may be used for Section VIII, Division 2, Class 2 application, provided the following requirements are met:

(a) The maximum allowable stresses for SA-182/SA-182M Class F91 in Section II, Part D, Subpart 1, Table 5A shall be used for SA-336/SA-336M Class F91.

(b) This Case number shall be shown on the Manufacturer's Data Report.

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Approval Date: January 8, 2015

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**Case 2816**  
**Use of Ultrasonic Examination in Lieu of Radiography**  
**for Material Thickness Less Than  $\frac{1}{2}$  in. (13 mm) But**  
**Greater Than or Equal to  $\frac{1}{4}$  in. (6 mm)**  
**Section I**

*Inquiry:* Under what conditions and limitations may an ultrasonic examination be used to examine materials thinner than  $\frac{1}{2}$  in. (13 mm) but thicker than or equal to  $\frac{1}{4}$  in. (6 mm) in lieu of radiography, when volumetric examination is required in accordance with Section I, PW-11?

*Reply:* It is the opinion of the Committee that all welds in material ranging from  $\frac{1}{4}$  in. to  $\frac{1}{2}$  in. (6 mm to 13 mm) in pressure vessels and power boilers may be examined using the ultrasonic (UT) method in lieu of the radiography (RT) method, provided that all of the following requirements are met:

(a) The ultrasonic examination area shall include the volume of the weld, plus 2 in. (50 mm) on each side of the weld. Alternatively, examination volume may be reduced to include the actual heat affected zone (HAZ) plus  $\frac{1}{4}$  in. (6 mm) of base material beyond the heat affected zone on each side of the weld, provided the following requirements are met:

(1) The extent of the weld HAZ is measured and documented during the weld qualification process.

(2) The ultrasonic (UT) transducer positioning and scanning device is controlled using a reference mark (paint or low stress stamp adjacent to the weld) to ensure that the actual HAZ plus an additional  $\frac{1}{4}$  in. (6 mm) of base metal is examined.

(b) A documented examination strategy or scan plan shall be provided showing transducer placement, movement, and component coverage that provides a standardized and repeatable methodology for weld acceptance. The scan plan shall also include ultrasonic beam angle used, beam directions with respect to weld centerline,

and vessel volume examined for each weld. The documentation shall be made available to the Owner/User upon request.

(c) The ultrasonic examination shall be performed in accordance with a written procedure conforming to the requirements of Section V, Article 4.<sup>1</sup> The procedure shall have been demonstrated to perform acceptably on a qualification block(s). The qualification block(s) shall be prepared by welding or the hot isostatic process (HIP) and shall contain a minimum of three flaws, oriented to simulate flaws parallel to the production weld's fusion line as follows:

(1) one surface flaw on the side of the block representing the vessel O.D. surface

(2) one surface flaw on the side of the block representing the vessel I.D. surface

(3) one subsurface flaw

(4) If the block can be flipped during UT examination, then one flaw may represent both the I.D. and O.D. surfaces. Thus only two flaws may be required.

Flaw size shall be no larger than the flaw in [Table 1](#) for the thickness to be examined. Acceptable performance is defined as response from the maximum allowable flaw and other flaws of interest demonstrated to exceed the reference level. Alternatively, for techniques that do not use amplitude recording levels, acceptable performance is defined as demonstrating that all imaged flaws with recorded lengths, including the maximum allowable flaws, have an indicated length equal to or greater than the actual length of the flaws in the qualification block.

(d) The ultrasonic examination shall be performed using a device employing automatic computer based data acquisition. The initial straight beam material examination (T-472 of Section V, Article 4) for reflectors that could interfere with the angle beam examination shall be performed (1) manually, (2) as part of a previous manufacturing process, or (3) during the automatic UT examination provided detection of these reflectors is demonstrated [subpara. (c)].

Sectorial scans (S-scans) with phased arrays may be used for the examination of welds, provided they are demonstrated satisfactorily in accordance with para. (c). S-scans provide a fan beam from a single emission point, which covers part or all of the weld, depending on transducer size, joint geometry, and section thickness. While S-scans can demonstrate good detectability from side drilled holes, because they are omnidirectional reflectors, the beams can be misoriented for planar reflectors (e.g., lack of fusion and cracks). An adequate number of flaws should be used in the demonstration block to ensure detectability for the entire weld volume.

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(e) Data is recorded in unprocessed form. A complete data set with no gating, filtering, or thresholding for response from examination volume in para. (a) above shall be included in the data record.

(f) Personnel performing and evaluating UT examinations shall be qualified and certified in accordance with their employer's written practice. ASNT SNT-TC-1A or CP-189 shall be used as a guideline. Only Level II or III personnel shall analyze the data or interpret the results.

(g) Contractor qualification records of certified personnel shall be approved by the Certificate Holder and maintained by their employer.

(h) In addition, personnel who acquire and analyze UT data shall be trained using the equipment in (d) above, and participate in the demonstration of (c) above.

(i) Data analysis and acceptance criteria shall be as follows:

(1) *Data Analysis Criteria.* Reflectors exceeding the limits in either (-a) or (-b) below, as applicable, shall be investigated to determine whether the indication originates from a flaw or is a geometric indication in accordance with para. (2) below. When a reflector is determined to be a flaw, it shall be evaluated for acceptance in accordance with para. (4), Flaw Evaluation and Acceptance Criteria.

(-a) For amplitude-based techniques, the location, amplitude, and extent of all reflectors that produce a response greater than 20% of the reference level shall be investigated.

(-b) For nonamplitude-based techniques, the location and extent of all images that have an indicated length greater than the limits in (-1) below, as applicable, shall be investigated.

(-1) Images with indicated lengths greater than 0.150 in. (3.8 mm) shall be investigated.

(2) *Geometric.* Ultrasonic indications of geometric and metallurgical origin shall be classified as follows:

(-a) Indications that are determined to originate from the surface configurations (such as weld reinforcement or root geometry) or variations in metallurgical structure of materials (such as cladding to base metal interface) may be classified as geometric indications, and

(-1) need not be characterized or sized in accordance with (3) below;

(-2) need not be compared to allowable flaw acceptance criteria of Table 1;

(-3) the maximum indication amplitude and location shall be recorded, for example: internal attachments, 200% DAC maximum amplitude, 1 in. (25 mm) above the weld centerline, on the inside surface, from 90 to 95 deg.

(-b) The following steps shall be taken to classify an indication as geometric:

(-1) Interpret the area containing the reflector in accordance with the applicable examination procedure;

(-2) Plot and verify the reflector coordinates, provide a cross-sectional display showing the reflector position and surface discontinuity such as root or counterbore; and

(-3) Review fabrication or weld prep drawings.

(-c) Alternatively, other NDE methods or techniques may be applied to classify an indication as geometric (e.g., alternative UT beam angles, radiography, I.D. and/or O.D. profiling).

(3) *Flaw Sizing.* Flaws shall be sized in accordance with a procedure demonstrated to size similar flaws at similar material depths. Alternatively, a flaw may be sized by a supplemental manual technique so long as it has been qualified by the demonstration above. The dimensions of the flaw shall be determined by the rectangle that fully contains the area of the flaw. (Refer to Figures 1 through 5.)

(-a) The length of the flaw ( $\ell$ ) shall be drawn parallel to the inside pressure-retaining surface of the component.

(-b) The depth of the flaw shall be drawn normal to the inside pressure retaining surface and shall be defined as  $a$  for a surface flaw or  $2a$  for a subsurface flaw.

(4) *Flaw Evaluation and Acceptance Criteria.* Flaws shall be evaluated for acceptance using the applicable criteria of Table 1 and with the following additional requirements:

(-a) *Surface Connected Flaws.* Flaws identified as surface flaws during the UT examination may or may not be surface connected. Therefore, unless the UT data analysis confirms that that flaw is not surface connected, it shall be considered surface connected or a flaw open to the surface, and is unacceptable unless a surface examination is performed in accordance with (-1), (-2), or (-3) below. If the flaw is surface connected, the requirements above still apply; however, in no case shall the flaw exceed the acceptance criteria in the applicable Construction Code for the method employed.

Acceptable surface examination techniques are:

(-1) Magnetic particle examination (MT) in accordance with Nonmandatory Appendix A, A-260 of Section I as applicable

(-2) Liquid penetrant examination (PT) in accordance with Nonmandatory Appendix A, A-270 of Section I as applicable

(-3) Eddy current examination (ET) in accordance with Supplement I of this Case. All relevant ET indications that are open to the surface are unacceptable regardless of length.

(-b) *Multiple Flaws*

(-1) Discontinuous flaws shall be considered a singular planar flaw if the distance between adjacent flaws is equal to or less than  $S$  as shown in Figure 2.

(-2) Discontinuous flaws that are oriented primarily in parallel planes shall be considered a singular planar flaw if the distance between the adjacent planes is equal to or less than  $\frac{1}{2}$  in. (13 mm). (Refer to Figure 3.)

(-3) Discontinuous flaws that are coplanar and nonaligned in the through-wall thickness direction of the component shall be considered a singular planar flaw if the distance between adjacent flaws is equal to or less than  $S$  as shown in Figure 4.

(-4) Discontinuous flaws that are coplanar in the through-wall direction within two parallel planes  $\frac{1}{2}$  in. (13 mm) apart (i.e., normal to the pressure-retaining surface of the component) are unacceptable if the additive flaw depth dimension of the flaws exceeds those shown in Figure 5.

(-c) *Subsurface Flaws.* Flaw length,  $\ell$ , shall not exceed  $4t$ .

(j) The nameplate shall be marked under the Certification Mark by applying UT to indicate ultrasonic examination of welded seams required to be inspected in accordance with Section I.

(k) This Case number shall be shown on the Manufacturer's Data Report, and the extent of the UT examination shall be noted.

**Table 1**  
**Flaw Acceptance Criteria for Welds With**  
**Thickness Between  $\frac{1}{4}$  in. and  $<\frac{1}{2}$  in. (6 mm**  
**and  $<13$  mm)**

Thickness, $t$ in. (mm)	Surface Flaw, $a$ in. (mm)	Subsurface Flaw, $a$ in. (mm)	Length of Flaw, $\ell$ in. (mm)
$\frac{1}{4}$ (6)	0.040 (0.95)	0.020 (0.48)	$\leq \frac{1}{4}$ ( $\leq 6.4$ )
$\frac{3}{8}$ (10)	0.042 (1.04)	0.021 (0.52)	$\leq \frac{1}{4}$ ( $\leq 6.4$ )
$<\frac{1}{2}$ ( $<13$ )	0.044 (1.13)	0.022 (0.57)	$\leq \frac{1}{4}$ ( $\leq 6.4$ )

GENERAL NOTES:

- (a) The parameter  $t$  is the thickness of the weld excluding any allowable reinforcement, and the parameter  $\ell$  is the length of the flaw. For a butt weld joining two members having different thicknesses at the weld,  $t$  is the thinner of these two thicknesses. If a full penetration weld includes a fillet weld, then the thickness of the throat of the fillet weld shall be included in  $t$ .
- (b) The acceptance limits specified here are based upon workmanship considerations and are not necessarily intended for use in evaluating flaws identified after the vessel has gone into service.
- (c) Parameters  $a$  and  $\ell$  are as defined in (i)(3)(-a) and (i)(3)(-b).
- (d) For intermediate thicknesses of  $t$  [ $\frac{1}{4}$  in. (6 mm)  $< t < \frac{1}{2}$  in. (13 mm)], linear interpolation is permissible.
- (e) The criteria for thickness  $<\frac{1}{2}$  in. ( $<13$  mm) is for interpolation of intermediate thicknesses only. See Code Case 2235 for the examination of material  $\frac{1}{2}$  in. (13 mm) thickness or greater.
- (f) A subsurface indication shall be considered as a surface flaw if the separation ( $S$  in Figure 1) of the indication from the nearest surface of the component is equal to or less than half the through dimension ( $2d$  in Figure 1, illustration (b)) of the subsurface indication.



**Figure 2**  
**Multiple Planar Flaws Oriented in Plane Normal to Pressure Retaining Surface**

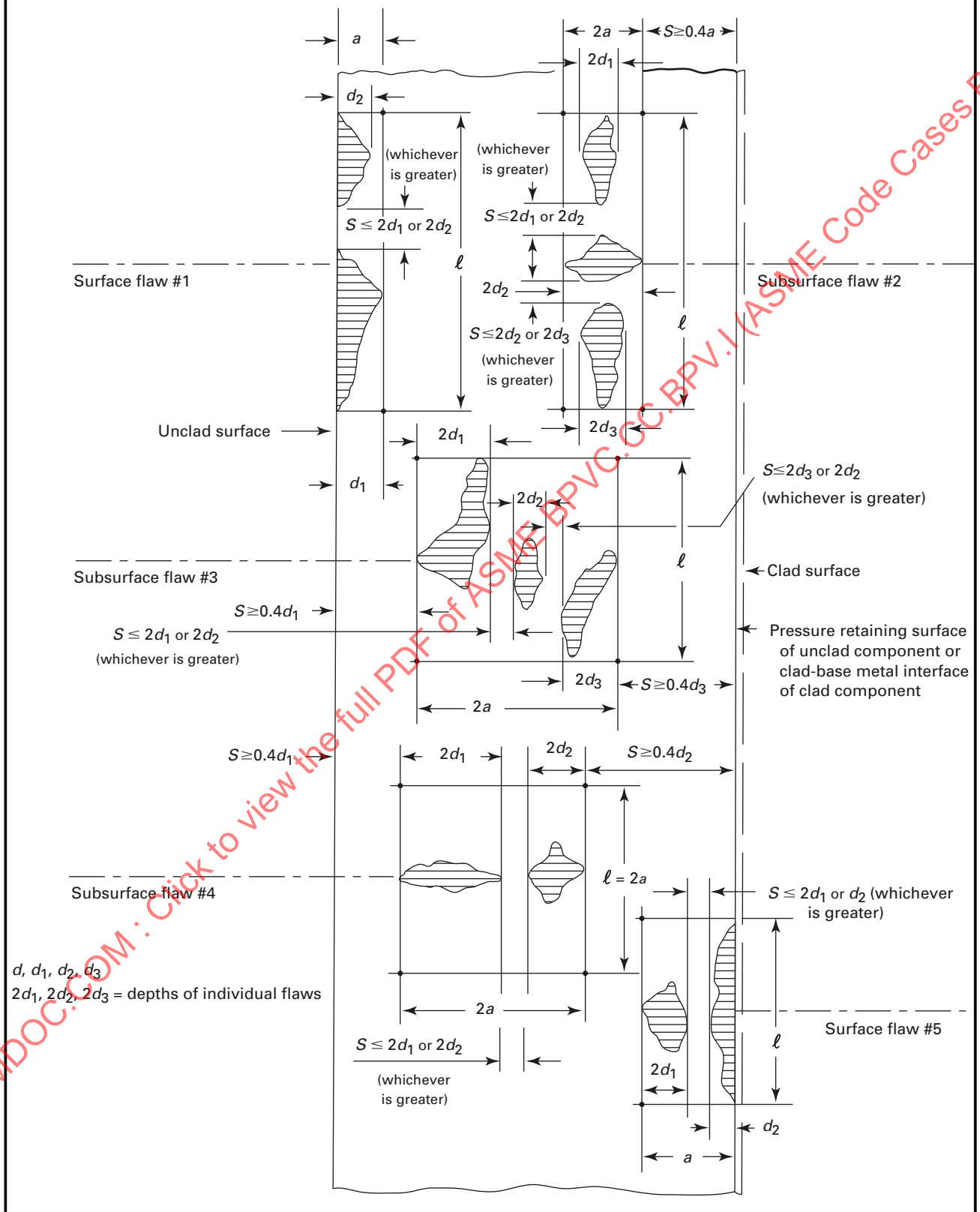
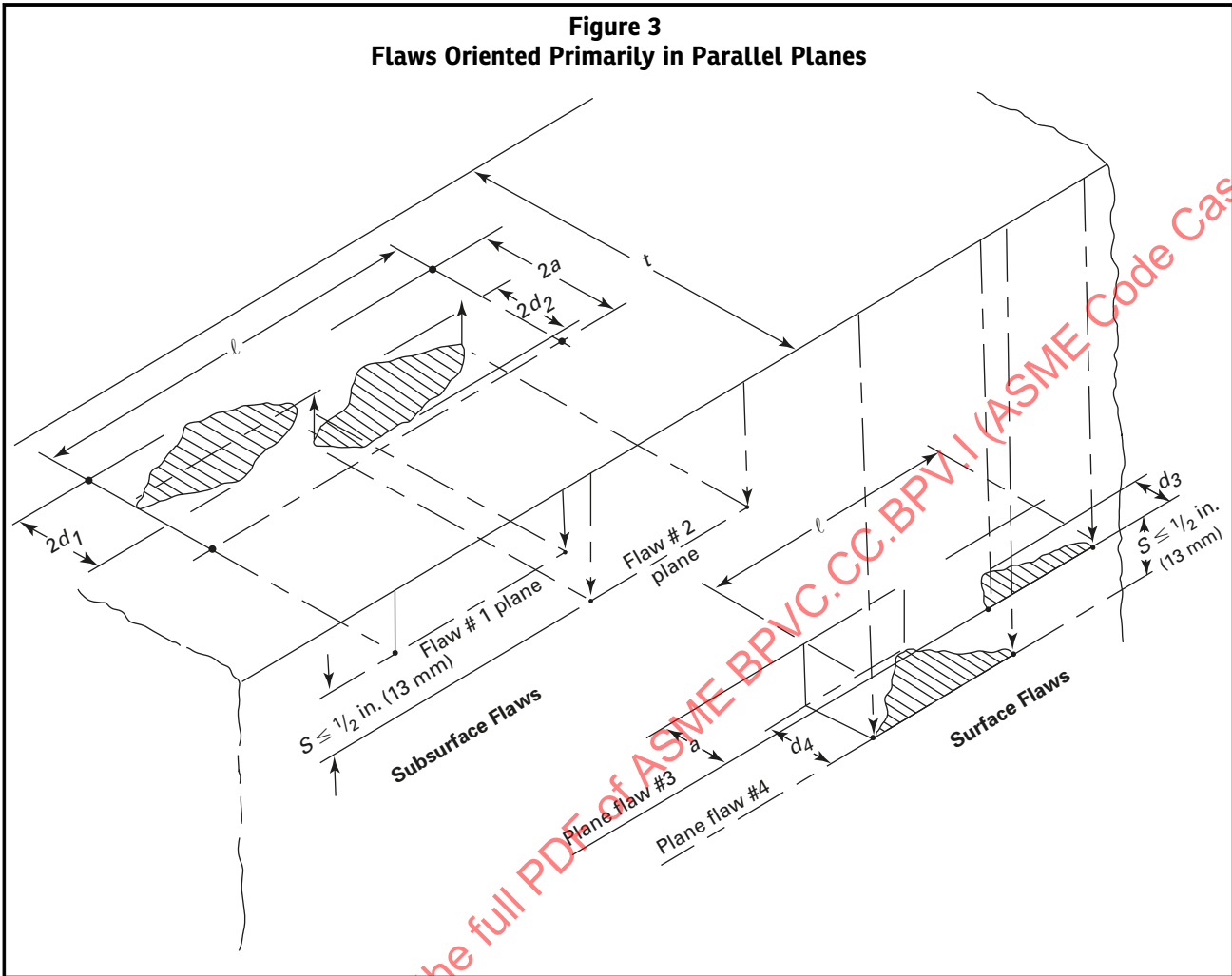
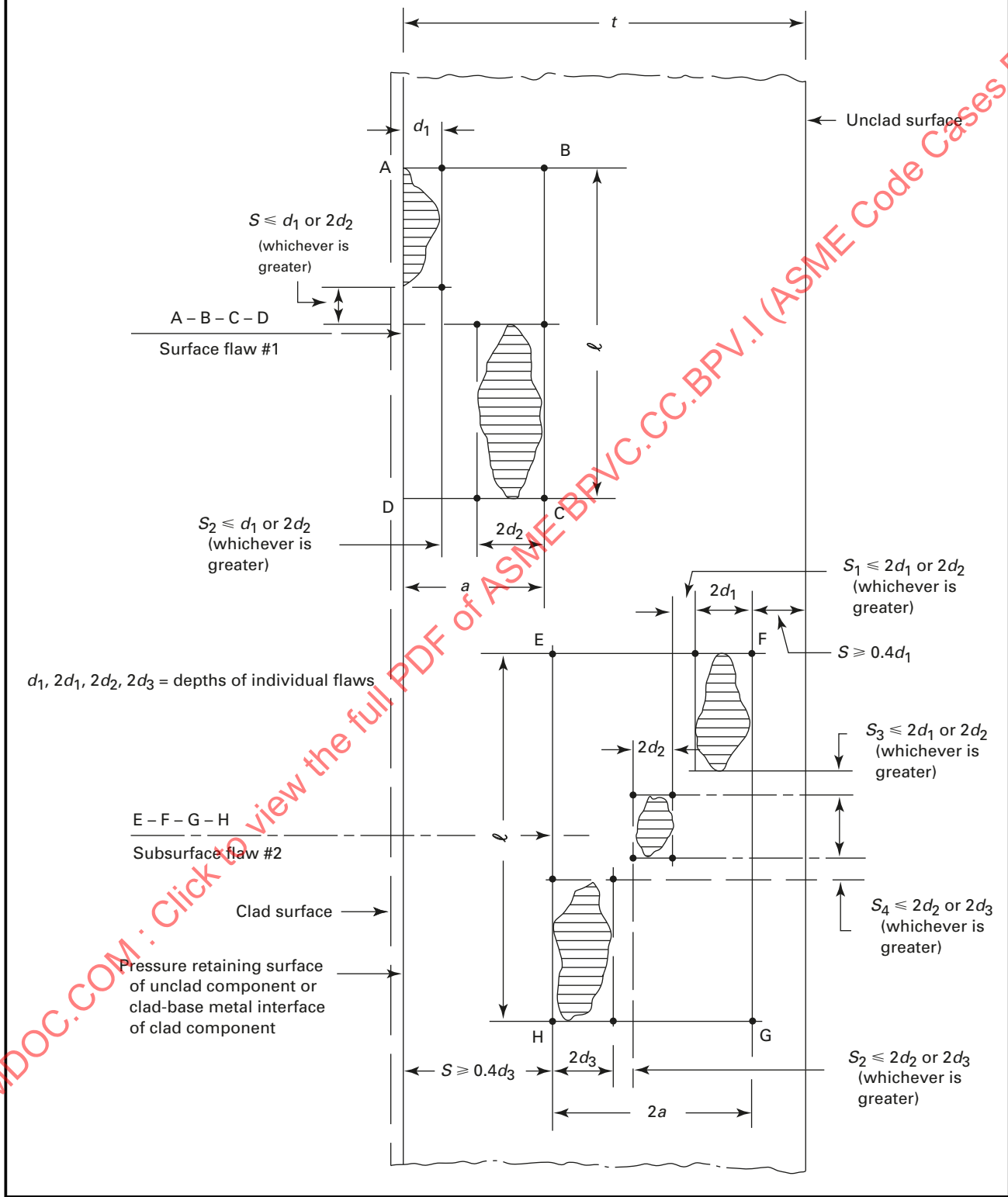


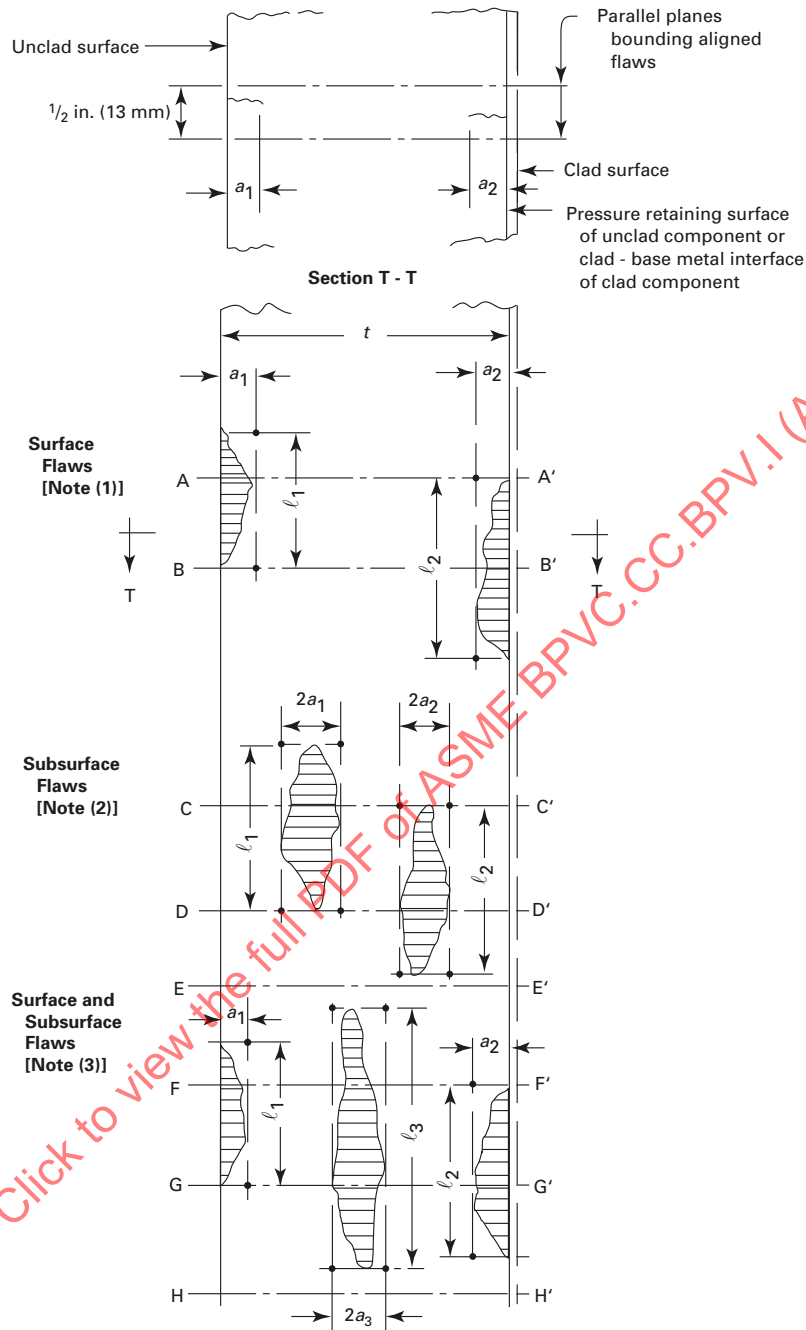
Figure 3  
Flaws Oriented Primarily in Parallel Planes



**Figure 4**  
**Nonaligned Coplanar Flaws in Plane Normal to Pressure Retaining Surface (Illustrative Flaw Configurations)**



**Figure 5**  
**Multiple Aligned Planar Flaws**



GENERAL NOTE: In the Notes below, the flaw depth dimensions  $a_s$  and  $a_e$  are the allowable flaw standards for surface and subsurface flaws, respectively.

NOTES:

- (1) This illustration indicates two surface flaws. The first,  $a_1$ , is on the outer surface of the component, and the second,  $a_2$ , is on the inner surface:  $(a_1 + a_2) \leq (a_s + a'_s)/2$  within planes A-A' and B-B'
- (2) This illustration indicates two subsurface flaws:  $(a_1 + a_2) \leq (a_e + a'_e)/2$  within planes C-C' and D-D'
- (3) This illustration indicates two surface flaws and one subsurface flaw:
  - (a)  $(a_1 + a_3) \leq (a_s + a'_e)/2$  within planes E-E' and F-F'
  - (b)  $(a_1 + a_2) \leq (a_s + a_e + a'_s)/3$  within planes F-F' and G-G'
  - (c)  $(a_2 + a_3) \leq (a'_s + a_e)/2$  within planes G-G' and H-H'

## SUPPLEMENT I: EDDY CURRENT SURFACE EXAMINATION PROCEDURE REQUIREMENTS

(a) *Procedure Requirements.* A written procedure shall be provided containing a statement of scope that specifically defines the limits of procedure applicability (e.g., material specification, grade, type, or class). The procedure shall reference a technique specification, delineating the essential variables, qualified in accordance with the requirements below.

### (b) *Procedure Specifications*

(1) The eddy current procedure shall specify the following regarding data acquisition:

(-a) instrument or system, including manufacturer's name and model

(-b) size and type of probe, including manufacturer's name and part number

(-c) analog cable type and length

(-d) examination frequencies, or minimum and maximum range, as applicable

(-e) coil excitation mode (e.g., absolute or differential)

(-f) minimum data to be recorded

(-g) method of data recording

(-h) minimum digitizing rate (samples per inch) or maximum scanning speed (for analog systems), as applicable

(-i) scan pattern, when applicable (e.g., helical pitch and direction, rectilinear rotation, length, scan index, or overlap)

(-j) magnetic bias technique, when applicable

(-k) material type

(-l) coating type and thickness, when applicable

(2) The eddy current procedure shall define the following regarding data analysis:

(-a) method of calibration (e.g., phase angle or amplitude adjustments)

(-b) channel and frequencies used for analysis

(-c) extent or area of the component evaluated

(-d) data review requirements (e.g., secondary data review, computer screening)

(-e) reporting requirements (i.e., signal-to-noise threshold, voltage threshold, flaw depth threshold)

(-f) methods of identifying flaw indications and distinguishing them from nonrelevant indications, such as indications from probe lift-off or conductivity and permeability changes in weld material

(-g) manufacturer and model of eddy current data analysis equipment, as applicable

(-h) manufacturer, title, and version of data analysis software, as applicable

(3) The procedure shall address requirements for system calibration. Calibration requirements include those actions required to ensure that the sensitivity and accuracy of the signal amplitude and time outputs of the examination system, whether displayed, recorded, or automatically processed, are repeatable and correct.

Any process of calibrating the system is acceptable; a description of the calibration process shall be included in the procedure.

(4) Data acquisition and analysis procedures may be combined or separate, provided the above requirements are met.

### (c) *Personnel Requirements*

(1) Personnel performing data acquisition shall have received specific training and shall be qualified by examination, in accordance with the employer's written practice, in the operation of the equipment, applicable techniques, and recording of examination results.

(2) Personnel performing analysis of data shall have received additional specific training in the data analysis techniques used in the procedure qualification and shall successfully complete the procedure qualification described below.

(3) American Society of Nondestructive Testing (ASNT) standards SNT-TC-1A or CP 189 shall be used as a guideline.

(4) Personnel qualifications may be combined provided all requirements are met.

### (d) *Procedure Qualification*

(1) Data sets for detection and sizing shall meet requirements shown below.

(2) The eddy current procedure and equipment shall be considered qualified upon successful completion of the procedure qualification.

(3) *Essential Variables.* An essential variable is a procedure, software, or hardware item that, if changed, could result in erroneous examination results. Further, any item that could decrease the signal-to-noise ratio to less than 2:1 shall be considered an essential variable.

(4) Any two procedures with the same essential variables are considered equivalent. Equipment with essential variables that vary within the demonstrated ranges identified in the Data Acquisition Procedure Specification shall be considered equivalent. When the procedure allows more than one value or range for an essential variable, the qualification test shall be repeated at the minimum and maximum value for each essential variable with all other variables remaining at their nominal values. Changing essential variables may be accomplished during successive procedure qualifications involving different personnel; each data analyst need not demonstrate qualification over the entire range of every essential variable.

### (e) *Qualification Requirements*

(1) Specimens to be used in the qualification test shall meet the requirements listed herein unless a set of test specimens is designed to accommodate specific limitations stated in the scope of the examination procedure (e.g., surface roughness or contour limitations). The same specimens may be used to demonstrate both detection and sizing qualification. For examination of vessels with coated surfaces, Section V, Article 8 shall apply.

(2) Specimens shall be fabricated from the same base material nominal composition (UNS Number) and heat treatment (e.g., solution annealed, precipitation hardened, solution heat treated and aged) as those to be examined.

(3) Specimen surface roughness and contour shall be generally representative of the surface roughness and contour of the component surface to be examined. The examination surface curvature need not be simulated if the ratio of the component diameter to the coil diameter exceeds 20:1.

(4) Welding shall be performed with the same filler material AWS classification and postweld heat treatment (e.g., as welded, solution annealed, stress relieved) as the welds to be examined.

(5) *Defect Conditions*

(-a) The qualification flaws shall be cracks or notches.

(-b) The length of cracks or notches open to the surface shall not exceed 0.125 in. (3.2 mm).

(-c) The maximum depth of a crack or compressed notch shall be 0.040 in. (1.02 mm).

(-d) Machined notches shall have a maximum width of 0.010 in. (0.25 mm) and a maximum depth of 0.020 in. (0.51 mm).

(6) *Demonstration Specimens.* The demonstration specimen shall include one crack or notch at each of the following locations:

(-a) on the weld

(-b) in the heat affected zone

(-c) at the fusion line of the weld

(-d) in the base material

(7) *Procedure Qualification Acceptance Criteria.* All flaws in each of the four identified areas shall be detected with a minimum 2:1 signal-to-noise ratio at the maximum digitization rate (for digital systems) or maximum scanning speed (for analog systems) permitted by the procedure.

(f) *Evaluation of Eddy Current Results.* Eddy current results are evaluated in accordance with the procedure described in para. (b)(2) above. For this Case, ET is used to simply confirm that a UT flaw is in fact, surface connected. If a UT flaw is determined by ET to be surface connected, it shall comply with Acceptance Standards in para. (g) below.

(g) *Acceptance Standards.* These acceptance standards apply unless other more restrictive standards are specified for specific materials or applications within the Construction Code. All surfaces examined shall be free of relevant ET surface flaw indications.

Approval Date: January 8, 2015

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2817**  
**Section VIII, Division 1 Plate-and-Frame Heat Exchanger in Section I Feedwater System**  
**Section I**

*Inquiry:* Under what conditions may a plate-and-frame heat exchanger constructed under the provisions of Section VIII, Division 1 be installed in a Section I feedwater piping system?

*Reply:* It is the opinion of the Committee that a plate-and-frame heat exchanger constructed in accordance with the rules of Section VIII, Division 1 may be installed in a Section I boiler, provided the following requirements are met:

(a) The heat exchanger is installed in boiler external piping (BEP) within the certification boundary of the Section I completed boiler unit.

(b) The heat exchanger shall conform to the rules for unfired steam boilers of Section VIII, Division 1, UW-2(c).

(c) The MAWP of the feedwater side of the heat exchanger shall not be less than the design pressure requirements of ASME B31.1, paragraph 122.1.3.

(d) The design temperature of the plates shall not be lower than that permitted by ASME B31.1 for saturated steam. If the heat exchanger is heated with superheated steam, the design temperature of the plates shall not be lower than the saturation temperature permitted by ASME B31.1 plus 35°F (20°C). Gasket material shall be suitable for the design pressure and temperature of the plates.

(e) The materials shall be limited to those permitted by Section VIII, Division 1.

(f) The requirements for postweld heat treatment shall be per Section VIII, Division 1, UW-40. For P-No. 1 materials, the postweld heat treatment exemptions of Table UCS-56-1, General Note (b) may be applied.

(g) The heat exchanger shall be stamped with the ASME Certification Mark with the U Designator and also shall include this Case number in the stamping.

(h) The heat exchanger shall be documented with Form U-1, Manufacturer's Data Report (Section VIII, Division 1) and be referenced in the Section I Master Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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**Case 2818  
Acoustic Pulse Reflectometry (APR)  
Examination Method That May Be Used for  
Examination of Heat Exchanger Tubing and  
Other Tubing and Piping  
Section V**

**ANNULLED**

Annulment Date: December 30, 2018

Reason: No longer needed.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: November 29, 2014

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2820**  
**Composite Pressure Vessels for High Pressure Fluids in**  
**Accordance With Mandatory Appendix 8**  
**Section X**

*Inquiry:* Under what conditions and requirements may oil and gas industry drilling fluids or other general fluids be used as the operating fluid in composite pressure vessels designed and constructed under the rules of Section X, Mandatory Appendix 8 for Class III vessels with nonload-sharing liners?

*Reply:* It is the opinion of the Committee that Class III composite pressure vessels may be designed and constructed under the rules of Section X, Mandatory Appendix 8 with drilling fluids or other general fluids as the operating fluid, provided the following requirements are met:

(a) Contained fluids shall be compatible with the composite, liner, and nozzle materials. If compatibility is not already demonstrated, testing must be conducted to

confirm compatibility. Confirmation of compatibility shall be reported in the Fabricator's Data Report. Known compatible fluid materials and noncompatible fluid materials shall be listed in the User's Design Specification. Toxic gases shall not be used.

(b) Allowed permeation rates shall be included in the User Design Specification. The fabricator shall confirm permeation rate through testing, as described in Mandatory Appendix 8, 8-700.5.7.

(c) Permeation testing may be conducted with the fluid to be contained, or by using an alternate fluid with adjustment in rate made by considering relative molecular weight, or by using relative viscosity, as appropriate.

(d) Additional pressure and bending loads present due to containment of the fluids shall be considered in the stress analysis, in addition to changes made to the test pressures or procedures as appropriate during qualification testing to accurately assess the maximum design stresses.

(e) This Case number shall be shown on the Fabricator's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: February 24, 2015

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2821**  
**Impact Testing of SA-540/SA-540M, Grade B23, Class 3**  
**Bolting**  
**Section VIII, Division 2**

*Inquiry:* May bolting conforming to SA-540/SA-540M, Grade B23, Class 3, up to 150 mm (6 in.) diameter, inclusive, be used at an MDMT colder than permitted by Table 3.4 for flanges designed to para. 4.16?

*Reply:* It is the opinion of the Committee that bolting conforming to SA-540/SA-540M, Grade B23, Class 3, up to 150 mm (6 in.) diameter, inclusive, may be used at

an MDMT colder than permitted by Table 3.4 for flanges designed to Section VIII, Division 2, para. 4.16, provided the following requirements are met:

(a) Impact tests shall be performed in accordance with the procedures in SA-320/SA-320M at the required MDMT. The average for three full-size Charpy V-notch impact specimens shall be at least 41 J (30 ft-lb), with the minimum value for any individual specimen no less than 34 J (25 ft-lb).

(b) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2822-2**  
**Fatigue Evaluation for Class 2 Parts Constructed With SA-182/SA-182M F91, SA-213/SA-213M T91, SA-335/SA-335M P91, SA-336/SA-336M F91, and SA-387/SA-387M 91 Class 2 at Temperatures Greater Than 371°C (700°F) and Less Than or Equal to 500°C (932°F) Section VIII, Division 2**

*Inquiry:* Under what requirements may Section VIII, Division 2, Class 2 pressure parts constructed with SA-182/SA-182M F91, SA-213/SA-213M T91, SA-335/SA-335M P91, SA-336/SA-336M F91, and SA-387/SA-387M 91 Class 2 for operating temperatures greater than 371°C (700°F) and less than or equal to 500°C (932°F) be evaluated for fatigue?

*Reply:* It is the opinion of the Committee that Section VIII, Division 2, Class 2 pressure parts constructed with SA-182/SA-182M F91, SA-213/SA-213M T91, SA-335/SA-335M P91, SA-336/SA-336M F91, and SA-387/SA-387M 91 Class 2 for operating temperatures greater than 371°C (700°F) and less than or equal to 500°C (932°F) may be evaluated for fatigue, provided the following requirements are satisfied.

(a) The time, temperature, and load history shall be provided in the User's Design Specification. The load history shall include both design and operating conditions. The design conditions shall be used for analyses defined in (b) and (c). The operating conditions are used for analyses defined in (d) and (e). The maximum permissible temperature for the analyses defined in (d) and (e) is 500°C (932°F).

(b) The design of pressure parts or nonpressure parts, i.e., skirt and skirt attachment, may be in accordance with the design-by-rule requirements of Part 4 or the design-by-analysis requirements of Part 5. In either case, the allowable stress,  $S$ , to be used for design shall be in accordance with Table 5A of ASME Section II, Part D. If design-by-analysis is used to qualify the design of a pressure part or nonpressure part, the design-by-analysis shall be based on the elastic stress analysis methods in Part 5.

(c) Restrictions on the design of pressure parts shall be as follows:

(1) The diameter ratio of the shell shall satisfy  $D_o/D_i \leq 1.2$ .

(2) Standard pressure parts that comply with an ASME product listed in Part 1, Table 1.1, and para. 4.1.11 may be used for closure components or piping connections at the pressure-temperature rating listed in the ASME standard.

(3) The skirt attachment detail shall be in accordance with para. 4.2, Fig. 4.2.4, illustration (e). Figure 4.2.4, illustration (f) may be used if the requirements of (d)(5) are satisfied.

(4) Integral reinforcement shall be used for nozzles and conical transitions.

(5) Flange designed in accordance with Part 4, para. 4.16 may be used for closure components or piping connections, except that the allowable stress,  $S$ , shall be in accordance with Table 1A of Section II, Part D.

(6) The rules for external pressure and compressive stress design in Part 4, para. 4.4 may be used if the strain rate computed using eq. (d)(3)(3) based on the membrane stress for the most severe combination of applied loads that results in compressive stress satisfy eq. (1)

$$\dot{\epsilon} \leq \frac{3(10)^{-8}}{\text{hr}} \quad (1)$$

(d) An inelastic analysis including the effect of creep shall be performed for pressure parts based on the following requirements. This analysis is not required for standard pressure parts and bolted flanges specified in (c)(2) and (c)(5).

(1) The inelastic analysis shall be based on the histogram defined in (-a) using one of the following options. Either option may be used for different components in the vessel.

(-a) *Option 1.* An approximate ratcheting analysis may be performed, based on establishing elastic shake-down at all points in the structure. If this option is chosen, a conservative load histogram shall be used based on the most extreme conditions of stress and temperature. A minimum of two complete cycles shall be computed, including a hold time of a minimum of one year, for the purpose of establishing the effects of creep relaxation. During the last computed cycle, a state of linear elasticity must be demonstrated throughout the cycle. If this criterion is not

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

achieved, a full inelastic analysis using the actual time-dependent thermal and mechanical loading histograms shall be performed as per Option 2.

(-b) *Option 2.* If it is elected not to perform a simplified analysis as per Option 1, or if such an analysis is carried out and fails to demonstrate elastic shakedown according to the criterion stated in Option 1, then a full inelastic analysis shall be performed using the actual time-dependent thermal and mechanical loading histograms, including all operating cycles and their associated hold times. This analysis shall be continued for all cycles defined in the load histogram including their associated hold times, or until the analysis demonstrates shakedown to a stable state or a steady ratchet deformation. In either case, the strain limits in (6)(-a) shall be satisfied.

Protection against ratcheting may be demonstrated using an elastic analysis in lieu of inelastic analysis. To evaluate protection against ratcheting, the following limit shall be satisfied:

$$P_L + P_b + Q + F \leq (S_h + S_{yc}) \quad (2)$$

(2) Elastic, perfectly plastic stress-strain curves based on the yield strengths consistent with the operating temperature envelope, and the following creep rate shall be used in the analysis.

(3) The strain rate to be used in the inelastic analysis (i.e., creep model) shall be determined using eqs. (3) through (14). The coefficients for these equations are provided in Tables 1 and 1M.

$$\dot{\epsilon}_c = \frac{\dot{\epsilon}_{oc}}{1 - D_c} \quad (3)$$

$$\log_{10} \dot{\epsilon}_{oc} = - \left\{ A_0 + \left( \frac{A_1 + A_2 S_l + A_3 S_l^2 + A_4 S_l^3}{T} \right) \right\} \quad (4)$$

$$S_l = \log_{10}(\sigma_e) \quad (5)$$

$$\sigma_e = \frac{1}{\sqrt{2}} [(\sigma_1 - \sigma_2)^2 + (\sigma_1 - \sigma_3)^2 + (\sigma_2 - \sigma_3)^2]^{0.5} \quad (6)$$

$$D_c = \int_0^t \dot{D}_c dt \leq 1.0 \quad (7)$$

$$\dot{D}_c = \Omega_m \dot{\epsilon}_{oc} \quad (8)$$

$$\Omega_m = \Omega_n^{\delta + 1} \quad (9)$$

$$\Omega_n = \max. [(\Omega - n), 3.0] \quad (10)$$

$$\log_{10} \Omega = B_0 + \left( \frac{B_1 + B_2 S_l + B_3 S_l^2 + B_4 S_l^3}{T} \right) \quad (11)$$

$$n = \left( \frac{A_2 + 2A_3 S_l + 3A_4 S_l^2}{T} \right) \quad (12)$$

$$\delta = \beta \left( \frac{3p}{\sigma_e} - 1.0 \right) \quad (13)$$

$$p = \frac{\sigma_1 + \sigma_2 + \sigma_3}{3} \quad (14)$$

(4) The inelastic analysis shall be performed for selected locations experiencing the most extreme conditions of stress and temperature to determine the creep life absent fatigue,  $L_{caf}$ . Sufficient locations shall be selected to ensure that the most critical conditions have been considered. The creep life absent fatigue is defined as the time in which the inelastic analysis produces an accumulated creep damage such that  $0.95 \leq D_c < 1.0$  or 1,000,000 hours, whichever is reached first. A range is given for  $D_c$  to account for numerical accuracy in the inelastic analysis. For design purposes and to account for

**Table 1**  
**MPC Project Omega Creep Data**

Material	Strain Rate Parameter, $\dot{\epsilon}_0$ [Note (1)]		Omega Parameter, $\Omega$ [Note (1)]	
9Cr-1Mo-V	$A_0$	-34	$B_0$	-2.00
	$A_1$	73,201.8	$B_1$	7,200.0
	$A_2$	-2,709.0	$B_2$	-1,500.0
	$A_3$	-4,673.0	$B_3$	0
	$A_4$	-569	$B_4$	0

GENERAL NOTE: The coefficients in this table represent minimum material behavior.

NOTE:

(1) The units of measure for computing the strain rate parameter,  $\dot{\epsilon}_0$ , and the Omega parameter,  $\Omega$ , using the coefficients in this table are ksi and °R.

**Table 1M**  
**MPC Project Omega Creep Data**

Material	Strain Rate Parameter, $\dot{\epsilon}_0$ [Note (1)]		Omega Parameter, $\Omega$ [Note (1)]	
9Cr-1Mo-V	$A_0$	-34	$B_0$	-2
	$A_1$	40 290.39	$B_1$	4 698.864
	$A_2$	2 182.414	$B_2$	-833.333
	$A_3$	-1 800.8	$B_3$	0
	$A_4$	-316.111	$B_4$	0

GENERAL NOTE: The coefficients in this table represent minimum material behavior.

NOTE:

(1) The units of measure for computing the strain rate parameter,  $\dot{\epsilon}_0$ , and the Omega parameter,  $\Omega$ , using the coefficients in this table are MPa and °K.

uncertainties in the analysis, a lower value of  $D_c$  may be used, at the discretion of the designer, to establish a conservative value for  $L_{caf}$ .

(5) The creep damage at all locations shall be such that  $D_c < 1.0$ . In addition, the weldment and adjacent base material of all weld joints shall be located a minimum distance of 25 mm (1 in.), measured from the weld bevel, from regions where the creep damage,  $D_c$ , exceeds 0.50.

(6) Based on the results of the inelastic analysis, the following criteria shall be satisfied:

(-a) The equivalent total accumulated inelastic strain shall not exceed the values in Table 2.

(-b) If the design of the component is based on Part 5, see para. (b), then the protection against local failure shall be determined in accordance with Part 5, para. 5.3.3. This analysis shall not consider the effects of creep.

(e) The permissible number of cycles,  $N$ , and the creep life with fatigue,  $L_{cwf}$ , at each point in the component shall be determined in accordance with one of the following methods. The permissible number of cycles and the creep life with fatigue shall satisfy the specified design requirements in the User's Design Specification.

(1) If Option 1 is used in (d)(1), the fatigue screening analysis in accordance with Part 5, para. 5.5.2.4 may be used except that the fatigue curves in Figures 1 and 1M and Tables 3 and 3M shall be used in the screening assessment, and the value of  $S_{as}$  shall be based on  $(10)^4$  cycles. In addition, in Steps 3 and 4 of para. 5.5.2.4, the alternating equivalent stress amplitude based on the primary plus

secondary plus peak stress determined from shakedown analysis in (d)(1) may be used instead of  $C_1S$ . The permissible number of cycles,  $N$ , in eq. (15) is determined in Step 3 of para. 5.5.2.4. The creep life with fatigue,  $L_{cwf}$ , is determined using eq. (15) or (16), as applicable. The equivalent plastic strain amplitude,  $\Delta\epsilon_{peq}$ , in eqs. (15) and (16) may be determined from Table 4 as a function of the alternating equivalent stress amplitude.

$$L_{cwf} = L_{caf} \cdot \left( \frac{\beta_{cf} \cdot \Delta\epsilon_{peq} \cdot N}{\exp[\beta_{cf} \cdot \Delta\epsilon_{peq} \cdot N] - 1} \right), \quad \Delta\epsilon_{peq} > 0 \quad (15)$$

$$L_{cwf} = L_{caf}, \quad \Delta\epsilon_{peq} = 0 \quad (16)$$

(2) If Option 2 is used in (d)(1), then the fatigue analysis shall be performed in accordance with Part 5, para. 5.5.4, except that the fatigue curves in Figures 1 and 1M and Tables 3 and 3M shall be used to determine the accumulated fatigue damage. The accumulated fatigue damage shall satisfy the requirements of Part 5, para. 5.5.4. The creep life with fatigue,  $L_{cwf}$ , is determined using eq. (1)(15) or (1)(16), as applicable. The equivalent plastic strain range for the  $k^{th}$  loading condition or cycle in eqs. (17) and (18) is determined directly from the strain-based fatigue analysis results.

$$L_{cwf} = L_{caf} \cdot \left[ \frac{\beta_{cf} \cdot \sum_{i=1}^k \Delta\epsilon_{peq,k}}{\exp\left[\beta_{cf} \cdot \sum_{i=1}^k \Delta\epsilon_{peq,k}\right] - 1} \right], \quad \Delta\epsilon_{peq} > 0 \quad (17)$$

$$L_{cwf} = L_{caf}, \quad \Delta\epsilon_{peq} = 0 \quad (18)$$

(f) Nondestructive examination of all welds shall be performed in accordance with Examination Group 1a, see Part 7, Tables 7.1 and 7.2. The supplemental examination for cyclic service in para. 7.4.7 shall be performed.

**Table 2**  
**Total Accumulated Inelastic Strain**

Type of Stress	Equivalent Total Accumulated Inelastic Strain	
	Weld and HAZ	Other Parts
Membrane	0.5%	1.0%
Membrane plus bending	1.25%	2.5%
Local (at any point)	2.5%	5.0%

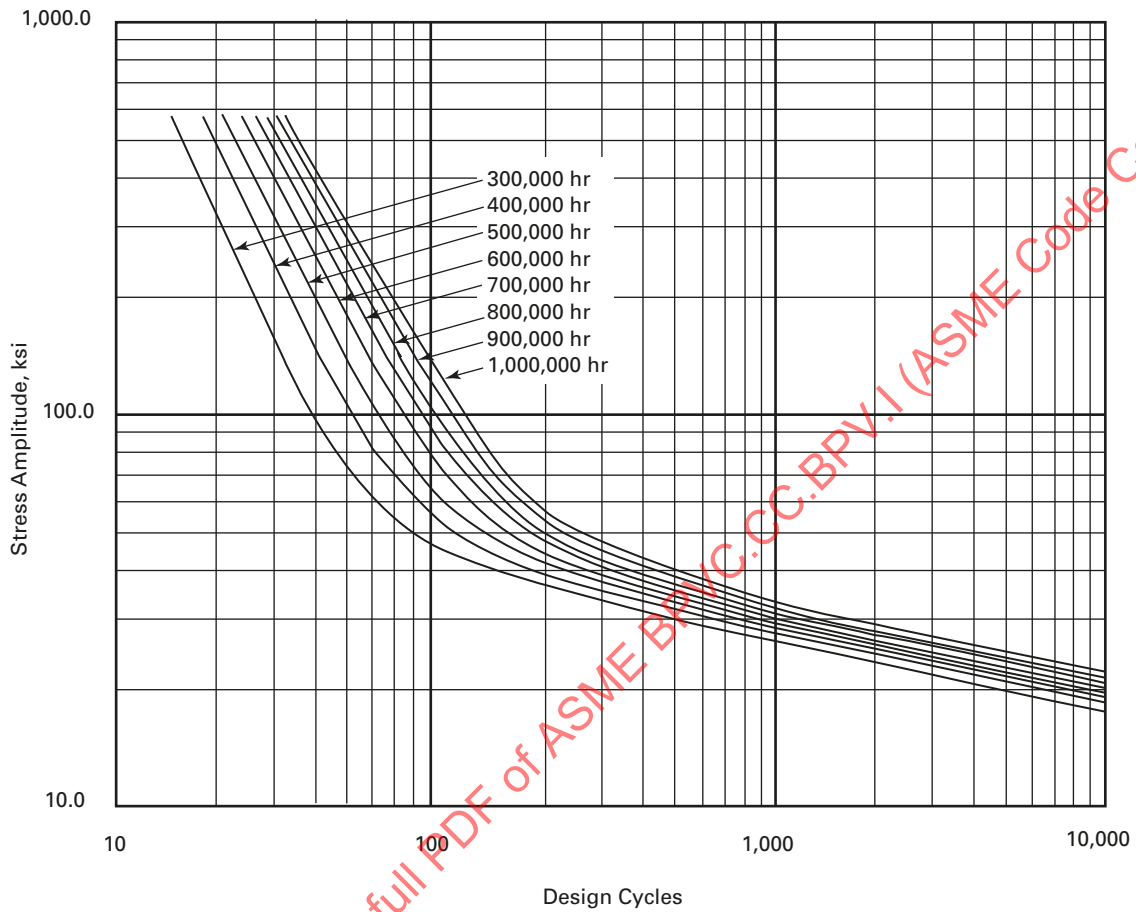
(g) This Case number shall be marked on the nameplate and shown in the Manufacturer's Data Report.

(h) Nomenclature

$A_0 \dots A_4$  = material coefficients for the MPC Project Omega strain-rate-parameter, see Tables 1 and 1M  
 $B_0 \dots B_4$  = material coefficients for the MPC Project Omega Omega-parameter, see Tables 1 and 1M  
 $\beta$  = MPC Project Omega parameter equal to  $1/3$   
 $\beta_{cf}$  = creep fatigue damage factor equal to 2.0  
 $D_c$  = creep damage  
 $\dot{D}_c$  = creep damage rate  
 $\Delta\epsilon_{peq}$  = equivalent plastic strain amplitude based on the alternating equivalent stress amplitude determined in the fatigue screening analysis  
 $\Delta\epsilon_{peq,k}$  = equivalent plastic strain amplitude for the  $k^{th}$  loading condition or cycle  
 $\delta$  = MPC Project Omega parameter  
 $\dot{\epsilon}_c$  = creep strain rate  
 $\dot{\epsilon}_{c0}$  = initial creep strain rate at the start of the time period being evaluated based on the stress state and temperature  
 $F$  = additional stress produced by the stress concentration over and above the nominal stress

$L_{caf}$  = creep life absent fatigue  
 $L_{cwf}$  = creep life with fatigue  
 $n$  = MPC Project Omega parameter  
 $N$  = permissible number of cycles  
 $p$  = hydrostatic stress  
 $P_b$  = primary bending equivalent stress  
 $P_L$  = local primary membrane equivalent stress  
 $Q$  = secondary equivalent stress resulting from operating loadings  
 $\sigma_e$  = effective stress  
 $\sigma_1$  = principal stress in the 1-direction  
 $\sigma_2$  = principal stress in the 2-direction  
 $\sigma_3$  = principal stress in the 3-direction  
 $S_h$  = allowable stress at the maximum temperature for the cycle under consideration  
 $S_{yc}$  = yield strength at the minimum temperature for the cycle under consideration  
 $t$  = time, hr  
 $T$  = temperature  
 $\Omega$  = uniaxial Omega damage parameter  
 $\Omega_m$  = multiaxial Omega damage parameter  
 $\Omega_n$  = adjusted uniaxial Omega damage parameter

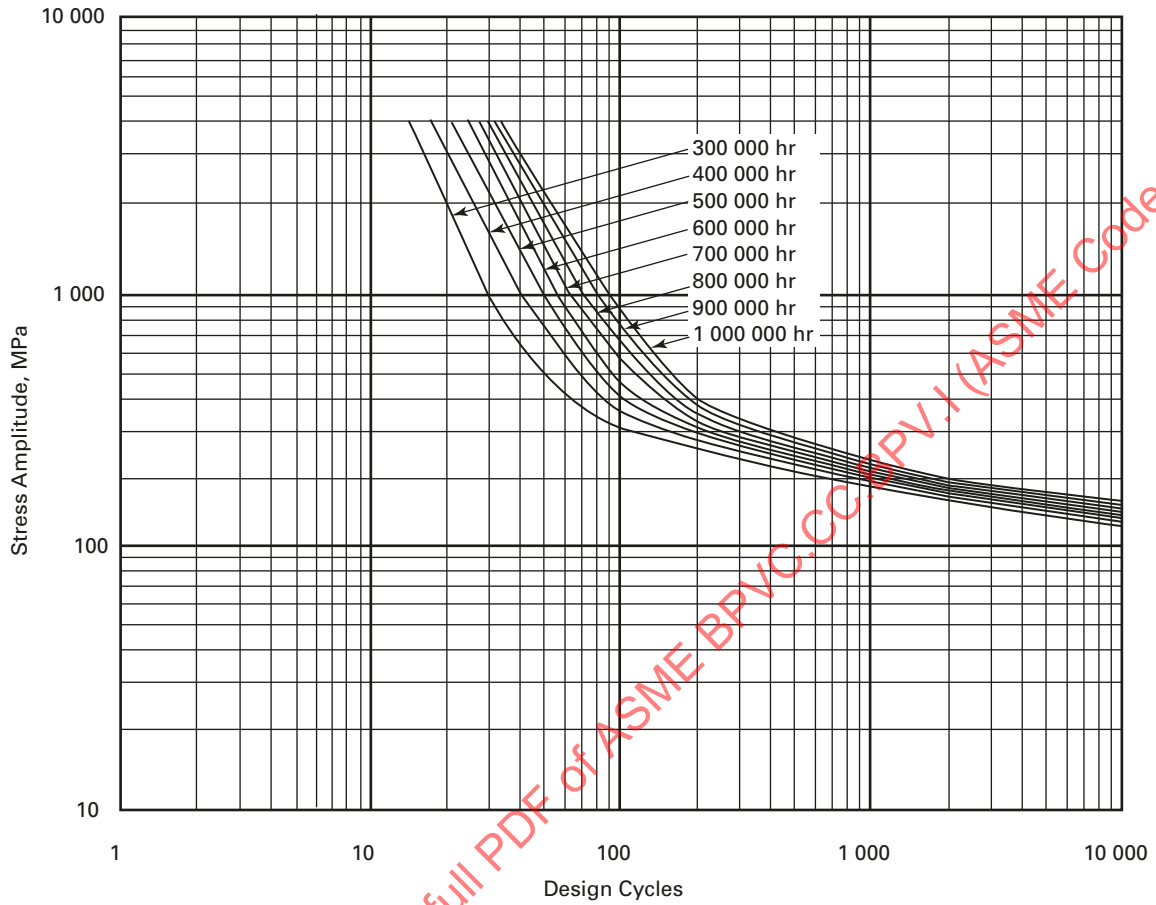
**Figure 1**  
**Design Fatigue Curve for 9Cr-1Mo-V Steel for Temperatures Not Exceeding 932°F, Design Cycles as a Function of Stress Amplitude and Creep Life Absent Fatigue**



GENERAL NOTES:

- (a) Interpolation of design cycles as a function of design life is permitted.
- (b) Extrapolation of design cycles as a function of stress amplitude is not permitted.
- (c) The reference temperature and Young's Modulus for these fatigue curves are 932°F and 26,106 ksi, respectively.

**Figure 1M**  
**Design Fatigue Curve for 9Cr-1Mo-V Steel for Temperatures Not Exceeding 500°C, Design Cycles as a Function of Stress Amplitude and Creep Life Absent Fatigue**



GENERAL NOTES:

- (a) Interpolation of design cycles as a function of design life is permitted.
- (b) Extrapolation of design cycles as a function of stress amplitude is not permitted.
- (c) The reference temperature and Young's Modulus for these fatigue curves are 500°C and 180 000 MPa, respectively.

**Table 3**  
**Design Fatigue Curve for 9Cr-1Mo-V Steel for Temperatures Not Exceeding 932°F, Design Cycles as a**  
**Function of Stress Amplitude and Creep Life Absent Fatigue**

Stress Amplitude, ksi	Creep Life Absent Fatigue, hr							
	300,000	400,000	500,000	600,000	700,000	800,000	900,000	1,000,000
577.3	15	18	21	24	26	29	31	32
440.6	17	21	25	28	31	34	37	39
339.2	20	25	29	33	37	40	44	47
263.9	22	28	34	39	43	48	52	56
207.9	26	33	39	45	51	56	61	66
166.2	29	37	45	52	59	65	71	77
135.2	33	42	51	60	68	75	83	89
112.0	37	48	58	68	78	87	95	104
94.6	41	54	66	77	88	99	109	119
81.5	46	61	74	88	100	113	125	136
71.6	52	68	84	99	114	128	142	155
64.1	58	76	94	111	128	145	161	176
58.3	64	85	105	125	144	163	181	199
53.9	72	95	117	139	161	183	204	224
50.3	80	105	131	156	180	205	228	252
47.6	88	117	145	174	201	229	256	282
45.3	98	130	162	193	224	255	285	315
43.4	109	144	180	215	249	284	318	352
41.9	121	160	199	238	277	316	354	392
40.6	133	177	221	265	308	351	394	436
39.4	148	197	245	294	342	390	437	485
38.4	164	218	272	325	379	432	485	538
37.4	181	241	301	360	420	479	538	597
36.6	200	267	333	399	465	531	596	662
35.8	222	295	369	442	515	588	661	734
35.0	245	327	408	489	570	651	732	813
34.3	271	361	451	541	631	721	810	900
33.6	300	400	499	599	698	798	897	996
33.0	332	442	553	663	773	883	993	1,102
32.3	367	489	611	733	855	977	1,098	1,220
31.7	406	541	676	811	946	1,080	1,215	1,350
31.1	449	598	747	897	1,046	1,195	1,344	1,493
30.5	496	661	827	992	1,157	1,322	1,487	1,651
30.0	549	731	914	1,097	1,279	1,462	1,644	1,826
29.4	607	809	1,011	1,213	1,415	1,616	1,818	2,020
28.9	671	894	1,118	1,341	1,564	1,787	2,011	2,234
28.3	742	989	1,236	1,483	1,730	1,976	2,223	2,470
27.8	820	1,093	1,366	1,639	1,912	2,185	2,458	2,731
27.3	906	1,209	1,511	1,813	2,115	2,416	2,718	3,020
26.8	1,002	1,336	1,670	2,004	2,338	2,672	3,006	3,339
26.3	1,108	1,477	1,847	2,216	2,585	2,954	3,323	3,692
25.8	1,225	1,633	2,042	2,450	2,858	3,266	3,674	4,082
25.3	1,354	1,806	2,257	2,709	3,160	3,611	4,063	4,514
24.8	1,497	1,997	2,496	2,995	3,494	3,993	4,492	4,991
24.4	1,656	2,207	2,759	3,311	3,863	4,414	4,966	5,518
23.9	1,830	2,440	3,050	3,661	4,271	4,881	5,491	6,100
23.5	2,024	2,698	3,373	4,047	4,722	5,396	6,070	6,745
23.1	2,237	2,983	3,729	4,474	5,220	5,966	6,711	7,457
22.6	2,473	3,298	4,122	4,947	5,771	6,596	7,420	8,244
22.2	2,735	3,646	4,558	5,469	6,381	7,292	8,204	9,115
21.8	3,023	4,031	5,039	6,047	7,054	8,062	9,070	10,078
21.4	3,343	4,457	5,571	6,685	7,799	8,913	10,028	11,142
21.0	3,696	4,927	6,159	7,391	8,623	9,855	11,086	12,318
20.6	4,086	5,448	6,809	8,171	9,533	10,895	12,257	13,619
20.2	4,517	6,023	7,528	9,034	10,540	12,045	13,551	15,057
19.9	4,994	6,659	8,323	9,988	11,652	13,317	14,982	16,646
19.5	5,521	7,362	9,202	11,042	12,883	14,723	16,564	18,404
19.1	6,104	8,139	10,174	12,208	14,243	16,278	18,312	20,347

**Table 3**  
**Design Fatigue Curve for 9Cr-1Mo-V Steel for Temperatures Not Exceeding 932°F, Design Cycles as a Function of Stress Amplitude and Creep Life Absent Fatigue (Cont'd)**

Stress Amplitude, ksi	Creep Life Absent Fatigue, hr							
	300,000	400,000	500,000	600,000	700,000	800,000	900,000	1,000,000
18.8	6,749	8,998	11,248	13,497	15,747	17,996	20,246	22,495
18.4	7,461	9,948	12,435	14,922	17,409	19,896	22,383	24,870
18.1	8,249	10,998	13,748	16,498	19,247	21,997	24,747	27,496
17.8	9,120	12,160	15,200	18,240	21,279	24,319	27,359	30,399
17.4	10,083	13,443	16,804	20,165	23,526	26,887	30,248	33,609
17.1	11,147	14,863	18,579	22,294	26,010	29,726	33,441	37,157
16.8	12,324	16,432	20,540	24,648	28,756	32,864	36,972	41,080
16.5	13,625	18,167	22,709	27,250	31,792	36,334	40,875	45,417
16.2	15,064	20,085	25,106	30,127	35,149	40,170	45,191	50,212
15.9	16,654	22,205	27,757	33,308	38,860	44,411	49,962	55,514
15.6	18,412	24,550	30,687	36,825	42,962	49,100	55,237	61,375
15.3	20,356	27,142	33,927	40,713	47,498	54,284	61,069	67,854

## GENERAL NOTES:

- (a) Interpolation of design cycles as a function of design life is permitted.
- (b) Extrapolation of design cycles as a function of stress amplitude is not permitted.
- (c) The reference temperature and Young's Modulus for these fatigue curves are 932°F and 26,106 ksi, respectively.

**Table 3M**  
**Design Fatigue Curve for 9Cr-1Mo-V Steel for Temperatures Not Exceeding 500°C, Design Cycles as a**  
**Function of Stress Amplitude and Creep Life Absent Fatigue**

Stress Amplitude, MPa	Creep Life Absent Fatigue, h							
	300 000	400 000	500 000	600 000	700 000	800 000	900 000	1 000 000
3 982	15	18	21	24	26	29	31	32
3 039	17	21	25	28	31	34	37	39
2 339	20	25	29	33	37	40	44	47
1 820	22	28	34	39	43	48	52	56
1 434	26	33	39	45	51	56	61	66
1 147	29	37	45	52	59	65	71	77
932	33	42	51	60	68	75	83	89
772	37	48	58	68	78	87	95	104
652	41	54	66	77	88	99	109	119
562	46	61	74	88	100	113	125	136
494	52	68	84	99	114	128	142	155
442	58	76	94	111	128	145	161	176
402	64	85	105	125	144	163	181	199
371	72	95	117	139	161	183	204	224
347	80	105	131	156	180	205	228	252
328	88	117	145	174	201	229	256	282
312	98	130	162	193	224	255	285	315
300	109	144	180	215	249	284	318	352
289	121	160	199	238	277	316	354	392
280	133	177	221	265	308	351	394	436
272	148	197	245	294	342	390	437	485
265	164	218	272	325	379	432	485	538
258	181	241	301	360	420	479	538	597
252	200	267	333	399	465	531	596	662
247	222	295	369	442	515	588	661	734
242	245	327	408	489	570	651	732	813
237	271	361	451	541	631	721	810	900
232	300	400	499	599	698	798	897	996
227	332	442	553	663	773	883	993	1 102
223	367	489	611	733	855	977	1 098	1 220
219	406	541	676	811	946	1 080	1 215	1 350
215	449	598	747	897	1 046	1 195	1 344	1 493
211	496	661	827	992	1 157	1 322	1 487	1 651
207	549	731	914	1 097	1 279	1 462	1 644	1 826
203	607	809	1 011	1 213	1 415	1 616	1 818	2 020
199	671	894	1 118	1 341	1 564	1 787	2 011	2 234
195	742	989	1 236	1 483	1 730	1 976	2 223	2 470
192	820	1 093	1 366	1 639	1 912	2 185	2 458	2 731
188	906	1 209	1 511	1 813	2 115	2 416	2 718	3 020
185	1 002	1 336	1 670	2 004	2 338	2 672	3 006	3 339
181	1 108	1 477	1 847	2 216	2 585	2 954	3 323	3 692
178	1 225	1 633	2 042	2 450	2 858	3 266	3 674	4 082
175	1 354	1 806	2 257	2 709	3 160	3 611	4 063	4 514
171	1 497	1 997	2 496	2 995	3 494	3 993	4 492	4 991
168	1 656	2 207	2 759	3 311	3 863	4 414	4 966	5 518
165	1 830	2 440	3 050	3 661	4 271	4 881	5 491	6 100
162	2 024	2 698	3 373	4 047	4 722	5 396	6 070	6 745
159	2 237	2 983	3 729	4 474	5 220	5 966	6 711	7 457
156	2 473	3 298	4 122	4 947	5 771	6 596	7 420	8 244
153	2 735	3 646	4 558	5 469	6 381	7 292	8 204	9 115
150	3 023	4 031	5 039	6 047	7 054	8 062	9 070	10 078
148	3 343	4 457	5 571	6 685	7 799	8 913	10 028	11 142
145	3 696	4 927	6 159	7 391	8 623	9 855	11 086	12 318
142	4 086	5 448	6 809	8 171	9 533	10 895	12 257	13 619
140	4 517	6 023	7 528	9 034	10 540	12 045	13 551	15 057
137	4 994	6 659	8 323	9 988	11 652	13 317	14 982	16 646
135	5 521	7 362	9 202	11 042	12 883	14 723	16 564	18 404

**Table 3M**  
**Design Fatigue Curve for 9Cr-1Mo-V Steel for Temperatures Not Exceeding 500°C, Design Cycles as a Function of Stress Amplitude and Creep Life Absent Fatigue (Cont'd)**

Stress Amplitude, MPa	Creep Life Absent Fatigue, h							
	300 000	400 000	500 000	600 000	700 000	800 000	900 000	1 000 000
132	6 104	8 139	10 174	12 208	14 243	16 278	18 312	20 347
130	6 749	8 998	11 248	13 497	15 747	17 996	20 246	22 495
127	7 461	9 948	12 435	14 922	17 409	19 896	22 383	24 870
125	8 249	10 998	13 748	16 498	19 247	21 997	24 747	27 496
123	9 120	12 160	15 200	18 240	21 279	24 319	27 359	30 399
120	10 083	13 443	16 804	20 165	23 526	26 887	30 248	33 609
118	11 147	14 863	18 579	22 294	26 010	29 726	33 441	37 157
116	12 324	16 432	20 540	24 648	28 756	32 864	36 972	41 080
114	13 625	18 167	22 709	27 250	31 792	36 334	40 875	45 417
112	15 064	20 085	25 106	30 127	35 149	40 170	45 191	50 212
110	16 654	22 205	27 757	33 308	38 860	44 411	49 962	55 514
108	18 412	24 550	30 687	36 825	42 962	49 100	55 237	61 375
106	20 356	27 142	33 927	40 713	47 498	54 284	61 069	67 854

## GENERAL NOTES:

- (a) Interpolation of design cycles as a function of design life is permitted.  
 (b) Extrapolation of design cycles as a function of stress amplitude is not permitted.  
 (c) The reference temperature and Young's Modulus for these fatigue curves are 500°C and 180 000 MPa, respectively.

**Table 4**  
**Stress Amplitude Versus Plastic Strain**

Alternating Equivalent Stress Amplitude		Equivalent Plastic Strain Amplitude
ksi	MPa	
577.5	3 982	0.02000000
440.7	3 039	0.01480000
339.2	2 339	0.01095200
263.9	1 820	0.00810400
207.9	1 434	0.00599700
166.3	1 147	0.00443800
135.2	932	0.00328400
112.0	772	0.00243000
94.6	652	0.00179800
81.5	562	0.00133100
71.7	494	0.00098500
64.1	442	0.00072900
58.3	402	0.00053900
53.9	371	0.00039900
50.4	347	0.00029500
47.6	328	0.00021900
45.3	312	0.00016200
43.5	300	0.00012000
41.9	289	0.00008860
40.6	280	0.00006550
39.4	272	0.00004850
38.4	265	0.00003590
37.4	258	0.00002660
36.6	252	0.00001960
35.8	247	0.00001450
35.0	242	0.00001080
34.3	237	0.00000796
33.6	232	0.00000589
33.0	227	0.00000436
32.3	223	0.00000323
31.7	219	0.00000239
31.1	215	0.00000177
30.5	211	0.00000131
30.0	207	0.00000097

## GENERAL NOTES:

- (a) The plastic strain below 207 MPa (30 ksi) shall be taken as 0.0.
- (b) Interpolation of data values is permitted.
- (c) Extrapolation of data values is not permitted.

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Approval Date: December 18, 2017

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2823-1**  
**Use of UNS S32003 Ferritic/Austenitic Stainless Steel**  
**Plate, Pipe, and Tube for Boilers**  
**Section IV**

*Inquiry:* Under what conditions may UNS S32003 ferritic/austenitic stainless steel in SA-240/SA-240M plate, SA-790 pipe, and SA-789 tube specifications be used in the construction of Section IV boilers?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used in the construction of Section IV boilers, provided the following requirements are met:

(a) The material shall be furnished in the heat-treated condition with the heat treatment as listed in the specification.

(b) The allowable stresses for plate, seamless pipe, and seamless tube furnished in accordance with SA-240/SA-240M, SA-789, and SA-790 shall be as listed in Tables 1, 1M, 2, and 2M.

(c) The allowable stresses for welded pipe and tube furnished in accordance with SA-789 and SA-790 shall be as listed in Tables 3, 3M, 4, and 4M.

(d) Welding procedures and performance qualifications shall be conducted in accordance with Section IX.

(e) This material may utilize the minimum thickness exceptions of HF-301.1(c) at pressures up to 160 psi (1 100 kPa).

(f) Tubing may utilize the thickness requirements of HF-204.3.

(g) All other requirements of Section IV shall be met.

(h) This Case number shall be shown on the Manufacturer's Data Report.

NOTE: This steel may be expected to develop embrittlement after service at moderately elevated temperatures; see Section II, Part D, Nonmandatory Appendix A.

**Table 1**  
**Maximum Allowable Stress Values: SA-789**  
**Seamless Tube, 100 ksi Tensile Strength and**  
**70 ksi Yield Strength**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Value, ksi
100	20.0
200	19.4
300	18.2
400	18.1
500	18.1

**Table 1M**  
**Maximum Allowable Stress Values: SA-789**  
**Seamless Tube, 690 MPa Tensile Strength**  
**and 485 MPa Yield Strength**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Value, MPa
40	138
65	138
100	132
125	128
150	126
200	124
250	124
275	124 [Note (1)]

NOTE:

(1) The maximum use temperature shall be 260°C. The value at 275°C is provided for interpolation purposes.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 2**  
**Maximum Allowable Stress Values: SA-240/  
 SA-240M Plate and SA-790 Seamless Tube,  
 90 ksi Tensile Strength and 65 ksi Yield  
 Strength**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Value, ksi
100	18.0
200	17.5
300	16.4
400	16.3
500	16.3

**Table 2M**  
**Maximum Allowable Stress Values: SA-240/  
 SA-240M Plate and SA-790 Seamless Tube,  
 620 MPa Tensile Strength and 450 MPa  
 Yield Strength**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Value, MPa
40	124
65	124
100	119
125	116
150	113
200	112
250	112
275	112 [Note (1)]

NOTE:

(1) The maximum use temperature shall be 260°C. The value at 275°C is provided for interpolation purposes.

**Table 3**  
**Maximum Allowable Stress Values: SA-789  
 Welded Tube, 100 ksi Tensile Strength and  
 70 ksi Yield Strength**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Value, ksi [Note (1)]
100	17.0
200	16.5
300	15.5
400	15.3
500	15.3

NOTE:

(1) For welded pipe and tube, the allowable stress values have been multiplied by a factor of 0.85.

**Table 3M**  
**Maximum Allowable Stress Values: SA-789  
 Welded Tube, 690 MPa Tensile Strength and  
 485 MPa Yield Strength**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Value, MPa [Note (1)]
40	117
65	117
100	113
125	109
150	107
200	106
250	106
275	106 [Note (2)]

NOTES:

(1) For welded pipe and tube, the allowable stress values have been multiplied by a factor of 0.85.

(2) The maximum use temperature shall be 260°C. The value at 275°C is provided for interpolation purposes.

**Table 4**  
**Maximum Allowable Stress Values: SA-790**  
**Welded Pipe, 90 ksi Tensile Strength and 65**  
**ksi Yield Strength**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Value, ksi [Note (1)]
100	15.3
200	14.8
300	14.0
400	13.8
500	13.8

NOTE:

(1) For welded pipe and tube, the allowable stress values have been multiplied by a factor of 0.85.

**Table 4M**  
**Maximum Allowable Stress Values: SA-789**  
**Welded Tube, 690 MPa Tensile Strength and**  
**485 MPa Yield Strength**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Value, MPa [Note (1)]
40	106
65	106
100	101
125	98.2
150	96.1
200	95.2
250	95.2
275	95.2 [Note (2)]

NOTES:

(1) For welded pipe and tube, the allowable stress values have been multiplied by a factor of 0.85.

(2) The maximum use temperature shall be 260°C. The value at 275°C is provided for interpolation purposes.

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Approval Date: March 23, 2015

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2824**  
**Use of UNS R50400 Titanium Seamless and Welded**  
**Tube**  
**Section IV**

*Inquiry:* Under what conditions may UNS R50400 titanium seamless and welded tubing in material specification SB-338 Grade 2 be used in the construction of Section IV boilers?

*Reply:* It is the opinion of the Committee that the material described in the Inquiry may be used in the construction of Section IV boilers, provided the following requirements are met:

(a) The allowable stresses shall be as listed in [Table 1](#) and [Table 1M](#).

(b) The maximum design temperature shall be 500°F (260°C).

(c) For external pressure, Figure NFT-2 of Section II, Part D shall be used.

(d) Welding procedures and performance qualifications shall be conducted in accordance with Section IX.

(e) All other requirements of Section IV shall be met.

(f) This Case number shall be shown on the Manufacturer's Data Report.

**Table 1**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress Value, ksi [Note (1)]
-20 to 100	10.0
150	9.4
200	8.7
250	8.0
300	7.2
350	6.7
400	6.2
450	5.8
500	5.3

NOTE:

(1) For welded construction, multiply the allowable stress values by 0.85.

**Table 1M**  
**Maximum Allowable Stress Values**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress Value, MPa [Note (1)]
-30 to 40	69.0
65	63.8
100	58.7
125	54.3
150	49.9
175	46.5
200	43.1
225	40.5
250	37.8
275	35.3 [Note (2)]

NOTES:

(1) For welded construction, multiply the allowable stress values by 0.85.

(2) The maximum use temperature shall be 260°C. The value at 275°C is provided for interpolation purposes.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: March 6, 2015

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2825**  
**Removal of Nameplate With Certification Mark from**  
**Prefabricated or Preformed Parts**  
**Section VIII, Division 1**

*Inquiry:* Under what circumstances may the manufacturer of the completed vessel remove a nameplate that contains the ASME Certification Mark on prefabricated or preformed parts?

*Reply:* It is the opinion of the Committee that when a nameplate furnished with the Certification Mark on prefabricated or preformed parts may be removed from the completed pressure vessel if all of the following conditions are satisfied:

(a) The nameplate interferes with further fabrication or service.

(b) The Manufacturer of the completed vessel has agreement from the Authorized Inspector to remove the nameplate.

(c) The removal of the nameplate shall be noted in the Remarks section of the vessel Manufacturer's Data Report.

(d) The removed nameplate shall be destroyed.

(e) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: August 14, 2018

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2826-1**  
**Automatic Pressure Decay Test in Lieu of Hydrostatic Testing**  
**Section IV**

*Inquiry:* Under what conditions may a hot water heating boiler or boiler part be tested using an automatic pressure decay test in lieu of hydrostatic test as required by HG-510?

*Reply:* It is the opinion of the Committee that a hot water heating boiler or boiler part may be tested using an automatic pressure decay test in lieu of hydrostatic test as required by HG-510, provided the following requirements are met:

(a) The test method shall be performed by pressure decay test according to the requirements of the Standard Practice ASTM E2930-13 and Section V, Article 10, Mandatory Appendix VI.

(b) A written procedure shall describe this test and shall be included in the quality control system.

(c) Safety measures according to the local jurisdictional requirements shall be applied to protect personnel conducting and/or witnessing the test.

(d) The maximum water volume shall not exceed 1.0 ft<sup>3</sup> (0.028 m<sup>3</sup>), and the maximum allowable working pressure shall not exceed 160 psi (1103 kPa).

(e) The test pressure shall not be less than the greater of 30 psi (262 kPa) or 1.1 times the design pressure.

(f) Maximum material thickness of any component part shall not exceed 1/2 in. (12.7 mm).

(g) No components of the heating boiler or boiler part that will be subject to pneumatic testing may be constructed of cast iron or cast aluminum.

(h) Nitrogen or clean, dry, oil-free air shall be used.

(i) The maximum differential temperature between the test equipment and the tested part shall not exceed 5°F (3°C).

(j) The minimum room temperature during the pneumatic test shall be at least 60°F (16°C) for the test equipment and the tested part.

(k) This Case number shall be shown on the Manufacturer's Data Report Form.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: June 29, 2018

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2827-2**  
**Low Power Density Laser Beam Welding**  
**Section I; Section VIII, Division 1; Section VIII, Division 2;**  
**Section IX**

*Inquiry:* Under what conditions may machine and automatic Low Power Density Laser Beam Welding (LLBW) be used?

*Reply:* It is the opinion of the Committee that machine and automatic Low Power Density Laser Beam Welding can be used, provided the following requirements are met:

(a) Low Power Density Laser Beam Welding (LLBW) shall be defined as a variation of the laser beam welding process in which the coherent light beam employs reduced power density, such that coalescence of materials is achieved by conduction (i.e., melt-in) without keyhole welding.

(b) Low Power Density Laser Beam Welding (LLBW) procedure specification qualification shall be as follows:

(1) The welding procedure specification (WPS) shall be qualified in accordance with the variables defined in Table 1.

(2) The melt-in technique shall be used, and filler material may be added to any portion of the molten weld metal (i.e., filler addition need not be located at the leading edge of the molten weld metal).

(3) Combination of welding processes is permissible in accordance with QW-200.4(b).

(4) Temper bead welding is permissible in accordance with QW-290.2. LLBW heat input shall be calculated as follows:

$$\text{LLBW heat input [J/in. (J/mm)]} = \text{Power (W)} \times 60 / \text{Travel speed [in./min (mm/min)]}$$

(c) Qualification of welding operators shall comply with QW-305. Table QW-451 (including Note 3) shall be used for groove weld tension tests and transverse bend tests.

(d) This Case number shall be shown on the welding procedure specification (WPS), procedure qualification record (PQR), and Manufacturer's Data Report.

**Table 1**  
**Welding Variables for Low Power Density Laser Beam Welding (LLBW)**

Paragraph	Brief of Variables	Essential	Supplementary Essential	Nonessential
QW-402, Joints	.1 $\phi$ Groove design	...	...	X
	.5 Backing	...	...	X
	.10 $\phi$ Root spacing	...	...	X
	.11 $\pm$ Retainers	...	...	X
QW-403, Base Metals	.5 $\phi$ Group number	...	X	...
	.6 T limits	...	X	...
	.8 T qualified	X	...	...
	.11 $\phi$ P-No. qualified	X	...	...

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**Table 1**  
**Welding Variables for Low Power Density Laser Beam Welding (LLBW) (Cont'd)**

Paragraph	Brief of Variables	Essential	Supplementary Essential	Nonessential	
QW-404, Filler Metals	.3	φ Size	...	...	X
	.4	φ F-number	X	...	...
	.5	φ A-number	X	...	...
	.12	φ Classification	...	X	...
	.14	± Filler	X	...	...
	.22	± Consumable insert	...	...	X
	.23	φ Filler metal product form	X	...	...
	.30	φ <i>t</i>	X	...	...
	.33	φ Classification	...	...	X
	.50	± Flux	...	...	X
QW-405, Positions	.1	+ Position	...	...	X
	.2	φ Position	...	X	...
	.3	φ ↑↓ Vertical welding	...	...	X
QW-406, Preheat	.1	Decrease > 100°F (55°C)	X	...	...
	.3	Increase > 100°F (55°C) interpass temperature	...	X	...
QW-407, PWHT	.1	φ PWHT	X	...	...
	.2	φ PWHT (temperature and time range)	...	X	...
	.4	<i>T</i> limits	X	...	...
QW-408, Gas	.1	± Trail or φ composition	...	...	X
	.2	φ Single, mixture, or %	X	...	...
	.3	φ Flow rate	...	...	X
	.5	± or φ Backing flow	...	...	X
	.9	- Backing or φ composition	X	...	...
	.10	φ Shielding or trailing	X	...	...
QW-409, Electrical Characteristics	.1	> Heat input	...	X	...
	.19	φ Pulse	X	...	...
	.20	φ Mode, energy	X	...	...
	.21	Decrease >10% power	X	...	...
QW-410, Technique	.3	φ Orifice, cup, or nozzle size	...	...	X
	.5	φ Method cleaning	...	...	X
	.6	φ Method back gouge	...	...	X
	.7	φ Oscillation	...	...	X
	.9	φ Multi- to single-pass/side	...	X	X
	.11	φ Closed to out chamber	X	...	...
	.26	± Peening	...	...	X
	.64	Use of thermal processes	X	...	...
	.66	φ Travel, beam factors	X	...	...
	.67	φ Optical techniques	X	...	...
	.68	φ Type of equipment	X	...	...
	.77	φ Wavelength	X	...	...
.80	φ Spot size	X	...	...	

Legend:

φ = Change  
+ = Addition  
- = Deletion

↑ = Uphill  
↓ = Downhill

Approval Date: June 1, 2015

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2828**  
**Use of SA/EN 10216-2, Grade 16Mo3 Seamless Steel**  
**Tubes for Pressure Purposes**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions may seamless steel tubes manufactured in accordance with SA/EN-10216-2, Grade 16Mo3 be used in Section VIII, Division 1 (2013 edition and later) construction?

*Reply:* It is the opinion of the Committee that seamless steel tubes manufactured in accordance with SA/EN-10216-2, Grade 16Mo3 may be used in Section VIII, Division 1 (2013 edition and later) construction, provided the following requirements are met:

- (a) The design temperature shall not exceed 1,000°F (538°C).
- (b) The maximum allowable stress values shall be those listed in Table 1A in Section II, Part D for this material.
- (c) The yield and tensile strengths shall be as shown in Section II, Part D, Tables Y-1 and U, respectively, for this material.
- (d) For physical properties, the material shall be considered a C- $\frac{1}{2}$ Mo steel.
- (e) For external pressure design, the requirements of Figure CS-2 of Section II, Part D shall apply.
- (f) This material shall be considered UCS material.
- (g) Welding procedures and performance qualifications shall be conducted in accordance with Section IX.
- (h) This Case number shall be shown on the Manufacturer's Data Report.

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Approval Date: June 1, 2015

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**Case 2830**  
**Use of ASTM A234/A234M Butt Weld Elbows, Grade WPB**  
**Section VIII, Division 1**

*Inquiry:* May butt weld elbows manufactured in accordance with ASTM A234/A234M-11a, -13e1, or -14, Grade WPB, and containing the higher limit for manganese be used for Section VIII, Division 1 welded construction?

*Reply:* It is the opinion of the Committee that butt weld elbows manufactured in accordance with ASTM A234/A234M-11a, -13e1, or -14, Grade WPB, and containing

the higher limit for manganese may be used in Section VIII, Division 1 construction, provided the following requirements are met:

(a) The composition shall conform to Table 1 of ASTM A234/A234M-11a, -13e1, or -14 for Grade WPB, including Note D.

(b) All other requirements of SA-234/SA-234M shall apply.

(c) Allowable stresses shall be those for SA-234/SA-234M, Grade WPB.

(d) This Case number shall be shown on the material marking and documentation, and the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: September 30, 2018

(19)

*Code Cases will remain available for use until annulled by the applicable Standards Committee.*

**Case 2831-1**  
**UNS S31266, 24Cr-22Ni-6Mo-2W-Cu-N Super Austenitic**  
**Stainless Steel (Class 2)**  
**Section VIII, Division 1; Section VIII, Division 2**

*Inquiry:* Under what conditions may UNS S31266 super austenitic stainless steel be used in welded construction conforming to the rules of Section VIII, Division 1 and Division 2, Class 2?

*Reply:* It is the opinion of the Committee that UNS S31266 super austenitic stainless steel be used in welded construction conforming to the rules of Section VIII, Division 1 and Division 2, Class 2, provided the following requirements are met:

(a) The material shall meet the requirements of SA-182 for forgings, SA-240 for plate, or SA-358 for welded pipe.

(b) Other product forms shall meet the requirements in the product specifications listed in Table 1, and shall meet the room temperature mechanical property requirements in Table 2 and the chemical requirements in Table 3.

(c) The materials listed in Table 1 shall be furnished in the solution annealed condition. The solution annealing shall be performed within the range of 2,085°F to 2,138°F (1 140°C to 1 170°C) followed by liquid quenching or rapid cooling by other means.

(d) The rules for austenitic-stainless steels in Section VIII, Division 1, Subsection C, Part UHA shall apply for Division 1 construction.

(e) The rules for austenitic-stainless steels in Section VIII, Division 2, Part 3 shall apply for Division 2, Class 2 construction.

(f) The design temperature shall not exceed 800°F (426°C).

(g) The maximum allowable design stress values for Division 1 shall be as listed in Table 4 and Table 4M. For welded pipe, tube, or fittings, a 0.85 joint efficiency factor shall be applied to these values.

(h) The maximum allowable stress values for Division 2, Class 2 shall be as listed in Table 5 and Table 5M. For welded pipe, tube, or fittings, a 0.85 joint efficiency factor shall be applied to these values.

(i) In order to satisfy the protection against failure from cyclic loading provisions of Section VIII, Division 2, Class 2, 5.5.1 through 5.5.4, this material shall be considered Table 3-F.3 material.

(j) Tensile and yield strength values are shown in Table 6 and Table 6M.

(k) For physical properties, the following values shall be applied:

(1) thermal expansion: Section II, Part D, Table TE-1, austenitic stainless steel, Group 4 alloys

(2) thermal conductivity and thermal diffusivity: Section II, Part D, Table TCD, high alloy steel, Group L

(3) Poisson's ratio and density: 0.31 and 0.293 lb/in.<sup>3</sup> (8 100 kg/m<sup>3</sup>), respectively

(4) elastic modulus: Table 7 and Table 7M

(l) For external pressure design, see Figure 1 and Figure 1M and Table 8 and Table 8M. Values for intermediate temperatures may be obtained by interpolation.

(m) Welding performance and welding procedure qualifications shall be performed in accordance with Section IX. The material shall be considered P-No. 45.

(n) Heat treatment after forming or fabrication is neither required nor prohibited, but when heat treatment is performed, the requirements of (c) shall apply.

(o) For specifications other than SA-182, SA-240, and SA-358, this Case number shall be shown on the documentation and marking of the material.

(p) This Case number shall be shown on the material marking and documentation, and the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1  
Product Specifications**

Product	Specification
Ferritic and austenitic alloy steel boiler, superheater, and heat exchanger tubes	SA-213/SA-213M
Seamless and welded austenitic stainless steel pipe	SA-312/SA-312M
Single or double welded austenitic stainless steel pipe	SA-813/SA-813M
Stainless steel bars and shapes for use in boilers and other pressure vessels	SA-479/SA-479M
Welded austenitic steel boiler, superheater, heat exchanger, and condenser tubes	SA-249/SA-249M
Wrought austenitic stainless steel pipe fittings	SA-403/SA-403M

**Table 2  
Mechanical Property Requirements**

Minimum tensile strength, ksi (MPa)	109 (750)
Yield strength, 0.2% offset, min., ksi (MPa)	61 (420)
Elongation in 2 in. (50 mm), min. %	35

**Table 3  
Chemical Requirements**

Element	Composition, %
Carbon, max.	0.030
Manganese	2.0-4.0
Phosphorus, max.	0.035
Sulfur, max.	0.020
Silicon, max.	1.00
Nickel	21.0-24.0
Chromium	23.0-25.0
Molybdenum	5.2-6.2
Nitrogen	0.35-0.60
Copper	1.00-2.50
Tungsten	1.50-2.50
Iron	Balance

**Table 4  
Maximum Allowable Stress Values,  
Division 1**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress, $S_a$ , ksi
100	31.1
150	31.1
200	30.8
250	29.8
300	28.9
350	28.2
400	27.7
450	27.2
500	26.9
550	26.6
600	26.3
650	26.1
700	25.9
750	25.7
800 [Note (1)]	25.4

NOTE:  
(1) The maximum use temperature is 800°F.

**Table 4M  
Maximum Allowable Stress Values,  
Division 1**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress, $S_a$ , MPa
40	215
65	215
100	210
125	204
150	199
175	195
200	191
225	188
250	186
275	184
300	182
325	181
350	179
375	178
400	177
425	175
450 [Note (1)]	174

NOTE:  
(1) The maximum use temperature is 426°C. The value at 450°C is for interpolation only.

**Table 5**  
**Maximum Allowable Stress Values,**  
**Division 2, Class 2**

For Metal Temperature Not Exceeding, °F	Maximum Allowable Stress, $S_a$ , ksi
100	40.7
150	40.7
200	40.7
250	40.7
300	40.7
350	40.7
400	40.7
450	40.7
500	40.7
550	40.7
600	40.7
650 [Note (1)]	40.6
700 [Note (1)]	40.4
750 [Note (1)]	40.3
800 [Note (1)], [Note (2)]	40.1

## NOTES:

- (1) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is possible. These higher stress values exceed  $66\frac{2}{3}\%$  but do not exceed 90% of the yield strength temperature. Use of these stresses are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction. Section II, Part D, Table Y-2 lists multiplying factors that, when applied to the yield strength values shown in Table Y-1, give allowable stress values that will result in lower levels of permanent strain.
- (2) The maximum use temperature is 800°F.

**Table 5M**  
**Maximum Allowable Stress Values,**  
**Division 2, Class 2**

For Metal Temperature Not Exceeding, °C	Maximum Allowable Stress, $S_a$ , MPa
40	280
65	280
100	280
125	280
150	280
175	280
200	280
225	280
250	280
275	280
300	280
325	280
350	280
375 [Note (1)]	279
400 [Note (1)]	278
425 [Note (1)]	277
450 [Note (1)], [Note (2)]	275

## NOTES:

- (1) Due to the relatively low yield strength of this material, these higher stress values were established at temperatures where the short-time tensile properties govern to permit the use of these alloys where slightly greater deformation is possible. These higher stress values exceed  $66\frac{2}{3}\%$  but do not exceed 90% of the yield strength temperature. Use of these stresses are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction. Section II, Part D, Table Y-2 lists multiplying factors that, when applied to the yield strength values shown in Table Y-1, give allowable stress values that will result in lower levels of permanent strain.
- (2) The maximum use temperature is 426°C. The value at 450°C is for interpolation only.

**Table 6  
Tensile and Yield Strengths**

For Metal		
Temperature Not Exceeding, °F	Yield Strength, ksi	Tensile Strength, ksi
100	61.0	109
150	56.2	109
200	53.7	108
250	51.7	104
300	50.0	101
350	48.7	98.9
400	47.6	96.9
450	46.8	95.3
500	46.1	94.0
550	45.7	92.9
600	45.3	92.1
650	45.1	91.3
700	44.9	90.6
750	44.7	89.8
800 [Note (1)]	44.5	88.9

NOTE:

(1) The maximum use temperature is 800°F.

**Table 6M  
Tensile and Yield Strengths**

For Metal		
Temperature Not Exceeding, °C	Yield Strength, MPa	Tensile Strength, MPa
40	421	752
65	388	752
100	367	736
125	355	715
150	344	697
175	336	683
200	329	670
225	324	660
250	319	651
275	316	644
300	314	638
325	312	633
350	311	628
375	310	624
400	308	619
425	307	614
450 [Note (1)]	306	607

NOTE:

(1) The value at 450°C is for interpolation only. The maximum use temperature is 426°C.

**Table 7  
Modulus of Elasticity**

Temperature, °F	E, ksi × 10 <sup>-3</sup>
-325	29.6
-200	28.8
-100	28.2
70	27.2
100	27.0
200	26.4
300	25.8
400	25.2
500	24.6
600	24.0
700	23.4
800	22.8
900	22.2
1,000	21.6

**Table 7M  
Modulus of Elasticity**

Temperature, °C	E, MPa × 10 <sup>-3</sup>
-200	204
-125	198
-75	195
25	187
100	182
150	178
200	174
250	171
300	167
350	163
400	159
450	156
500	152
550	148

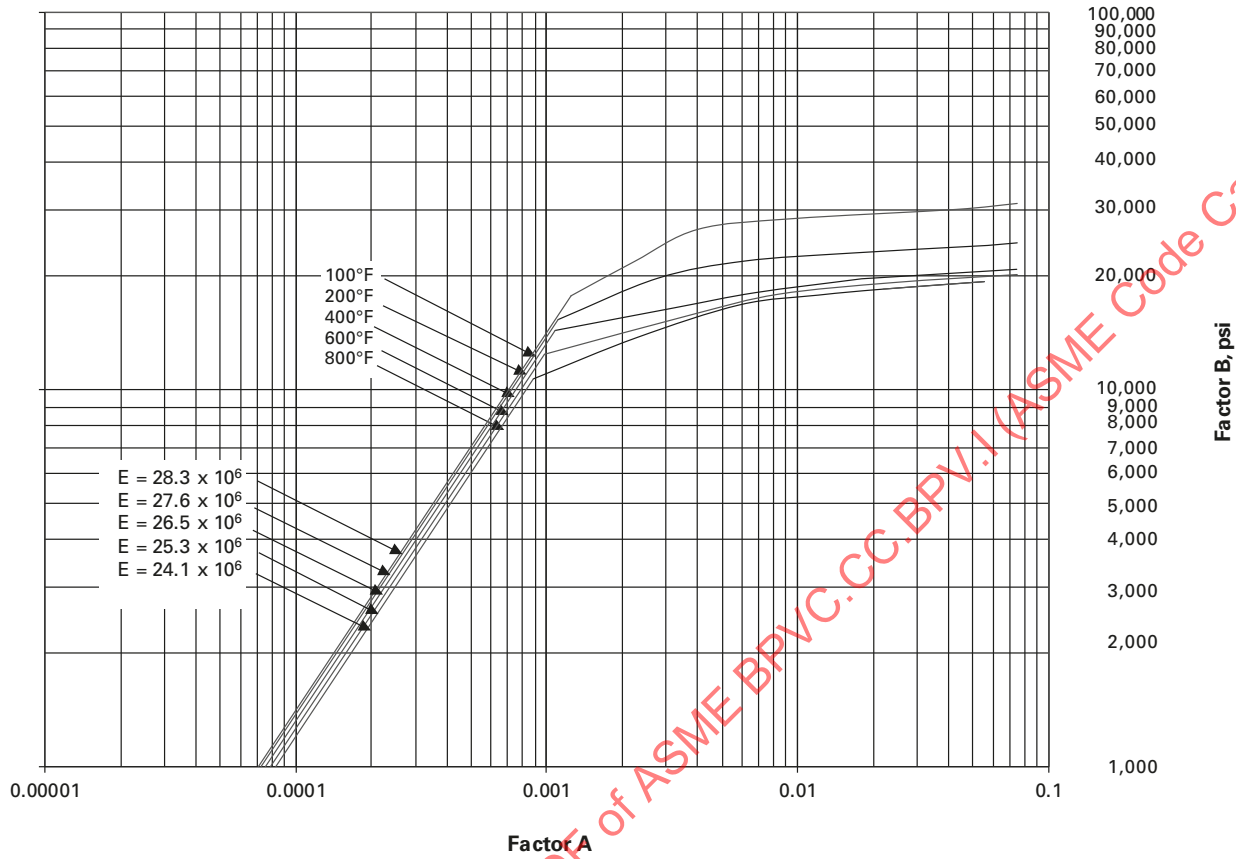
**Table 8**  
**Tabular Values for Figure 1**

Temperature, °F	A	B, psi
Up to 100	1.00 E-05	1.42 E+02
	7.07 E-04	1.00 E+03
	1.00 E-04	1.42 E+03
	1.25 E-03	1.77 E+04
	2.24 E-03	2.18 E+04
	4.01 E-03	2.66 E+04
	9.49 E-03	2.83 E+04
	4.29 E-02	3.00 E+04
	7.50 E-02	3.11 E+04
200	1.00 E-05	1.38 E+02
	7.25 E-04	1.00 E+03
	1.00 E-04	1.38 E+03
	1.11 E-03	1.53 E+04
	2.76 E-03	1.97 E+04
	6.14 E-03	2.19 E+04
	1.64 E-02	2.30 E+04
	5.72 E-02	2.41 E+04
	7.50 E-02	2.45 E+04
400	1.00 E-05	1.33 E+02
	7.55 E-04	1.00 E+03
	1.00 E-04	1.33 E+03
	1.08 E-03	1.43 E+04
	3.23 E-03	1.65 E+04
	6.78 E-03	1.81 E+04
	1.80 E-02	1.97 E+04
	7.47 E-02	2.08 E+04
	7.47 E-02	2.08 E+04
600	1.00 E-05	1.27 E+02
	7.91 E-04	1.00 E+03
	1.00 E-04	1.27 E+03
	9.79 E-04	1.24 E+04
	3.77 E-03	1.58 E+04
	8.38 E-03	1.79 E+04
	2.41 E-02	1.92 E+04
	7.50 E-02	2.02 E+04
	7.50 E-02	2.02 E+04
800	1.00 E-05	1.21 E+02
	8.30 E-04	1.00 E+03
	1.00 E-04	1.21 E+03
	8.84 E-04	1.07 E+04
	2.28 E-03	1.37 E+04
	5.90 E-03	1.68 E+04
	1.21 E-02	1.78 E+04
	2.19 E-02	1.85 E+04
	5.55 E-02	1.93 E+04
7.50 E-02	1.97 E+04	

**Table 8M**  
**Tabular Values for Figure 1M**

Temperature, °C	A	B, MPa
Up to 38	1.00 E-05	9.75 E-01
	1.03 E-04	1.00 E+01
	1.25 E-03	1.22 E+02
	2.24 E-03	1.51 E+02
	4.01 E-03	1.83 E+02
	9.49 E-03	1.95 E+02
	4.29 E-02	2.07 E+02
	7.50 E-02	2.14 E+02
	7.50 E-02	2.14 E+02
93	1.00 E-05	9.51 E-01
	1.05 E-04	1.00 E+01
	1.11 E-03	1.06 E+02
	2.76 E-03	1.36 E+02
	6.14 E-03	1.51 E+02
	1.64 E-02	1.58 E+02
	5.72 E-02	1.66 E+02
	7.50 E-02	1.69 E+02
	7.50 E-02	1.69 E+02
204	1.00 E-05	9.51 E-01
	1.09 E-04	1.00 E+01
	1.08 E-03	9.88 E+01
	3.23 E-03	1.13 E+02
	6.78 E-03	1.24 E+02
	1.80 E-02	1.35 E+02
	7.47 E-02	1.43 E+02
	7.47 E-02	1.43 E+02
	7.47 E-02	1.43 E+02
316	1.00 E-05	8.72 E-01
	1.15 E-04	1.00 E+01
	9.79 E-04	8.54 E+01
	3.77 E-03	1.09 E+02
	8.38 E-03	1.23 E+02
	2.41 E-02	1.32 E+02
	7.50 E-02	1.39 E+02
	7.50 E-02	1.39 E+02
	7.50 E-02	1.39 E+02
427	1.00 E-05	8.30 E-01
	1.20 E-04	1.00 E+01
	8.84 E-04	7.35 E+01
	2.28 E-03	9.46 E+01
	5.90 E-03	1.16 E+02
	1.21 E-02	1.23 E+02
	2.19 E-02	1.27 E+02
	5.55 E-02	1.33 E+02
	7.50 E-02	1.36 E+02

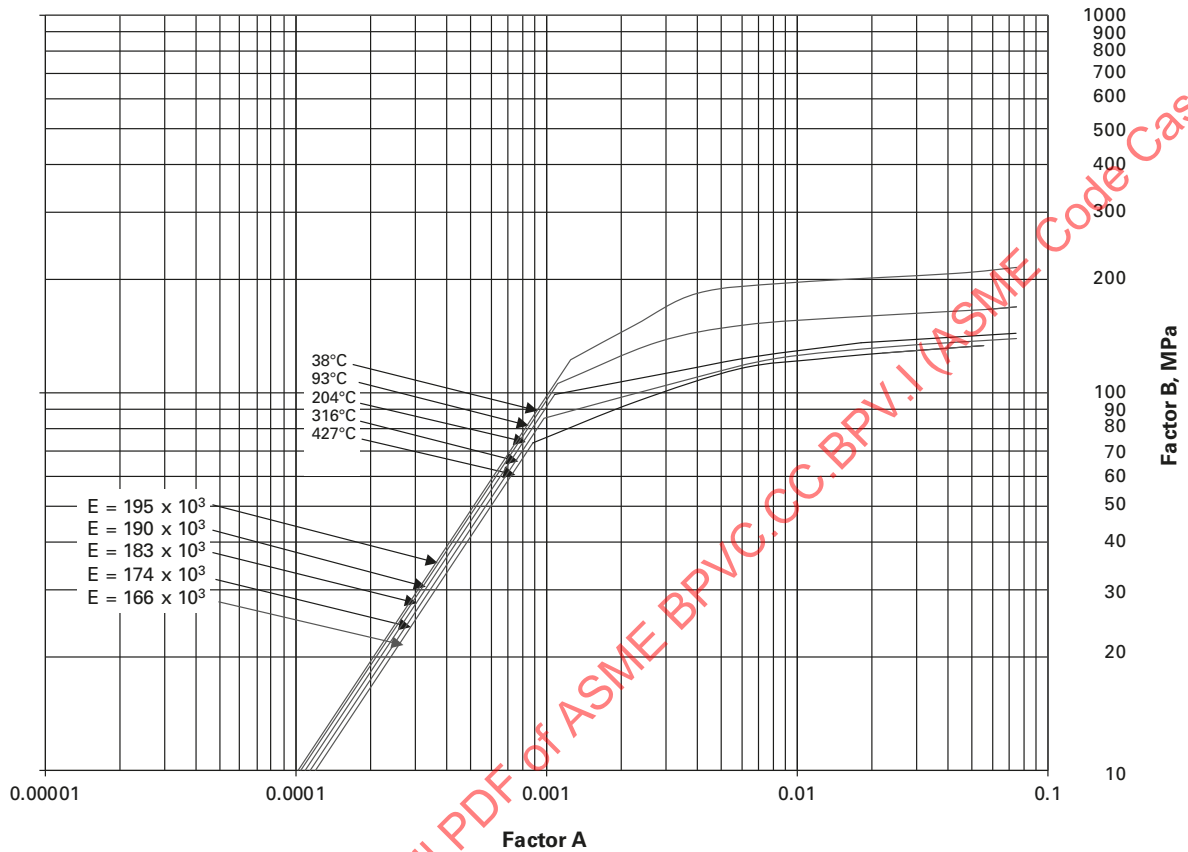
**Figure 1**  
**External Pressure Design for Austenitic Stainless Steel 24Cr-17Ni-6Mn-4.5Mo-N (UNS S34565)**



**GENERAL NOTES:**

- (a) The external pressure chart assigned does not account for the reduction of buckling strength due to creep under long-term loads. The effect of creep shall be considered at temperatures for which allowable stress are shown italicized in Section II, Part D, Tables 1A, 1B, 2A, 2B, 5A, and 5B.
- (b) The external pressure chart assigned for a particular material is obtained from the stress Tables 1A, 1B, 2A, 2B, 5A, and 5B under the column "External Pressure Chart No." for that material and is mandatory with the exception of Tables 5A and 5B.

**Figure 1M**  
**External Pressure Design for Austenitic Stainless Steel 24Cr-17Ni-6Mn-4.5Mo-N (UNS S34565)**



**GENERAL NOTES:**

- (a) The external pressure chart does not account for the reduction of buckling strength due to creep under long-term loads. The effect of creep shall be considered at temperatures for which allowable stress are shown italicized in Section II, Part D, Tables 1A, 1B, 2A, 2B, 5A, and 5B.
- (b) The external pressure chart assigned for a particular material is obtained from the stress Tables 1A, 1B, 2A, 2B, 5A, and 5B under the column "External Pressure Chart No." for that material and is mandatory with the exception of Tables 5A and 5B.

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**Case 2832**  
**WPS Qualification for Friction Taper Hydro Pillar**  
**(FTHP) Welding**  
**Section IX**

*Inquiry:* Under what conditions may a welding procedure specification (WPS) for the friction taper hydro pillar (FTHP) welding process be qualified in accordance with Section IX?

*Reply:* It is the opinion of the Committee that a welding procedure specification (WPS) for the friction taper hydro pillar (FTHP) welding process may be qualified in accordance with Section IX, provided the following conditions are met:

(a) The variables applicable for qualifying a welding procedure specification (WPS) for FTHP welding shall be those shown in Table 1, with new variables unique to FTHP welding described in detail in the Notes.

(b) The terminology used in the variable descriptions for the FTHP welding process are as defined as follows and illustrated in Figure 1.

*forging force:* the compressive force applied to the consumable rotating tool after the friction phase of the welding cycle is completed.

*forging phase:* the portion of the friction welding cycle during which the forging force is applied to the interface.

*forging time:* the duration of time when the forging force is applied.

*friction force:* the compressive force applied by the consumable rotating tool at the hole base diameter during the friction phase of the welding cycle.

*friction phase:* the portion of the welding cycle during which the heat necessary for welding is generated by the relative motion and application of the friction force at the interface.

*friction taper hydro pillar (FTHP) welding:* an automatic, solid state welding process completed by rotating a consumable tool (with or without a taper) inside a prepared blind hole (with a matching shape) in the base metal while applying downward axial pressure. The heat of

friction created between the rotating tool and the prepared surface of the hole forms a plasticized interface joining the rotating tool to the hole in the base metal once the tool rotation has ceased. The FTHP welding process is primarily used for repairing a hole in a pipe where material has been removed for metallurgical testing.

*friction time:* the duration of the friction phase.

*rotational speed:* the rpm of the consumable rotating tool during the friction phase.

*upset distance:* the total loss of axial length of the consumable rotating tool from the point of initial contact until the completion of the weld.

*weld flash:* the material that is displaced from the friction weld interface.

(c) The welding procedure shall be qualified by tensile testing and bend testing.

(1) The tensile test requirement shall be completed by removing two tensile test specimens from the test coupon with the weld area located in the center, and the axis of the weld transverse to the width of each tensile test specimen as shown in Figure 2. The tensile test specimens shall be removed from the test coupon with one face of each specimen common to the center of the weld, and prepared for tensile testing as shown in Figure QW-462.1(a).

(2) The bend test requirement shall be completed by removing three bend test specimens from the test coupon with the weld located in the center, and the axis of the weld perpendicular to the face of each bend test specimen as shown in Figure 3. The three bend test specimens shall be removed from near the weld surface, the middle of the weld depth, and  $\frac{1}{8}$  in. (3 mm) upward from the bottom of the weld.

(d) The FTHP welding process shall be used only for the repair of holes in piping where material has been removed for metallurgical testing. The FTHP welding process shall not be used for other types of repairs such as defects in boiler drums or shells of pressure vessels under the provisions of this Case.

(e) This Case number shall be shown on the Welding Procedure Specification (WPS), the Procedure Qualification Record (PQR), and the Welding Operator Performance Qualification (WPQ).

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

**Table 1**  
**Welding Variables for Friction Taper Hydro Pillar (FTHP) Welding**

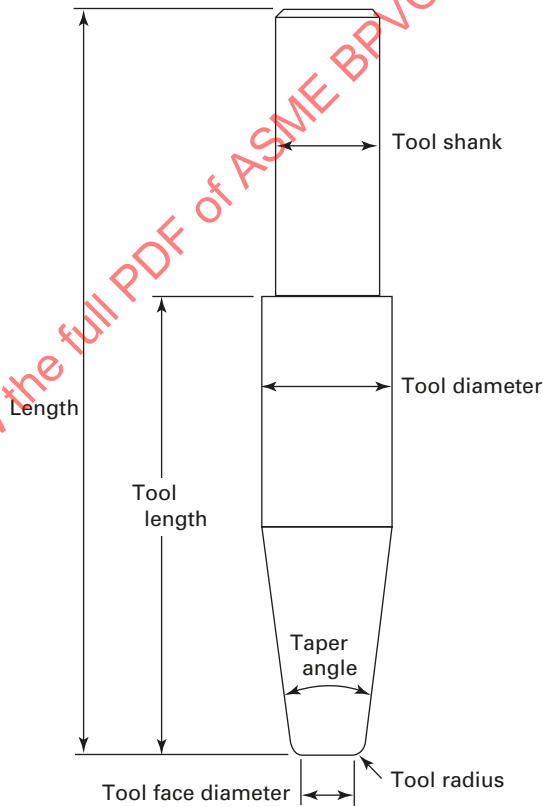
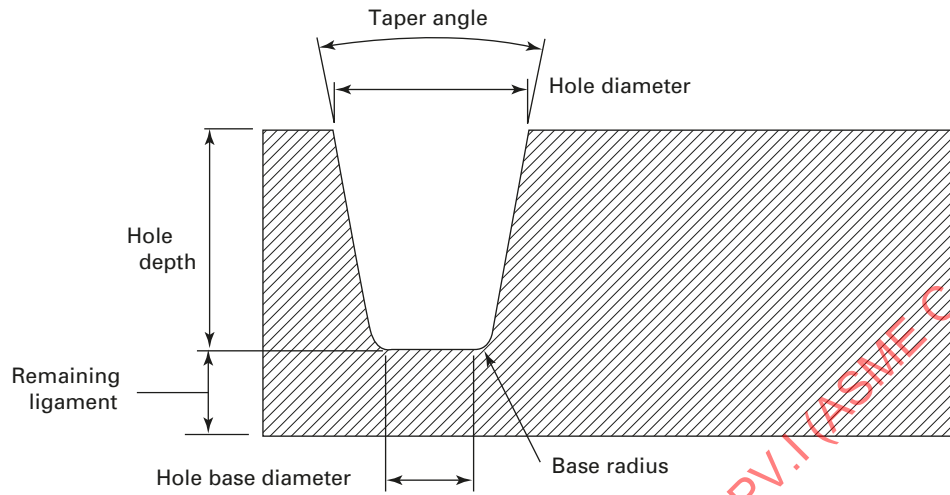
Paragraph	Brief of Variables	Essential	Supplementary Essential	Nonessential
QW-402, Joints	.X(a) $\phi$ Hole depth > $\pm 10\%$ [Note (1)]			X
	.X(b) $\phi$ Hole base diameter $\pm 10\%$ [Note (2)]	X		
	.X(c) $\phi$ Hole base radius [Note (3)]	X		
	.X(d) $\phi$ Hole taper angle $\pm 0.5$ deg [Note (4)]	X		
	.X(e) – Retaining ligament > 10% [Note (5)]			X
QW-403, Base Metals	.19 $\phi$ Type/grade	X		
QW-406, Preheat	.1 Decrease > 100°F	X		
QW-407, PWHT	.1 $\phi$ PWHT	X		
QW-408, Gas	.11 $\pm$ Gas shielding	X		
QW-410, Technique	.17 $\phi$ Welding equipment			X
	.31 $\phi$ Joint cleaning methods			X
	.X(a) $\phi$ Consumable rotating tool [Note (6)]	X		
	.X(b) $\phi$ Rotating tool operation [Note (7)]	X		

GENERAL NOTE: The Xs in paragraph and figure references are to be determined.

NOTES:

- (1) An increase in the hole depth greater than  $\pm 10\%$  (see Figure QW-461.XX)
- (2) A change in the hole base diameter greater than  $\pm 10\%$  (see Figure QW-461.XX)
- (3) A change in the hole base radius greater than +0.01 in./-0.0 in. (+0.25 mm/-0.0 mm) (see Figure QW-461.XX)
- (4) A change in the hole taper angle greater than  $\pm 0.5$  deg (see Figure QW-461.XX)
- (5) A reduction of the retaining ligament > 10% (see Figure QW-461.XX)
- (6) A change in the consumable rotating tool characteristics beyond the following limits (see Figure QW-461.XX):
  - (a) taper angle greater than  $\pm 0.5$  deg
  - (b) tool face radius greater than +0.01 in./-0.0 in. (+0.25 mm/-0.0 mm)
  - (c) tool face diameter greater than +5%/-0%, provided the tool face diameter is not less than 90% nor greater than 95% of the hole base diameter
  - (d) reduction in taper length to less than 140% of the hole depth
  - (e) material specification and grade or nominal chemistry
- (7) A change in the operating characteristics of the consumable rotating tool beyond the following limits (see QG-109.2):
  - (a) friction force greater than  $\pm 5\%$
  - (b) rotational rpm greater than  $\pm 10\%$
  - (c) reduction of forging force to less than friction force
  - (d) reduction in forging time to less than 25 sec
  - (e) upset distance greater than +5%. Continuous circumferential weld flash and some portion of the tapered length of the consumable rotating tool shall be visible after welding.

**Figure 1  
Terminology**



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Approval Date: July 15, 2015

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**Case 2833**  
**Design of Hubless Integral Flanges Using Part 4.16**  
**Section VIII, Division 2**

*Inquiry:* What values of  $F$ ,  $f$ ,  $V$ , and  $h$  shall be used for the design of a hubless flange (where  $g_o = g_1$ ) as shown in Figure 4.16.1, illustration (b) of Section VIII, Division 2?

*Reply:* It is the opinion of the Committee that when designing a hubless flange (where  $g_o = g_1$ ) as shown in Figure 4.16.1, illustration (b) of Section VIII Division 2, the following conditions shall apply:

(a) The following values shall apply:

$$F = 0.908920$$

$$f = 1.0$$

$$V = 0.550103$$

(b) The value of  $h$  used to calculate  $t_p$  in Table 4.16.7 shall be determined as follows:

$$0.7 \sqrt{\frac{B}{2g_o}}$$

(c) This Case number shall be shown on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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**Case 2834**  
**Hillside Nozzle in Spherical Shell or Hemispherical Head in 4.5.11**  
**Section VIII, Division 2**

*Inquiry:* May Section VIII, Division 2, 4.5.11 be applied for a hillside nozzle in a spherical shell or a hemispherical head?

*Reply:* It is the opinion of the Committee that Section VIII, Division 2, 4.5.11 may be applied for a hillside nozzle in a spherical shell or a hemispherical head, provided the following requirements are met:

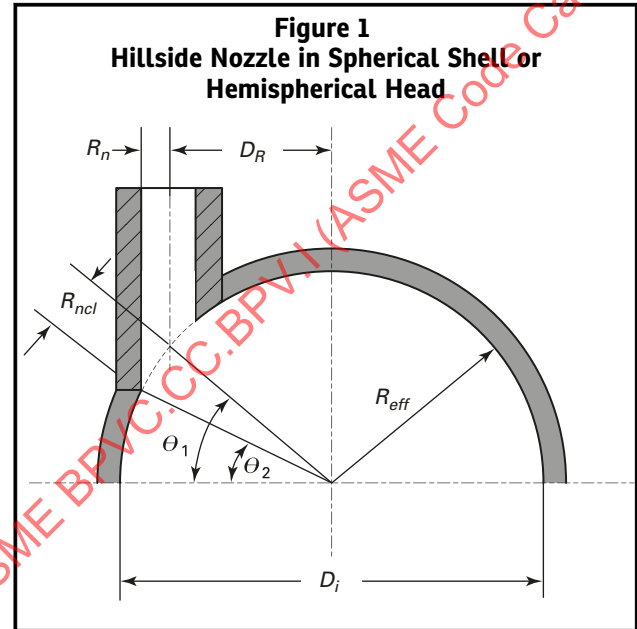
(a) The design procedure in 4.5.11 shall be used with  $R_{nc}$ , which is calculated using equations (4.5.63) through (4.5.66) in Section VIII, Division 2 by substituting  $D_R$  for  $D_X$ .

$D_R$  = distance from the head centerline to the nozzle centerline

$R_{eff}$  = effective pressure radius  
 $= 0.5D_i$

$R_{ncl}$  = radius of nozzle opening in the spherical shell or hemispherical head along the long arc for hillside nozzle (see Figure 1)

(b) This Case number shall be shown in the documentation and on the Manufacturer's Data Report.



The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: September 15, 2015

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2835**  
**Heat-Affected Zone Impact Testing in Weld Procedure**  
**Qualification, UG-84(g)(2)**  
**Section VIII, Division 1**

*Inquiry:* Under what conditions may welding procedure specifications qualified with toughness testing in accordance with the requirements of the 1988 Edition and subsequent Editions and Addenda of Section VIII, Division 1 be acceptable for construction without performing additional impact testing to meet the requirements of UG-84 (g)(2)?

*Reply:* It is the opinion of the Committee that welding procedure specifications qualified with toughness testing in accordance with the requirements of the 1988 Edition

and subsequent Editions and Addenda of Section VIII, Division 1 are acceptable for construction without performing additional impact testing to meet the requirements of UG-84(g)(2), provided the following requirements are met:

(a) The welding procedure specification has been previously qualified and has met the requirements of Section VIII, Division 1 prior to the 2013 Edition.

(b) The existing welding procedure specification may be used until the 2017 Edition of Section VIII, Division 1 goes into effect on January 1, 2018.

(c) This Case number shall be recorded on the Manufacturer's Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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**Case 2836-1**  
**Manufacture of a Hoop-Wrapped, Wire-Reinforced**  
**Cylindrical Pressure Vessel**  
**Section VIII, Division 3**

*Inquiry:* Under what conditions may a hoop-wrapped, wire-reinforced cylindrical pressure vessel whose cylindrical shell carries the pressure end load be produced using the rules of Section VIII, Division 3?

*Reply:* It is the opinion of the Committee that a hoop-wrapped, wire-reinforced cylindrical pressure vessel whose shell carries the end load may be produced using the rules of Section VIII, Division 3, provided the following additional requirements are met:

(a) The vessel shall be comprised of a monobloc cylindrical seamless shell with integrally forged heads.

(b) The shell shall meet the Charpy V-notch impact requirements of Table KM-234.2(a).

(c) The vessel heads shall not be wrapped.

(d) The vessel shall be wound in the hoop direction with a helix angle of the winding less than 1 deg.

(e) The maximum gap between the wires in the longitudinal direction of the vessel shall be the lesser of 5% of the wire width or 0.010 in. (0.25 mm).

(f) The cylindrical shell shall carry the end load due to pressure.

(g) The design temperature shall not exceed 200°F (93°C).

(h) No welding is permitted on the vessel, including the shell with integrally formed heads, or the wire. The wire winding shall be a single continuous length of wire.

(i) The design pressure of the shell with the wire wraps shall be demonstrated using finite element analysis in accordance with the rules of KD-230 or Mandatory Appendix 9.

(j) Under design conditions, the average stress intensity over the cross section of each individual wire at any point in the winding shall not exceed the yield strength of the wire,  $S_y$ . Under all operational loading conditions, including hydrostatic and autofrettage loading, each individual wire at any point in the winding shall not exceed the yield strength of the wire,  $S_y$ .

(k) The calculated collapse pressure of the shell alone shall be equal to or greater than 120% of the design pressure of the vessel. The calculation shall be performed using the minimum specified values of yield and tensile strengths. If an elastic-plastic analysis is used, strain hardening may be considered.

(l) The design fatigue life of the winding shall be calculated in accordance with KD-933. A design fatigue curve derived in accordance with KD-932 shall be used. For environmental conditions not covered by the derived design fatigue curve, the Manufacturer shall obtain supplementary fatigue test data.

(m) For all components other than the winding, the number of design cycles shall be determined in accordance with KD-140.

(n) For every combination of essential variables used in production of the vessel, a unique Wire Winding Procedure Specification shall be prepared. The essential variables shall include the following:

(1) wire specification, grade, and size

(2) volumetric expansion of the prototype vessel

(3) vessel dimensions

(4) description of the winding machine

(5) how tension is applied, controlled, and measured during winding.

The application of the winding onto the cylinder shall be carried out in a special winding machine equipped with devices that are able to control and measure the tensile force used for applying the wire. This force shall also be recorded on a diagram that shall be filed by the Manufacturer for each vessel. The measuring devices shall be calibrated at least every six months or any time there is reason to believe that the measurements are erroneous. The wire end shall be properly locked to prevent unwrapping.

(o) *Wire Winding Procedure Specification Qualification.* It shall be the Manufacturer's responsibility to qualify the Wire Winding Procedure Specification according to the requirements of this Case and document the results. Requalification shall follow the same procedure as the original qualification. Refer to Form WWPV-1.

(1) Vessels used to qualify the Wire Winding Procedure Specification shall be designated as prototype vessels. Prototype vessels used to qualify or requalify a

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Wire Winding Procedure Specification shall meet all of the requirements of Division 3 but shall not be Code stamped.

(2) Each vessel used for qualifying or requalifying the Wire Winding Procedure Specification shall be fabricated and examined in accordance with the requirements that follow, and the results documented on a Manufacturer's Data Report with the notation "Prototype Qualification."

(p) *Volumetric Expansion Tests.* Each vessel produced, including the prototype vessel, shall be subjected to a volumetric expansion test using a test fluid that complies with the requirements of KT-320.

(1) The volume of liquid used to fill the vessel at atmospheric pressure and temperature shall be compared with that required to fill it at the design pressure and at the same temperature. Care shall be taken to eliminate air pockets to ensure accuracy. The volume of liquid used in each instance shall be determined by any appropriate means, such as a weigh tank that has been calibrated to an accuracy of  $\pm 0.2\%$ . The results of this test shall be subsequently used in the production volumetric expansion test.

(2) Alternatively, the volumetric expansion may be determined by measuring the overall length of the vessel and its circumference at 5 ft (1.5 m) intervals along its length, with a minimum of three such determinations being made. All measurements shall be made with instruments that have been calibrated to an accuracy of  $\pm 0.05\%$ . These measurements shall be taken with the vessel filled with liquid at atmospheric pressure and at design pressure, both at the same temperature. The measurements thus made shall be subsequently used in the production volumetric expansion test.

(3) Acceptance criteria shall be in accordance with (q)(2) of this Case.

(q) *Production Testing.* Each vessel produced shall be subject to the tests required by (1) and (2) and shall conform to the specified requirements with results recorded on the Production Test Reports.

(1) *Hydrostatic Test.* For vessels to be installed at a fixed location, a hydrostatic test to a pressure at least 1.25 times the design pressure shall be performed on each vessel. For vessels to be used in transport service, a hydrostatic test to a pressure at least 1.25 times the

design pressure or 1.5 times the service or working pressure, whichever is greater, shall be performed on each vessel; see KT-310. This test may be combined with any hydrostatic pressurization procedure used to provide a prestress in the individual layers. The hydrostatic test shall be staged with examinations in (r) of this Case before the production volumetric expansion test. The vessel Production Test Report shall become part of the Manufacturer's Construction Records.

(2) *Volumetric Expansion Test.* A volumetric expansion test shall be performed on every vessel in accordance with the requirements of the Wire Winding Procedure Specification Qualification; see (o) and (p) of this Case. The results of these tests shall not differ by more than 5% from the values recorded in the original Prototype Qualification Test Report and Wire Winding Procedure Specification after correcting for any variance in material properties.

(r) *Examinations.* Each vessel shall be subjected to the examinations required by (1) and (2) and shall conform to the specified requirements, with results recorded in Production Test Reports. Examinations detailed in (1) and (2) shall be carried out before the hydrostatic test and the examination in Article KT-5 shall be carried out after the hydrostatic test. The Vessel Production Test Report shall become part of the Manufacturer's Construction Records.

(1) *Design Dimensions Examination.* Each vessel shall be examined for conformance with dimensions and tolerances shown on the design drawings.

(2) *Metallic Surface Examination After Hydrostatic Test.* The requirements of KE-400 cannot be applied to these vessels as examination of internal surfaces and external surfaces under the winding are not practical after hydrostatic test. The external surface of the vessel shall be inspected before winding of the vessel. The internal surfaces shall be inspected prior to forming of the heads on the end of the vessel. It shall be demonstrated by a fracture mechanics approach that the minimum detectable flaw size will not grow during the hydrostatic test to a size not accounted for in the analysis.

(s) Manufacturer's Data Report Form WWPV-2 shall be completed for vessels produced under this Case. Refer to Table 1 for instructions.

**FORM WWPV-1 RECOMMENDED FORM FOR QUALIFYING THE WIRE WINDING DESIGN AND THE WIRE WINDING PROCEDURE SPECIFICATION USED IN MANUFACTURING WIRE WOUND REINFORCED PRESSURE VESSELS**  
**As required by the Provisions of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 3, Case 2836**

Qualification Test Report No. \_\_\_\_\_

Wire Winding Procedure No. \_\_\_\_\_

A change in any of the essential variables denoted by an asterisk below requires a new Wire Winding Procedure Specification.

\*Wire Spec / Grade / Size \_\_\_\_\_

\*Variables of Winding Process

Helix Angle \_\_\_\_\_ (measured on cylinder between axis and band path)

Tension: Per strand (End), Roving, or Band (specify which) \_\_\_\_\_ per \_\_\_\_\_

Method of Control \_\_\_\_\_ Program \_\_\_\_\_

\*Inner Shell [Material, Grade, and Thickness, See Note (1)] \_\_\_\_\_

\*Shell Size and Configuration \_\_\_\_\_  
[OD, Length, Head Configuration (spherical, elliptical, etc.)]

\*Volumetric Expansion \_\_\_\_\_

Qualification Vessel Designation Number \_\_\_\_\_

Design Report Number \_\_\_\_\_

Original Qualification Report Number \_\_\_\_\_

If Requalification, Requalification Report Number \_\_\_\_\_

ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 3 \_\_\_\_\_  
(Year, Case No.)

We certify that the statements in this Specification are correct:

Date \_\_\_\_\_ Signed \_\_\_\_\_

By \_\_\_\_\_

Certificate of Authorization Number \_\_\_\_\_

NOTE:

(1) Where range of values or a tolerance applies, state the applicable range or tolerance.

**CERTIFICATION BY SHOP INSPECTOR OF QUALIFICATION OF WIRE WINDING DESIGN AND WIRE WINDING PROCEDURE SPECIFICATION**

Wire Winding Procedure Specification of \_\_\_\_\_ at \_\_\_\_\_ for \_\_\_\_\_  
 process of manufacturing vessel(s) described in User's Design Specification Number \_\_\_\_\_ and  
 Manufacturer's Design Report Number \_\_\_\_\_

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by \_\_\_\_\_ of \_\_\_\_\_ have inspected the pressure vessel and witnessed tests described in the Qualification Test Report of the Wire Winding Design and Wire Winding Procedure Specification and state that, to the best of my knowledge and belief, the Manufacturer has constructed this part in accordance with the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 3, and the Wire Winding Design and Wire Winding Procedure Specification being qualified. By signing this certificate, neither the inspector nor his employer make any warranty, expressed or implied, concerning the design or procedure covered by this Qualification Test Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or loss of any kind arising from or connected with this inspection.

Date \_\_\_\_\_ Signed \_\_\_\_\_ Commissions \_\_\_\_\_  
(Authorized Inspector) [National Board (incl. endorsements)]

FORM WWPV-2 MANUFACTURER'S DATA REPORT FOR WIRE WOUND PRESSURE VESSELS  
As Required by the Provisions of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 3, Case 2836

1. Manufactured and certified by \_\_\_\_\_<sup>①</sup>  
(name and address of Manufacturer)

2. Manufactured for \_\_\_\_\_<sup>②</sup>  
(name and address of purchaser)

3. Operating location \_\_\_\_\_<sup>③</sup>  
(where installed and where transported)

4. Type \_\_\_\_\_<sup>④</sup> \_\_\_\_\_<sup>⑤</sup> \_\_\_\_\_<sup>⑥</sup> \_\_\_\_\_<sup>⑦</sup> \_\_\_\_\_<sup>⑧</sup> \_\_\_\_\_<sup>⑨</sup>  
(horizontal/vertical) (Manufacturer's serial no.) (CRN) (National Board No.) (year built)  
Drawing no. \_\_\_\_\_ Prepared by \_\_\_\_\_

5. User's Design Specification on file at \_\_\_\_\_<sup>⑩</sup>  
Certified by \_\_\_\_\_<sup>⑩</sup> P.E. state \_\_\_\_\_<sup>⑪</sup> Reg. no. \_\_\_\_\_

6. Manufacturer's Design Report on file at \_\_\_\_\_<sup>⑩</sup>  
Certified by \_\_\_\_\_<sup>⑩</sup> P.E. state \_\_\_\_\_<sup>⑪</sup> Reg. no. \_\_\_\_\_

6a. Wire Winding Procedure Specification on file at \_\_\_\_\_<sup>⑩</sup>  
Qualification Report No. \_\_\_\_\_ Dated \_\_\_\_\_, \_\_\_\_\_ Latest requalification date \_\_\_\_\_, \_\_\_\_\_

7. Material \_\_\_\_\_<sup>⑫</sup> Impact tested at \_\_\_\_\_ °F

8. ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 3 \_\_\_\_\_<sup>⑬</sup> \_\_\_\_\_<sup>⑬</sup> \_\_\_\_\_<sup>⑭</sup>  
(year) (Addenda (if applicable) (date)) (Code Case no.)

9. Service \_\_\_\_\_<sup>⑮</sup>

10. Restrictions and warnings \_\_\_\_\_<sup>⑰</sup> \_\_\_\_\_<sup>⑱</sup>  
\_\_\_\_\_ cycles at \_\_\_\_\_ psig at \_\_\_\_\_ °F

11. Construction \_\_\_\_\_<sup>⑲</sup> \_\_\_\_\_<sup>⑳</sup> \_\_\_\_\_<sup>㉑</sup>  
Prestress method \_\_\_\_\_<sup>㉒</sup>

12. Size and configuration \_\_\_\_\_<sup>㉓</sup> \_\_\_\_\_<sup>㉔</sup> \_\_\_\_\_<sup>㉕</sup> \_\_\_\_\_<sup>㉖</sup>  
(I.D.) (length) (thickness) (cylindrical, spherical, other)

13. Supports and attachments \_\_\_\_\_<sup>㉗</sup>

14. Design pressure \_\_\_\_\_<sup>㉘</sup> psi at maximum coincident metal temperature \_\_\_\_\_<sup>㉙</sup> °F  
Service pressure \_\_\_\_\_<sup>㉚</sup> at vessel/contents temperature of 70°F (20°C)  
Maximum metal vessel temperature \_\_\_\_\_<sup>㉛</sup> °F at \_\_\_\_\_<sup>㉜</sup> psi  
Minimum design metal vessel temperature \_\_\_\_\_<sup>㉝</sup> °F at \_\_\_\_\_<sup>㉞</sup> psi

15. Test pressure \_\_\_\_\_<sup>㉟</sup> psi \_\_\_\_\_<sup>㊱</sup> at \_\_\_\_\_<sup>㊲</sup> °F  
(pneum./hydro./combination)  
Performed in the \_\_\_\_\_<sup>㊳</sup> position \_\_\_\_\_<sup>㊴</sup>  
(horiz./vertical) [fluid(s) used in test]

16. Closures \_\_\_\_\_<sup>㊵</sup>  
(describe)

17. Connections, or provisions, for overpressure relief \_\_\_\_\_<sup>㊶</sup>

FORM WWPV-2 (Back)

18. Nozzles and connections

Purpose (Inlet, Outlet Drain)	Quantity	Diameter or Size	Type	Material	Nominal Thickness	Reinforcement Material	How Attached	Location
(33) (34) (35)		(34)	(34) (36)	(12)	(25)			(35)

19. Manufacturer's Partial Data Reports, properly identified and signed by commissioned Inspectors, have been furnished for the following components \_\_\_\_\_ (37)

20. Remarks \_\_\_\_\_ (16) \_\_\_\_\_ (41)

**CERTIFICATE OF SHOP COMPLIANCE**

We certify that the statements in this report are correct and that all details of design, material, construction, and workmanship of this vessel conform to the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 3, Case 2836.

U3 Certificate of Authorization no. \_\_\_\_\_ expires \_\_\_\_\_, \_\_\_\_\_. (Stamped "U3" only)

Date \_\_\_\_\_ Co. name \_\_\_\_\_ (38) \_\_\_\_\_ Signed \_\_\_\_\_ (38) \_\_\_\_\_  
(Manufacturer) (representative)

**CERTIFICATE OF SHOP INSPECTION**

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province of \_\_\_\_\_ and employed by \_\_\_\_\_ of \_\_\_\_\_, have inspected the pressure vessel described in this Manufacturer's Data Report on \_\_\_\_\_, \_\_\_\_\_, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this part in accordance with the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 3, Case 2836. By signing this certificate, neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the part described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date \_\_\_\_\_ Signed \_\_\_\_\_ (39) \_\_\_\_\_ Commissions \_\_\_\_\_ (40) \_\_\_\_\_  
(Authorized Inspector) (National Board (incl. endorsements), state, prov., and no.)

**Table 1**  
**Instructions for the Preparation of Manufacturer's Data Report Form WWPV-2**

Ref. to Circled No. in the Form	Instruction
(1)	Name and street address of Manufacturer, as shown on Manufacturer's ASME Code Certificate of Authorization.
(2)	Name and address of purchaser.
(3)	Name of user and address of the Owner of the vessel.
(4)	Type of vessel, such as horizontal or vertical, separator, heat exchanger, reactor, storage, etc.
(5)	An identifying Manufacturer's serial number marked on the vessel (or vessel part) (see KS-120).
(6)	Canadian registration number where applicable.
(7)	Where applicable, National Board Number from Manufacturer's Series of National Board Numbers. National Board Number shall not be used for owner-inspected vessels.
(8)	Indicate drawing numbers, including revision numbers, which cover general assembly and list materials. For Canadian registration, also include the number of the drawing approved by Provincial authorities.
(9)	Organization that prepared drawing.
(10)	To be completed by the Manufacturer to show the disposition of the User's Design Specification and the Manufacturer's Design Report, and to identify the registered Professional Engineers who certify them.
(11)	State of the U.S.A. or province of Canada, as applicable.
(12)	Show the complete ASME specification number and grade of the actual material used in the vessel part. Material is to be as designated in Section VIII, Division 3. Exceptions: A specification number for a material not identical to an ASME specification may be shown only if such material meets the criteria in the Foreword of Section VIII, Division 3. When material is accepted through a Code Case, the applicable Case number shall be shown.
(13)	Issue date of Section VIII, Division 3 and Addenda (if applicable) under which vessel or vessel part was manufactured.
(14)	All Code Case numbers when vessel is manufactured according to any Cases.
(15)	Describe contents or service of the vessel.
(16)	Additional comments, including any Code restrictions on the vessel or any unusual Code or jurisdictional requirements that have been met, such as those noted in (17), (18), (20), (21), and (31). Indicate corrosion or erosion allowance.
(17)	Show need for start-up or shutdown temperature and/or controlled rate of heating or cooling, maximum temperature of any part.
(18)	Show results of fatigue analysis, number of cycles, limitations, or restrictions.
(19)	Type of longitudinal joint in cylindrical section, or any joint in a sphere (e.g., Type No. 1 butt or seamless).
(20)	When heat treatment is performed by the Manufacturer, give temperature and time. Explain any special cooling procedure and other pertinent heating during fabrication.
(21)	Indicate examination applied. Methods, location, and results should be included under Remarks.
(22)	Prestress, method, verification, etc.
(23)	Indicate inside diameter.
(24)	The shell length shall be shown as the overall length between closure.
(25)	Thickness is the nominal thickness of the material used in the fabrication of the vessel. It includes corrosion allowance.
(26)	Indicate provisions for support of the vessel and any attachments for superimposed equipment.
(27)	Show design pressure for which vessel is constructed (see KG-311). Other internal or external pressures with coincident temperatures shall be listed where applicable.
(28), (29)	Show maximum coincident metal temperatures permitted for vessel at the design pressures.
(30)	Show minimum design metal temperature at coincident pressure. List if more than one set.
(31)	Show hydrostatic or other tests made with specified test pressure at top of vessel in the test position that applies (pneumatic, hydrostatic, or combination test pressure). Indicate if vessel was tested in the vertical position.
(32)	Bolts used to secure removable head(s), closures, or seals of vessel.
(33)	Indicate nozzle or other opening that is designated for pressure relief (see Part KR).
(34)	Show other nozzles and openings by size, type, and purpose. See (36).
(35)	Show opening designated for inspection. Show location.
(36)	Data entries with descriptions acceptable to Inspector. Abbreviations, coded identification, or reference to Code figure and sketch number may be used to define any generic name. For ASME B16.5 flanges, the class should be identified. Flange facing and attachment to neck is not required. Some typical abbreviations: Flanged fabricated nozzle      Cl. 300 flg Long weld neck flange          Cl. 300 lwn Weld end fabricated nozzle      w.e.
(37)	To be completed when one or more parts of the vessel are furnished by others and certified on Data Report Form K-2 as required by KS-301. The part manufacturer's name and serial number should be indicated.

**Table 1**  
**Instructions for the Preparation of Manufacturer's Data Report Form WWPV-2 (Cont'd)**

Ref. to Circled No. in the Form	Instruction
(38)	Certificate of compliance block is to show the name of the Manufacturer as shown on Manufacturer's ASME Code Certificate of Authorization. This should be signed in accordance with organizational authority defined in the Quality Control System (see Appendix 2).
(39)	To be completed by the Manufacturer and signed by the Authorized Inspector who performs the shop Inspection or signs Form WWPV-2 for the completed vessel. Attach any applicable K-2 forms.
(40)	The Inspector's National Board Commission Number must be shown when the vessel is stamped "National Board." Otherwise, show only Inspector's state or province commission number.
(41)	If additional thickness is provided as a protective or sacrificial layer beyond the thickness specified in (25), then that additional thickness shall be indicated here.

GENERAL NOTE: Any quantity to which units of measure are needed shall be entered on the Manufacturer's Data Report with the chosen units.

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**Case 2837**  
**Use of PFA Tubing Material for Flue Gas Heat Exchanger Tubes**  
**Section VIII, Division 1**

*Inquiry:* May perfluoroalkoxy (PFA) copolymer be used for flue gas heat exchanger tubes with water as the tube-side fluid and flue gas as the shell-side fluid in Section VIII, Division 1 construction? For the purpose of this Case, flue gas heat exchangers are used downstream of the boiler and electrostatic precipitator in a power plant.

*Reply:* It is the opinion of the Committee that PFA may be used for flue gas heat exchanger tubes in Section VIII, Division 1 construction, provided the following requirements are met.

## 1 GENERAL REQUIREMENTS

(a) The virgin PFA material shall have no fillers, additives, or pigments and shall be in compliance with ASTM D3307-10 and shall be limited to the polymer with a classification designation of Type II. The PFA copolymer material shall be certified by the materials manufacturer, and a certificate of analysis shall be furnished to the vessel manufacturer for each batch of finished material from a production reactor.

(1) The resin manufacturer's certificate of analysis shall include the following at a minimum with respect to ASTM D3307.

(-a) name and address of production plant where the material was made.

(-b) reactor batch number. Batch is defined as the finished capacity of the reactor producing the material during one production cycle.

(-c) certification of conformance with applicable ASTM D3307 type.

(-d) apparent bulk density.

(-e) average pellet size.

(-f) standard specific gravity of material.

(2) The tube manufacturer's certified material test report shall include the following recorded data at a minimum.

(-a) name and address of production plant where tubes were made.

(-b) lot number for each extruder run. An extruder run is the length of tubing produced by the extruder in one production cycle and is given a unique serial number, which is the lot number by the tubing manufacturer.

(-c) reference to resin manufacturer's batch number from which the tubes were made and ASTM specification, type and grade, and class.

(-d) total length of lot.

(-e) number of tubes cut from the lot coil and their nominal lengths.

(-f) design drawing number and revision showing tube dimensions.

(-g) outside diameter (O.D.) and nominal thickness of tubes.

(-h) centerline U-bend radius for each tube referenced to tube serial number.

(-i) visual inspection results per Table 1 and dimensions (O.D. and wall thickness) with reference tolerances for each tube.

(-j) test pressure per 3(c) after bending and its duration for the lot and certification of acceptable results.

(-k) manufacturer's written tubing production procedure number.

(-l) extrusion pressure range at applicable draw down ratio.

(b) The tube side of the completed heat exchanger shall be limited to liquid water service. Any service classified per UW-2(a) is not allowed.

(c) The maximum allowable design pressure for the tube side of the heat exchanger shall be limited to 110 psi (758 kPa) at a maximum temperature of 325°F (163°C).

(d) The PFA tubing shall not be subject to any differential external pressure. The exchanger shall be installed in a system that controls the operation to ensure the tube design pressure and temperature are not exceeded (e.g., maximum tube temperature exceeded due to loss of water on the tube side).

(e) The shell-side of the tubes shall not be subjected to a flue gas temperature exceeding 383°F (195°C). The design temperature of the tubes shall not be less than the maximum flue gas temperature. The minimum tube

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design temperature shall be no colder than 40°F (4.4°C). The design pressure of the shell side of the exchanger shall be less than 15 psig (103 kPa).

(f) The maximum nominal outside diameter of the PFA tubing shall not exceed 0.63 in. (16 mm) with a minimum wall thickness of 0.035 in. (0.89 mm). The tolerance on outside diameter shall be  $\pm 1\%$ , and on nominal wall thickness  $+0.012$  in./ $-0$  in. ( $+0.3$  mm/ $-0$  mm).

(g) The heat exchanger shall be limited to a vertically oriented U-tube type with the U-bends at the bottom of the exchanger, and this service restriction shall be noted in the Remarks section of the Manufacturer's Data Report.

(h) The minimum centerline radius of the U-bends shall be 4 times the outside diameter of the tubing.

(i) Repairs to the PFA tubing shall not be permitted.

(j) The PFA tubing shall be mechanically attached to a metallic tubesheet using qualified procedures and operators per 2(e) and pull-tested per 4(c).

(k) The PFA tubing shall be marked with an attached identification tag or laser etched with a unique serial number on one end that will be trimmed off during installation into the tubesheet to provide traceability to the tubing material manufacturer's report of test results as well as the raw material supplier's certificate of analysis. The tubing manufacturer shall provide a map showing the location of each marked tube into the tubesheet.

(l) The tubing shall be manufactured using melt extrusion process in which virgin PFA copolymer pellets are fed into a hopper that feeds an extruder. This process shall be controlled by a written procedure in which all of the following process variables, which are also extrusion parameters, shall be considered essential:

- (1) tooling size, die and tip, in. (mm)
- (2) draw down ratio (ratio of the cross sectional area of the tip and die to the cross sectional area of the tube)
- (3) tooling temperature, °F (°C)
- (4) tube speed, ft/min (m/min)
- (5) extruder speed, rpm
- (6) nominal inlet pellet size, in. (mm)

A change in any of the essential variables outside any range specified in the procedure shall require requalification of the written procedure per the test procedure specified in sections 2 and 3. The procedure shall indicate the acceptable ranges for (2) through (6) above. The tube manufacturer shall also certify that the extruder lot of tubing meets the requirements of this Case.

(m) Tubing used for qualification testing shall not be used on Code-stamped heat exchangers.

(n) The design of the tubing shall take into account published cold flow data for PFA to ensure the tubes do not permanently lengthen or expand under pressure or their own weight plus the weight of liquid and the differential longitudinal pressure stress within. To ensure cold-flow or creep is not an issue, the total longitudinal stress shall be limited to 550 psi (3.8 MPa) at the design temperature

of the tube side of the exchanger. The total longitudinal stress due to pressure and weight shall be determined using the formulas in 5(b).

(o) The use of regrind or recycled material is prohibited.

(p) The completed tube-side of the heat exchanger shall be hydrostatically tested per UG-99(b) at 1.3 times the MAWP of the tube side.

NOTE: Since the tube side contains carbon steel components, the lowest stress ratio will be 1.0 at the design temperature.

(q) This Case number shall be shown on the Manufacturer's Data Report and marked on the tubing identification tag, all material test reports, and the Code nameplate.

(r) On Form U-1 line 13, the description of the tubes shall be PFA per ASTM D3307 grade to which it was manufactured listed.

## 2 DESIGN QUALIFICATION

The maximum allowable working pressure (which shall equal the design pressure) of the PFA tubing shall be established by the following procedure.

(a) Long term hydrostatic strength testing shall be conducted in accordance with ISO 9080:2012 or ASTM D2837-11. The testing laboratory shall be accredited by the American Association for Laboratory Accreditation (A2LA) in the USA, or shall be accredited by another agency recognized by the local jurisdiction elsewhere. The laboratory shall be qualified per ISO 17025 to perform this type of testing. The testing shall be conducted on a representative sample of a reactor batch of the virgin resin and of the extrusion lot to be used in actual production tubes using air or nitrogen as the test fluid. These tests shall be conducted at ambient, an intermediate temperature, and up to 36°F (20°C) above the design temperature for a period of 10,000 hr and use linear regression analysis to extrapolate the long-term strength for 50 yr per ISO 9080 or 100,000 hr per ASTM D2837. The long-term hydrostatic strength at the design temperature obtained shall have a design factor of 0.67 applied resulting in a design strength that does not exceed  $\frac{2}{3}$  of the yield strength. The ratio of the lower confidence limit strength to the long-term hydrostatic strength shall be a minimum of 0.9 for each method.

(b) The Authorized Inspector (AI) shall verify that the certified long-term hydrostatic strength test has been completed.

(c) The design qualification tubing shall be visually examined for imperfections prior to having samples subjected to the long-term hydrostatic testing. Classification and acceptance level of imperfections shall be according to Table 1.

(d) The rules of 5(a) of this Case shall be used to calculate the hoop stress in the tube at any pressure.

(e) Mechanical designs for the tube-to-tubesheet joint must have a written joining procedure and have a tube pull-out test per 4(c). The tube-to-tubesheet joining procedure shall include procedure specifications, performance qualifications, acceptance criteria, and a procedure for how workers joining tubes to tubesheets shall be qualified. The procedure shall be acceptable to the AI and the user.

### 3 PRODUCTION TUBES

(a) Each tubing extruder run or lot shall be examined by the tube manufacturer externally over its entire length for imperfections. Classification and acceptance level of imperfections shall be according to Table 1. Any defective area found larger than the maximum allowable size shall be removed in its entirety.

(b) All tubes in a production extruder lot shall be examined for conformance with dimensions and tolerances shown on the design drawings or given in ASTM D6867, whichever is more restrictive. Any dimension falling outside the specified limit or the tolerances of this Case shall require the defective section to be rejected, cut out, and not used.

(c) After the tube manufacturer bends the tubes, they shall be subjected to a minimum hydrostatic pressure test of 70% of the burst pressure at the tube manufacturer with water at 70°F ±5°F (21°C ±3°C) for a minimum hold time of 15 min. Any failure due to burst, visible deformation, or leakage shall reject that specific tube. Retesting is not permitted.

### 4 PRODUCTION QUALIFICATION

(a) At least one tube per 65,000 ft (20,000 m) or at least one tube per bundle, whichever is less, shall be subject to cold and hot burst tests by the exchanger manufacturer in accordance with the following procedures. These tests shall be witnessed by the AI and certified by the manufacturer.

#### (1) Cold Burst Pressure Test

(a) Cut five 10-in.  $\pm\frac{1}{16}$  in. (250-mm  $\pm 2$  mm) long samples from the test tube.

(b) Condition the tubes for at least 4 hr at 73°F ±5°F (23°C ±2.8°C) prior to testing. The test fluid temperature shall also be at this temperature.

(c) Measure the wall thickness and outer diameter, and record these values on the manufacturer's quality control form.

(d) Close one end of the tube with a compression plug fitting, and install a fill fitting on the other end. Fill the samples with mineral oil or water, and plug the fill fitting. Make sure no visible air bubbles are present in the tube.

(e) Raise the pressure of the fluid at a maximum rate of 145 psi/min (1 MPa/min) to 203 psig (1.4 MPa), and hold for a minimum of 6 min.

(f) Then raise the pressure at a maximum rate of 29 psi/min (200 kPa/min) until the tube bursts. If the end plug leaks or fails before the tube bursts or leaks, the test is not valid.

(g) Record the burst pressure at the end of the test as well as all test conditions.

(h) The burst hoop stress shall have a minimum value of 1,500 psi (10.3 MPa) for any of the samples that shall be calculated per 5(a).

#### (2) Hot Burst Pressure Test

(a) Cut five 6-in.  $\pm\frac{1}{16}$  in. (150-mm  $\pm 2$  mm) long samples from the test tube.

(b) Measure the wall thickness and outer diameter, and record these values on the manufacturer's quality control form.

(c) Close one end of the tube with a compression plug fitting.

(d) Fill each tube to 75% of its volume with water (the rest is air) at a minimum temperature of 60°F (15°C).

(e) Close the open end of the tube with a plug fitting.

(f) Install oven thermocouples onto the tubes.

(g) Heat the tubes in an oven preheated at 320°F ±4°F (160°C ±2°C) in a way that they are visible once the door is closed.

(h) Condition the tubes for 15 min at the preheated temperature.

(i) Raise the temperature at a maximum rate of 5.4°F/min (3°C/min) until all tubes burst or leak. If the end plug leaks or fails before the tube bursts or leaks, the test is not valid.

(j) Record the temperature during the whole test including rate of temperature rise.

(k) Note the burst or leak temperature of each tube, and record it on the certified test report.

(l) The steam pressure at burst can be calculated using the steam pressure table of water.

(m) The burst hoop stress shall be calculated per 5(a) and have a minimum value of 583 psi (4.02 MPa) for any of the samples.

(b) The tubing to be used for these tests shall be selected at random by the Authorized Inspector, and the test results shall be certified by the manufacturer on their material test report.

(c) In addition to meeting the procedure performance qualifications of 2(e) for tube-to-tubesheet joints, and before making production tube-to-tubesheet joints, each worker shall demonstrate to the satisfaction of the AI the ability to achieve complete tube-to-tubesheet joints by successfully assembling six test pieces with a minimum joint pull-out strength that exceeds the strength of the bare tube. The test pieces shall be visually examined to verify a complete joint, sectioned to verify minimum required tube thickness and complete compression of the

tube along the entire length of the joint. For each worker's mock-up assembly, a tube pull-out test shall be done for each size and thickness of tube being used using six tubes in a tubesheet mock-up. The tube pull-out test shall establish that the tubes will fail outside the tubesheet before the tube-to-tubesheet joint fails. The results shall be recorded and maintained with the performance qualification record. The results for each worker shall be acceptable to the AI before that worker performs any production tube-to-tubesheet joints.

**5 TUBE-STRESS CALCULATIONS**

(a) The hoop stress in the tubing at any pressure [see 2(d), 4(a)(1)(-h), and 4(a)(2)(-m)] shall be calculated based on the following equation for internal pressure.

$$S_h = Pr/t$$

where

- P* = internal pressure
- r* = maximum inside radius of the tube
- S<sub>h</sub>* = hoop stress value at a pressure, *P*
- t* = minimum thickness of the tube

(b) The longitudinal stress in the tubing at pressure, *P* [see 1(n)] and total longitudinal stress shall be calculated based on the following equations:

$$S_{lp} = Pr/2t$$

$$S_l = S_{lp} + W/A$$

where

- A* = cross sectional area of the tubing

*S<sub>l</sub>* = total longitudinal stress due to pressure and weight

*S<sub>lp</sub>* = longitudinal stress value at pressure, *P*

*W* = weight of suspended tubing below the tubesheet plus the weight of the water contained in the suspended tube

*P*, *r*, and *t* are defined in (a).

**6 PHYSICAL PROPERTIES**

Select physical properties for PFA to be used for design are as follows:

(a) Thermal Conductivity = 0.14 Btu/hr-ft-°F (0.25 W/m-K)

(b) Linear Coefficient of Expansion

(1) 70°F to 212°F (21°C to 100°C) = 7.8 × 10<sup>-5</sup> in./in. °F (14 × 10<sup>-5</sup> mm/mm °C)

(2) 212°F to 300°F (100°C to 149°C) = 9.8 × 10<sup>-5</sup> in./in. °F (18 × 10<sup>-5</sup> mm/mm °C)

(3) 300°F to 408°F (149°C to 208°C) = 12.1 × 10<sup>-5</sup> in./in. °F (22 × 10<sup>-5</sup> mm/mm °C).

**7 SUMMARY OF CODE CASE REQUIREMENTS**

Table 2 provides a summary and location of the Case requirements for material, design, and qualification.

**Table 1  
Visual Flaw Acceptance Criteria**

Defect	Definition	Maximum Size, in. (mm)
Black spots, brown streaks	Dark spots or streaks	0.015 (0.4)
Blisters	Hollows on or in the part	0.015 (0.4)
Bubbles	Air entrapped in the part	0.015 (0.4)
Burn marks, dieseling	Charred or dark plastic caused by trapped gas	0.015 (0.4)
Cracking, crazing	Any visible	0.015 (0.4)
Delamination	Single surface layers that flake off the part	0.015 (0.4)
Discoloration	Similar to burn marks but generally not as dark or severe	Acceptable
Flow, halo, blush marks	Marks seen on the part due to flow of molten plastic across the molding surface	0.015 (0.4)
Gels	Bubbles or blisters on or in the part due to poor melt quality	0.015 (0.4)
Jetting	Undeveloped frontal flow	0.015 (0.4)

**Table 2**  
**Summary of Material, Design, and Qualification Requirements**

Requirement	Paragraph	Comment
Material specification	1(a)	Resin raw material
Minimum wall thickness	1(f)	...
Maximum OD	1(f)	...
Extrusion process and procedure qualification	1(l)	Qualified procedure required
Tube side design pressure (internal and external)	1(c) and 1(d)	...
Tube side temperature	1(c)	...
Maximum shell side design pressure	1(e)	...
Maximum design temperature of shell side	1(e)	...
Maximum design temperature of tubes	1(e)	...
Tube configuration and orientation	1(g)	Vertical U-tube only
Maximum longitudinal tube stress	1(n)	...
Minimum bend radius	1(h)	...
Tube-to-tubesheet joint	1(j), 2(e), and 4(c)	...
Tube side hydrostatic test pressure	1(p)	...
Design pressure qualification	2(a)	Long-term hydrostatic tests
Production qualifications	4(a) and 4(c)	Cold and hot burst tests and pull-out tests
Tube stress calculation formulas	5(a) and 5(b)	Hoop and longitudinal stress
Material physical properties	6(a) and 6(b)	...

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Approval Date: September 15, 2015

Code Cases will remain available for use until annulled by the applicable Standards Committee.

**Case 2838**  
**NDE Personnel Qualification and Certification**  
**Requirements**  
**Section IX**

*Inquiry:* Under what conditions may NDE personnel qualification and certification be performed under the provisions of ISO 9712 or other national or international standards in lieu of the provisions of QW-191.2.2?

*Reply:* It is the opinion of the Committee that NDE personnel qualification and certification may be performed under the provisions of ISO 9712 or other national or

international standards in lieu of the provisions of QW-191.2.2, provided the following requirements are met:

(a) The applicable requirements of Section V, Article 1, T-120 shall be met.

(b) When NDE has been performed by personnel whose qualification and certification has been completed by an employer under the provisions of this Case, this Case number shall be shown on the affected welder performance qualification record.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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Approval Date: October 16, 2015

*Code Cases will remain available for use until annulled by the applicable Standards Committee.***Case 2839**  
**9Cr-3W-3Co-Nd-B Material**  
**Section I**

*Inquiry:* May normalized and tempered 9Cr-3W-3Co-Nd-B seamless tubes, pipes, and forgings conforming to the chemical analysis shown in [Table 1](#), the minimum mechanical properties listed in [Table 2](#), and otherwise conforming to the specifications listed in [Table 3](#) be used for Section I construction?

*Reply:* It is the opinion of the Committee that normalized and tempered 9Cr-3W-3Co-Nd-B seamless tubes, pipes, and forgings conforming to the chemical analysis shown in [Table 1](#), the minimum mechanical properties listed in [Table 2](#), and otherwise conforming to the specifications listed in [Table 3](#) may be used for Section I construction, provided the following requirements are met:

(a) The material shall be normalized at 1,960°F to 2,140°F (1 070°C to 1 170°C) and tempered at 1,380°F to 1,455°F (750°C to 790°C) as final heat treatment.

(b) The material shall not exceed a Brinell Hardness Number of 250 HBW (HRC 25).

(c) The maximum design temperature shall be 1,200°F (649°C).

(d) The maximum allowable stress values for the material shall be those given in [Tables 4](#) and [4M](#).

(e) Separate weld procedure qualifications conducted in accordance with Section IX shall be required for this material. For the purpose of performance qualification, the material shall be considered P-No. 15E, Group 1.

(f) Postweld heat treatment for this material is mandatory, and the following rules shall apply:

(1) The time requirement shall be those given for P-No. 15E, Group 1 materials in [Table PW-39](#).

(2) The PWHT temperature range shall be 1,350°F to 1,455°F (730°C to 790°C).

(g) All cold-formed material shall be heat treated as follows:

(1) Cold-forming is defined as any forming that is performed at a temperature below 1,300°F (705°C) and produces permanent strain in the material.

(2) The forming strains shall be calculated using the equations of PG-19. When the forming strains cannot be calculated as shown in PG-19, the Manufacturer shall have the responsibility to determine the maximum forming strain, except as limited by (3) and (8).

(3) For cold-formed flares, swages, or upsets in tubing or pipe, the material shall be normalized and tempered in accordance with (8).

(4) For design temperatures exceeding 1,000°F (540°C) but less than or equal to 1,115°F (600°C), and cold-forming strains greater than 25%, the material shall be normalized and tempered in accordance with (8).

(5) For design temperatures exceeding 1,115°F (600°C) and cold-forming strains greater than 20%, the material shall be normalized and tempered in accordance with (8).

(6) For design temperatures exceeding 1,000°F (540°C) but less than or equal to 1,115°F (600°C), and cold-forming strains greater than 5% but less than or equal to 25%, the material shall be heat treated in accordance with (9), (10), or (11).

(7) For design temperatures exceeding 1,115°F (600°C) and cold-forming strains greater than 5% but less than or equal to 20%, the material shall be heat treated in accordance with (10) or (11).

(8) Normalization and tempering shall be performed in accordance with the requirements of (a) and shall not be performed locally. The material shall either be heat treated in its entirety, or the cold-strained area (including the transition to the undeformed portion) shall be cut away from the balance of the component and heat treated separately, or replaced.

(9) Post-cold-forming heat treatment shall be performed at 1,350°F to 1,425°F (730°C to 775°C) for 1 hr/in. (1 h/25 mm) or 30 min minimum. Alternatively, the material may be normalized and tempered in accordance with (8).

(10) For design temperatures less than or equal to 1,115°F (600°C) and cold-forming strains greater than 5% but less than or equal to 25%, if a portion of the component is heated above the post-forming heat treatment, then the component shall be normalized and tempered according to (8).

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

(11) If a longitudinal weld is made to a portion of the material that is cold-strained, that portion shall be normalized and tempered in accordance with (8).

(12) In all other cases, heat treatment is neither required nor prohibited.

(h) All material formed at or above 1,300°F (705°C) shall be renormalized and tempered in accordance with (a). This heat treatment shall not be performed locally. The material shall be either heat treated in its entirety, or the hot-formed area (including the transition) shall be cut away from the balance of the tube or component and heat treated separately or replaced.

(i) Except as provided in (j), if during manufacturing any portion of the component is heated to a temperature greater than 1,455°F (790°C), then the component heated above 1,455°F (790°C) including the heat-affected zone created by the local heating shall be removed, renormalized, and tempered, and then replaced in the component.

(j) If the allowable stresses to be used are less than or equal to those provided in Section II, Part D, Subpart 1, Table 1A for Grade 9 (SA-213 T9) at the design temperature, then the requirements of (i) may be waived, provided that the portion of the component heated to a temperature greater than 1,455°F (790°C) is reheat treated within the temperature range 1,350°F to 1,425°F (730°C to 775°C).

(k) The yield strength and tensile strength values for use in design shall be as given in Tables 5 and 5M.

(l) The physical properties for the 9Cr-3W-3Co-Nd-B material are as follows:

(1) mean linear thermal expansion coefficients, as given in Tables 6 and 6M

(2) thermal conductivity, as given in Tables 6 and 6M

(3) density: 0.285 lb/in.<sup>3</sup> (7 900 kg/m<sup>3</sup>)

(4) modulus of elasticity, as given in Tables 6 and 6M

(5) Poisson's ratio: 0.29

(m) External pressure design is prohibited.

(n) This Case number shall be referenced in the documentation and marking of the material and shall be shown on the Manufacturer's Data Report.

**Table 1**  
**Chemical Requirements**

Element	Composition Limits, %
Carbon	0.05–0.10
Manganese	0.20–0.70
Phosphorus, max.	0.020
Sulfur, max.	0.008
Silicon	0.05–0.50
Chromium	8.50–9.50
Tungsten	2.5–3.5
Cobalt	2.5–3.5
Nickel, max.	0.20
Vanadium	0.15–0.30
Columbium + Tantalum	0.05–0.12
Neodymium	0.010–0.060
Boron	0.007–0.015
Aluminum, max.	0.030
Nitrogen	0.005–0.015
Oxygen, max.	0.0050

**Table 2**  
**Mechanical Property Requirements**

Tensile strength, min., ksi (MPa)	90 (620)
Yield strength, min., ksi (MPa)	64 (440)
Elongation in 2 in., min. % [Note (1)]	19

NOTE:

- (1) For longitudinal strip tests, a deduction from the basic values of 1.00% for each  $\frac{1}{32}$  in. (0.8 mm) decrease in wall thickness below  $\frac{5}{16}$  in. (7.8 mm) shall be made. The following table gives the computed values.

Wall Thickness, in.	Elongation in 2 in., Min. %
$\frac{5}{16}$ (0.312)	19.0
$\frac{9}{32}$ (0.281)	18.0
$\frac{1}{4}$ (0.250)	17.0
$\frac{7}{32}$ (0.219)	16.0
$\frac{3}{16}$ (0.188)	15.0
$\frac{5}{32}$ (0.156)	14.0
$\frac{1}{8}$ (0.125)	13.0
$\frac{3}{32}$ (0.094)	12.0
$\frac{1}{16}$ (0.062)	11.6
0.062 to 0.035, excl.	10.9
0.035 to 0.022, excl.	10.6
0.022 to 0.015, incl.	10.3

GENERAL NOTE: The above table gives the computed minimum elongation values for each  $\frac{1}{32}$  in. decrease in wall thickness. Where the wall thickness lies between two values shown above, the minimum elongation value shall be determined by the following equation:

$$E = 32t + 10.0$$

where

- $E$  = elongation in 2 in., %  
 $t$  = actual thickness of specimen

**Table 3**  
**Specifications**

Material	Specification
Forgings	SA-182/SA-182M
Pipe	SA-335
Tube	SA-213/SA-213M

**Table 4**  
**Maximum Allowable Stress Values**

For Metal Temperature	
Not Exceeding, °F	Stress, ksi
-20 to 100	25.7
200	25.7
300	25.1
400	24.3
500	23.8
600	23.3
650	23.0
700	22.7
750	22.2
800	21.7
850	21.0
900	20.2
950	19.2
1,000	18.1
1,050	16.9
1,100	15.5
1,150	12.0 [Note (1)]
1,200	6.5 [Note (1)]

NOTE:

- (1) These values are obtained from time-dependent properties.

**Table 4M**  
**Maximum Allowable Stress Values**

For Metal Temperature	
Not Exceeding, °C	Stress, MPa
-30 to 40	177
100	177
200	168
300	162
400	153
425	150
450	146
475	141
500	135
525	129
550	121
575	113
600	103 [Note (1)]
625	79 [Note (1)]
650	44 [Note (1)], [Note (2)]

NOTES:

- (1) These values are obtained from time-dependent properties.  
 (2) The maximum use temperature shall be 649°C. Datum for 650°C temperature is provided for interpolation purposes.

**Table 5  
Yield and Tensile Strength Values**

For Metal		
Temperature Not Exceeding, °F	Yield Strength, ksi [Note (1)]	Tensile Strength, ksi [Note (1)]
-20 to 40	64.0	90.0
100	62.5	88.2
200	59.1	83.5
300	57.0	79.9
400	56.0	77.5
500	55.5	75.7
600	55.1	74.1
650	54.8	73.2
700	54.3	72.1
750	53.5	70.7
800	52.4	68.9
850	50.9	66.8
900	49.0	64.3
950	46.6	61.2
1,000	43.7	57.7
1,050	40.4	53.8
1,100	36.5	49.4
1,150	32.1	44.7
1,200	27.3	39.7

NOTE:

(1) The tabulated values of tensile strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the values of tensile strength tend toward an average or expected value that may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. The tensile strength values do not correspond exactly to "average" as this term is applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section I require elevated temperature testing for tensile strengths of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile strength values for ASME Code acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

**Table 5M  
Yield and Tensile Strength Values**

For Metal		
Temperature Not Exceeding, °C	Yield Strength, MPa [Note (1)]	Tensile Strength, MPa [Note (1)]
-30 to 20	440	620
40	430	620
65	418	591
100	405	572
150	393	551
200	386	535
250	383	524
300	381	514
325	380	509
350	377	503
375	374	496
400	369	487
425	362	476
450	353	463
475	341	448
500	328	430
525	311	409
550	292	386
575	270	361
600	245	333
625	217	303
650 [Note (2)]	187	272

NOTES:

(1) The tabulated values of tensile strength are those that the Committee believes are suitable for use in design calculations. At temperatures above room temperature, the values of tensile strength tend toward an average or expected value that may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. The tensile strength values do not correspond exactly to "average" as this term is applied to a statistical treatment of a homogeneous set of data. Neither the ASME Material Specifications nor the rules of Section I require elevated temperature testing for tensile strengths of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile strength values for ASME Code acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material and suggesting the possibility of some error), further investigation by retest or other means should be considered.

(2) The maximum use temperature shall be 649°C. Datum for 650°C temperature is provided for interpolation purposes.

**Table 6**  
**Physical Properties**

Temperature, °F	Modulus of Elasticity, 10 <sup>3</sup> ksi	Thermal Conductivity, Btu/ft-hr-°F	Mean CTE, 10 <sup>-6</sup> in./in./°F [Note (1)]	Specific Heat, Btu/lb-°F
68	31.6	13.0	...	0.102
200	31.2	13.6	5.8	0.109
400	30.4	14.3	5.9	0.117
600	29.3	14.7	6.1	0.127
800	27.7	15.0	6.4	0.139
1,000	25.7	15.1	6.6	0.157
1,150	24.4	15.2	6.7	0.169
1,200	22.7	15.3	6.8	0.183

NOTE:

(1) Mean CTE values are those from 68°F to indicated temperature.

**Table 6M**  
**Physical Properties**

Temperature, °C	Modulus of Elasticity, GPa	Thermal Conductivity, W(m <sup>-1</sup> /K <sup>-1</sup> )	Mean CTE, 10 <sup>-6</sup> °C <sup>-1</sup> [Note (1)]	Specific Heat, kJ kg <sup>-1</sup> °C <sup>-1</sup>
20	218	22.5	...	0.434
100	215	23.3	10.4	0.446
200	210	24.7	10.6	0.491
300	203	25.5	11.0	0.530
400	194	25.8	11.4	0.572
500	182	26.2	11.7	0.630
600	167	26.1	12.1	0.705
700	143	26.6	12.4	0.831

NOTE:

(1) Mean CTE values are those from 20°C to indicated temperature.

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(19)

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**Case 2840-1**  
**29Cr-6.5Ni-2Mo-N Austenitic-Ferritic Stainless Steel,**  
**UNS S32906 Hot Isostatically-Pressed Material**  
**(Class 2)**  
**Section VIII, Division 1; Section VIII, Division 2**

*Inquiry:* May solution annealed alloy UNS S32906 hot isostatically-pressed flanges, fittings, valves, and parts with chemical compositions conforming to Table 1, mechanical properties conforming to Table 2, and otherwise conforming to the respective requirements of ASTM A988/A988M-15 be used in welded construction under the rules of Section VIII, Division 1 or Division 2, Class 2?

*Reply:* It is the opinion of the Committee that solution annealed UNS S32906 material for hot isostatically-pressed alloy steel powder metallurgy parts as described in the Inquiry may be used in welded construction under the rules of Section VIII, Division 1 or Division 2, Class 2, provided that the following additional requirements are met:

- (a) The maximum use temperature is 600°F (316°F).
- (b) The material shall be heat treated to a temperature of 1,850°F to 2,100°F (1 010°C to 1 150°C) followed by rapid cooling in air or water.
- (c) Welding procedures and performance qualifications shall be conducted in accordance with Section IX. This material shall be considered P-No. 10H, Group 1.
- (d) For external pressure design, Section II, Part D, Subpart 2, Figure HA-5 and Table HA-5 shall apply.
- (e) The maximum allowable stress values for UNS S32906 shall be those given in Section II, Part D, Subpart 1, Table 1A for thicknesses of 0.40 in. (10 mm) and greater for Division 1 construction, and Section II, Part D, Subpart 1, Table 5A for thicknesses of 0.40 in. (10 mm) and greater for Division 2, Class 2 construction.
- (f) The maximum allowable powder size is 0.019 in. (0.5 mm), and the powder shall be produced by the gas atomization process.
- (g) In addition to a chemical composition analysis of the final blend powder, a chemical analysis of a sample (component or compact) from each lot of parts shall be required and conform to the requirements of Table 1.

(h) For use in design, the tensile strength values for thicknesses of 0.40 in. (10 mm) and greater shall be applied from Section II, Part D, Subpart 1, Table U.

(i) For use in design, the yield strength values for thicknesses of 0.40 in. (10 mm) and greater shall be applied from Section II, Part D, Subpart 1, Table Y-1.

(j) The physical properties from Section II, Part D for UNS S32906 (29Cr-6.5Ni-2Mo-N) shall apply.

(k) For Division 2, Class 2 fatigue analysis, this material shall be considered Table 3-F.3 material.

(l) The rules in Section VIII, Division 1, Subsection C that shall apply are those given in Part UHA for austenitic-ferritic duplex stainless steels. For Section VIII, Division 2, Class 2 application, the rules for austenitic-ferritic duplex stainless steels shall apply.

(m) This Case number shall be shown on the marking and certification of the material and on the Manufacturer's Data Report.

**Table 1**  
**Chemical Requirements**

Element	Composition Limit, %
Carbon	0.030 max.
Manganese	0.80-1.50
Phosphorous	0.030 max.
Sulfur	0.030 max.
Silicon	0.50 max.
Chromium	28.0-30.0
Nickel	5.8-7.5
Molybdenum	1.50-2.60
Copper	0.80 max.
Nitrogen	0.30-0.40

**Table 2**  
**Mechanical Test Requirements (Room Temperature)**

Minimum Tensile Strength, ksi (MPa)	Minimum Yield Strength, 0.2% Offset, ksi (MPa)	Minimum Elongation in 2 in. (50 mm) %
109 (750)	80 (550)	25

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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**Case 2841**  
**Alternative Rules for Access in Firetube Boilers**  
**Section I**

*Inquiry:* Under what conditions may the minimum clearance of 12 in. (300 mm) between the underside of the wet-bottom and the floor in PFT-46.6 be reduced to minimum clearance of 6 in. (150 mm)?

*Reply:* It is the opinion of the Committee that minimum clearance between the underside of the wet-bottom and the floor may be reduced to a minimum clearance of 6 in. (150 mm), provided the following requirements are met:

(a) The boiler is a horizontal firetube boiler with a shell radius of 20 in. (500 mm) or less.

(b) Inspection openings are provided on both sides of the boiler at an angle no less than 30 deg and no greater than 45 deg from the bottom of the shell at locations along the length of the boiler to facilitate inspection of the wet bottom.

(c) The boiler is equipped with washout plugs at the bottom to facilitate flushing of the boiler in accordance with PFT-43.

(d) This Case number shall be shown on the Master Data Report.

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

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