SUBSECTION HC
CLASS B METALLIC PRESSURE BOUNDARY COMPONENTS

SUBPART A
LOW TEMPERATURE SERVICE

ARTICLE HCA-1000
INTRODUCTION

HCA-1100 GENERAL
HCA-1110 SCOPE

The rules of this Subsection HC, Subpart A constitute the requirements associated with Class B metallic components used in the construction of high temperature reactor systems and their supporting systems when subjected to low temperature service.

(a) Subsection HC, Subpart A provides rules for the material, design, fabrication, examination, testing, overpressure relief, marking, stamping, and preparation of reports by the Certificate Holder of metallic pressure boundary components that are intended to conform to the requirements for Class B construction for service when Service Loading temperatures do not exceed the appropriate temperature limits established in Table HAA-1130-1 for the material under consideration.

(b) The rules of Subsection HC, Subpart A are contained in Division 1, Subsection NC except for those paragraphs or subparagraphs (with numbered headers) replaced by corresponding numbered HCA paragraphs or subparagraphs in this Subpart or new numbered HCA paragraphs or subparagraphs added to this Subpart.

(c) Division 1 rules may use different terminology than Division 5 (e.g., Class 2 versus Class B, etc.), but the application of these rules is identical for Division 5 use.

(d) The rules of this Subpart cover the strength and pressure integrity of items the failure of which would violate the pressure-retaining boundary. The rules cover load stresses but do not cover deterioration that may occur in service as a result of corrosion, radiation effects, or instability of materials.

(e) This Subpart does not contain rules to cover all details of construction of Class B vessels and components. Where complete details are not provided in this Subpart, it is intended that the N Certificate Holder, subject to the approval of the Owner or his designee and acceptance by the Inspector, shall provide details of construction that will be consistent with those provided by the rules of this Subpart.

(f) Class B vessels are to be designed using the standard design method in NC-3300 or the alternative design rules of NC-3200, which allow the use of analysis with the higher design stress intensity values of Section II, Part D, Subpart 1, Tables 2A, 2B, and 4.

(g) As an alternative for Class B components, the requirements in HAA-2134 may be used for construction utilizing higher class requirements.

Editor: Replace "NC" highlighted with "NCD".

Editor: Insert the sentence: "References to Division 1, Subsection NCD apply to the applicable Class 2 rules in NCD."
SUBPART B
ELEVATED TEMPERATURE SERVICE

ARTICLE HCB-1000
INTRODUCTION

HCB-1100 GENERAL

HCB-1110 SCOPE

The rules of this Subsection HC, Subpart B constitute the requirements associated with Class B metallic components used in the construction of high temperature reactor systems and their supporting systems when subjected to elevated temperature service.

(a) Subsection HC, Subpart B provides rules for the material, design, fabrication, examination, installation, testing, overpressure relief, marking, stamping, and preparation of reports by the Certificate Holder of metallic pressure boundary components or portions of those components that are intended to conform to the requirements for Class B construction for service when Service Loading temperatures exceed the appropriate temperature limits established in Table HAA-1130-1 for the material under consideration. These zones of elevated temperature service shall have their finalized geometry descriptions and temperature profile details finalized in the Design Report prior to any fabrication and examination efforts.

(b) The rules of Subsection HC, Subpart B are contained in Division 1, Subsection NC, except for those paragraphs or subparagraphs (with numbered headers) replaced by corresponding numbered HCB paragraphs or subparagraphs in this Subpart or new numbered HCB paragraphs or subparagraphs added to this Subpart.

(c) Division 1 rules may use different terminology than Division 5 (e.g., Class 2 versus Class B, etc.), but the application of these rules is identical for Division 5 use.

(d) References to Appendices are to the Section III Appendices, unless otherwise identified as a Subsection HC, Subpart B Appendix, or other subsection-specific Appendix.

(e) The rules of this Subpart cover the strength and pressure integrity of items the failure of which would violate the pressure-retaining boundary. The rules cover load stresses but do not cover deterioration that may occur in service as a result of corrosion, radiation effects, or instability of materials.

(f) This Subpart does not contain rules to cover all details of construction of Class B components. Where complete details are not provided in this Subpart, it is intended that the N Certificate Holder, subject to the approval of the Owner or his designee and acceptance by the Inspector, shall provide details of construction that will be consistent with those provided by the rules of this Subpart.

(g) The rules of this Subpart are independent of the initial fluid contained by the component. However, if the Owner (or his designee) specifies in the Design Specification that the component will contain lethal or other hazardous substances such as sodium, then the additional requirements of HCB-3160, HCB-4160, and HCB-5160 shall also apply. The limited weld joint types and requirement that the welds shall be properly examined by radiography (HCB-3160 and HCB-5160, respectively) are intended to yield weld joints with no crevices.

(h) Design procedures and material data not contained in this Subpart may be required to ensure the structural integrity or continued functioning of the structural part during the specified service life. For example, the rules do not provide methods to evaluate deterioration that may occur in service as a result of corrosion, mass transfer phenomena, radiation effects, or other material instabilities. Nor do the rules ensure continued functional performance of deformation-sensitive structures such as valves and pumps.

(i) This Subpart is not applicable to storage tanks constructed in accordance with Division 1, NC-3800 and NC-3900. This Subpart is not applicable to internal structures outside the scope of (j) below.

(j) The rules of this Subpart apply to those permanent attachments as described in the Design Specifications and to portions of components covered by the Code, as explained as follows:

(1) Divisions 1 and 2, NCA-3252(a): Code Boundary Description in Design Specification

The rules of this Subpart apply to the applicable Class 2 rules in NCD.
(3) **HAA-1130:** Parts Excluded From Code Coverage

**HCB-1120 ALTERNATIVE RULES**

(a) The alternative design rules of Division 1, **NC-3200** are not permitted to be used in this Subpart B.

(b) As an alternative, the requirements in **HAA-2134** may be used to construct Class B components utilizing higher class requirements.

Editor: Replace "NC" highlighted with "NCD".
ARTICLE HCB-2000
MATERIAL

HCB-2100  GENERAL REQUIREMENTS FOR MATERIAL

All pressure-retaining material and material welded thereeto shall meet the requirements of Division 1, Article NC-2000, except as modified herein. In addition, the material shall also conform to the specification, grade, class, and type requirements of the tables in Mandatory Appendix HCB-II.

HCB-2400
HCB-2430
HCB-2433

HCB-2433.2  Acceptance Standards. For Design Temperatures up to and including 800°F (425°C), the minimum acceptable delta ferrite shall be 5 FN (Ferrite Number). For Design Temperatures exceeding 800°F (425°C), the delta ferrite shall be limited to the range 3 FN to 10 FN. The results of the delta ferrite determination shall be included in the Certified Material Test Report of Division 1, NC-2130 or NC-4120.

HCB-2500
HCB-2570
HCB-2571  Required Examination

(a) Cast products shall be examined by volumetric and/or surface methods, including repairs, as required for the product form by Division 1, Table NC-2571-1.

(b) For cast valves furnished to ASME B16.34 Special Class category, neither the size exclusions nor the quality factor pressure ratings of Division 1, Table NC-2571-1 shall be applied so as to reduce the required examinations of that standard. The required examinations by ASME B16.34 for Special Class category valves shall be performed in accordance with the procedures and acceptance standards of this Subsection.

(c) In addition to the requirements of Division 1, NC-2571, a determination of delta ferrite shall be performed on each heat of austenitic-type stainless steel castings. These determinations shall conform to the rules in the subparagraphs below.

HCB-2571.1  Method. The delta ferrite determinations shall be performed by use of the chemical analysis required by the material specification in conjunction with Division 1, Fig. NC-2433.1-1.

HCB-2571.2  Acceptance Standards. For Design Temperatures exceeding 800°F (425°C), the delta ferrite shall be limited to a maximum of 12 FN. The results of the delta ferrite determination shall be included in the Certified Material Test Report of Division 1, NC-2130 or NC-4120.
ARTICLE HCB-3000
DESIGN

HCB-3100  GENERAL DESIGN

All pressure-retaining material and material welded thereto shall meet the requirements of Division 1, Article NC-3000, except as modified herein.

HCB-3110

HCB-3114  Acceptability

An acceptable component design is one that meets the requirements of (a) through (c) below. Alternative methods are provided under (d) below.

(a) The design satisfies the general design requirements of HCB-3100.

(b) The design satisfies the appropriate component rules in either HCB-3300 (vessels designed by formula), HCB-3400 (pumps), HCB-3500 (valves), or HCB-3600 (piping). The Design Specification shall state which subarticle (HCB-3300, HCB-3400, HCB-3500, or HCB-3600) is appropriate for the particular component.

(c) The design shall guard against failure from low-energy fracture. The Design Specification may contain additional requirements as to tests, analyses, or other methods by which the designer can demonstrate proper consideration of this failure mode.

(d) The Certificate Holder may invoke alternative methods for demonstrating compliance to those portions of (a) and (b) above that relate to buckling, ratcheting, and creep–fatigue failure. However, these alternative methods shall be approved by the Owner. The Owner's approval shall be indicated by incorporating the alternative methods and criteria into the Design Specifications.

HCB-3115  Design Report and Certification

(a) In addition to the requirements of Divisions 1 and 2, NCA-3550, a Design Report shall be prepared for a component if any portion (zone of elevated temperature service) is

(1) designed in accordance with the rules in HCB-3630 of this Article

(2) designed using either buckling rules in HCB-3114(d), HCB-3142, or HCB-3143 of this Article

(b) In addition to the applicable requirements from Divisions 1 and 2, NCA-3550, the contents of the Design Report shall include an evaluation of those zones of elevated temperature service of the component (and the details related to failure modes) described in (a)(1) and (a)(2) above.

(c) Design Reports shall be certified as being complete and correct by Certifying Engineers competent in elevated temperature component design.

HCB-3140  BUCKLING INSTABILITY LOADINGS

HCB-3141  General Requirements

(a) If a portion (zone of elevated temperature service) of a Class B component is subjected to buckling instability loadings and the conditions of Mandatory Appendix HCB-III are satisfied, then the rules of Division 1, NC-3133 shall apply for external pressure loadings.

(b) If Mandatory Appendix HCB-III is not satisfied, the limits on buckling loadings given in the remaining rules of HCB-3141, HCB-3142, and HCB-3143 shall be satisfied.

HCB-3141.1  Scope of Rules. The stability limits in Division 1, NC-3133 pertain only to specific geometrical configurations under specific loading conditions. These limits include the effects of initial geometrical imperfections permitted by fabrication tolerances. However, they do not consider the effects of creep due to long-term loadings at elevated temperatures and the effects of the other loads or other geometries. The rules in HCB-3141, HCB-3142, and HCB-3143 provide additional limits that may cause buckling or instability due to time-dependent creep behavior of the material. These additional limits are applicable to all loading conditions.

HCB-3141.2  Load-Controlled and Strain-Controlled Buckling. For the limits specified here, distinction is made between load-controlled buckling and strain-controlled buckling. Load-controlled buckling is characterized by continued application of an applied load in the post-buckling regime leading to failure, as exemplified by collapse of a tube under external pressure. Strain-controlled buckling is characterized by the immediate reduction of load due to strain-induced deformations. Even though it is self-limiting, strain-controlled buckling must be avoided to guard against failure by fatigue, excessive strain, loss of function due to excessive deformation, and interaction with load-controlled buckling.

HCB-3141.3  Interaction of Load-Controlled and Strain-Controlled Buckling. For conditions under which strain-controlled and load-controlled buckling may interact, as exemplified by elastic follow-up, the higher Load
Factors applicable to load-controlled buckling shall be used for the combinations of load-controlled and strain-controlled loadings.

**HCB-3141.4 Effects of Initial Geometry Imperfections.** The requirements listed in (a) and (b) below shall be addressed.

(a) For load-controlled buckling, the effects of initial geometrical imperfections and tolerances shall be considered in the time-independent calculations according to the requirements of HCB-3142. The effects of geometrical imperfections and tolerances, whether initially present or induced by service, shall be considered in the time-dependent calculations of HCB-3143.

(b) In calculating the instability strain under pure strain-controlled buckling, the effects of geometrical imperfections and tolerances, whether initially present or induced by service, need not be considered. However, if significant geometrical imperfections are initially present, enhancement due to creep may cause excessive deformation or strain, and these effects shall be considered in the application of deformation and strain limits.

**HCB-3141.5 Stress–Strain Data.** The expected minimum stress–strain curve for the material at the specified temperatures shall be used. The expected minimum curve values may be obtained by taking the inelastic portion of the average hot tensile strength values (shown on iso-chronous stress–strain curves) and normalizing them to the tabulated yield strength values at the specified temperature. Properties data are available in the rules for Class A components in elevated temperature service.

When re-solution annealed (see HCB-4215) Type 300 series austenitic stainless steel is utilized, the tabulated yield strength shall be further reduced by 17%. This reduction is not required if it is demonstrated by test that the room temperature yield strength meets the specified minimum values following re-solution annealing.

**HCB-3142 Time-Independent Buckling Limits.**

For load-controlled buckling, the Load Factor, and for strain-controlled buckling, the Strain Factor, shall equal or exceed the values given in Table HBB-T-1521-1 for the specified Design and Service Loadings to protect against time-independent (instantaneous) buckling.

**HCB-3143 Time-Dependent Buckling Limits.**

To protect against load-controlled time-dependent creep buckling, it shall be demonstrated that instability will not occur during the specified lifetime for a load history obtained by multiplying the specified service loads by the factors given in Table HBB-T-1522-1. A design factor is not required for purely strain-controlled buckling because strain-controlled loads are reduced concurrently with resistance of the structure to buckling when creep is significant.

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**HCB-3150 LIMITATIONS ON USE**

(a) Unless the requirements of Mandatory Appendix HCB-III are satisfied, components with non-integral reinforcement, such as pad-type nozzles and pad-type branch connections, are not acceptable for elevated temperature service. The reinforcement requirements of Division 1, NC-3300 shall be satisfied only by material that is integral with either the nozzle, or vessel, or both. Weld metal added as reinforcement may be considered as integral metal.

(b) Socket welds may be used only for nominal diameter 2 in. (50 mm) or less.

**HCB-3160 COMPONENTS CONTAINING LETHAL OR HAZARDOUS SUBSTANCES**

For those components containing lethal substances or other hazardous substances such as sodium, the acceptable weld types shall comply with requirements (a) through (c) listed below.

(a) Category A weld joints in vessels and similar weld joints in other components shall be Type No. (1) (see Division 1, Subsection NC, NC-4262 for definitions).

(b) Category B and C weld joints in vessels and similar weld joints in other components shall be Type No. (1) or Type No. (2).

(c) Category D weld joints in vessels and similar weld joints in other components shall be full penetration welds extending through the entire thickness of the pressure boundary wall.

**HCB-3300 VESSEL DESIGN**

**HCB-3310 GENERAL REQUIREMENTS**

Class B vessel requirements for elevated temperature service as stipulated in the Design Specifications (Divisions 1 and 2, NCA-3250) shall conform to the design requirements of this Article.

(a) Elevated temperature Class B vessels designed by equation shall satisfy the requirements of Division 1, NC-3300, except as modified per HCB-3100.

(b) The rules of (a) above do not explicitly address fatigue damage resulting from cyclic service.

(c) For design calculations, the allowable stress values, $S$, at elevated temperatures shall be obtained from the tables of Mandatory Appendix HCB-II. These tables are extensions of Section II, Part D, Subpart 1, Tables 1A, 1B, and 3.

**HCB-3400 PUMP DESIGN**

(a) Elevated temperature Class B pumps designed by equation shall satisfy the requirements of Division 1, NC-3400, except as modified per HCB-3100.
For a pump that has a pipe-like configuration (such as an electromagnetic pump that conforms to a length of pipe), the requirements of (a) above may be satisfied by using the rules of HCB-3600.

The rules of (a) above do not explicitly address fatigue damage resulting from cyclic service.

For design calculations, the allowable stress values, \( S \), at elevated temperatures shall be obtained from the Tables of Mandatory Appendix HCB-II. These tables are extensions of Section II, Part D, Subpart 1, Tables 1A, 1B, and 3.

### HCB-3500 Valve Design
#### HCB-3510 General Requirements

(a) Elevated temperature Class B valves designed by equation shall satisfy the requirements of Division 1, NC-3500 except as modified per HCB-3100.

(b) The rules of (a) above do not explicitly address fatigue damage resulting from cyclic service.

(c) For design calculations, the allowable stress values, \( S \), at elevated temperatures shall be obtained from the Tables of Mandatory Appendix HCB-II. These tables are extensions of Section II, Part D, Subpart 1, Tables 1A, 1B, and 3.

### HCB-3600 Piping Design
#### HCB-3630 General Requirements

Elevated temperature Class B piping design shall conform to the rules of either HCB-3632 for piping with negligible creep effects or HCB-3634 for piping with creep effects.

#### HCB-3632 Piping With Negligible Creep Effects

For a particular component, the requirements are given in (a) and (b) below.

(a) The exemption criteria of Mandatory Appendix HCB-III shall be satisfied.

(b) The Design and Service Limits of Division 1, NC-3600 shall be satisfied for Class B piping with the exceptions and additions listed in (1) through (4) below.

1. **NC-3611.1:** The allowable stress values in Section II, Part D, Subpart 1, Tables 1A, 1B, and 3 may be extended by using values in Table HCB-III-2000-1 of Mandatory Appendix HCB-II.

2. **NC-3611.2(b):** The rules of HCB-3140 of this Article may satisfy this requirement on external pressure loadings.

3. **NC-3641.2:** Limits may be satisfied by the rules of HCB-3140.

4. **NC-3643.3(c)(7):** Nonintegral reinforcements are excluded by HCB-3100.

#### HCB-3634 Piping With Creep Effects

(a) The requirements of Division 1, NC-3600, as modified by this subarticle, shall be satisfied for all specified Design and Service Loadings on Class B piping. The allowable stress values in Section II, Part D, Subpart 1, Tables 1A, 1B, and 3 may be extended to elevated temperatures using the values of the tables in Mandatory Appendix HCB-II. In this subarticle and for all Division 1, NC-3600 references, eqs. (10a) and (11) of Division 1, NC-3653.2 shall be modified as in (b) and (c) below.

(b) The allowable stress values, \( S_A \), for thermal expansion stresses in eq. (10a) of Division 1, NC-3653.2 shall be determined by the form of eq. (10b) listed below:

\[
S_A = f(1.25S_Y + 0.25S_0) 
\]

The stress range reduction factor, \( f \), shall be determined as per Mandatory Appendix HCB-I.

In addition, all thermal cycles shall satisfy the following stress criteria:

\[
\frac{\Delta T_i}{\Delta T_E} \left( \frac{\text{Calculated thermal expansion stress for the full temperature change}}{4(1 - \nu)} \right) + \frac{E_a}{\Delta T_i} \leq (0.75S_{yc} + 0.25S_0) \]

where

- \( S_{yc} \) = specified (Section II, Part D, Subpart 1, Table Y-1) yield strength at the minimum (cold) temperature of the \( i^{th} \) thermal cycle.
- \( \Delta T_i \) = temperature range for the \( i^{th} \) cycle (Division 1, NB-3653.2)
- \( \Delta T_E \) = maximum temperature range for all Service Level A, B, and C events. That is, the highest temperature during all events less the minimum temperature during all events.

(c) The allowable stress values in eq. (11) of Division 1, NC-3653.2 shall be determined by the modified eq. (11) listed below:

\[
S_{TE} \leq \text{lesser of } (S_A + S_0) \text{ or } (0.75S_{yc} + 0.25S_0) \]

where \( S_A \) and \( S_{yc} \) are stress values as defined in (b).

(d) The definitions of other terms used above in (b) and (c) are provided in Division 1, NC-3611.2(c).

(e) Additional modifications for Division 1, NC-3600 rules are stated in (1) through (6) below.

1. **NC-3611.2(b):** The requirements are satisfied by the rules of HCB-3100.

2. **NC-3641.2:** The requirements are satisfied by the rules of HCB-3140.

3. **NC-3643(c)(7):** Nonintegral reinforcements are excluded by HCB-3100.
(4) NC-3643.6: Burst or proof tests and short-term experiments are not acceptable for "other designs."

(5) NC-3649: Proof tests and short-time experiments are not adequate proof of acceptable designs.

(6) NC 3671.2; NC 3671.4(d)(2); NC 3671.7: All durations of elevated temperature service shall also be duplicated in the tests.

Editor: Replace "NC" highlighted with "NCD".
ARTICLE HCB-4000
FABRICATION AND INSTALLATION

HCB-4100 GENERAL REQUIREMENTS

All pressure-retaining material and material welded thereto shall meet the requirements of Division 1, Article NC-4000, except as modified herein.

(a) Those portions of the component that do not experience elevated temperature service shall either use the rules of this Article or Division 1, Article NC-4000 as applicable.

(b) Those portions or zones of elevated temperature service of a component that meet the condition that creep and stress rupture effects need not be considered (as defined by Mandatory Appendix HCB-III) shall either use the rules of this Article or Division 1, Article NC-4000, as applicable.

(c) Those zones of elevated temperature service of the component that do not meet the conditions in (a) or (b) above shall comply with the provisions of this Article.

(d) Those portions or zones of elevated temperature service of the component that use either options (a) and (b), or (c) above, shall be so identified during all steps of fabrication and installation.

HCB-4160 COMPONENTS CONTAINING LETHAL OR HAZARDOUS SUBSTANCES

For those components containing lethal substances or other hazardous substances such as sodium, the component shall be postweld heat treated in accordance with this Article when the pressure boundary material includes either carbon or low alloy steels.

HCB-4200
HCB-4210
HCB-4215 Additional Requirements for Forming and Bending Processes

The rules of this paragraph shall supplement those of Division 1, Article NC-40212 and NC-40213, as applicable. Any process may be used to form pressure-retaining materials at temperatures exceeding those for which allowable stresses are given in this Subpart, including weld metal, provided that the requirements of the subparagraphs below are met.

(a) Post-fabrication heat treatment [in accordance with (b) below] of materials that have been formed during fabrication shall be required unless one of the following conditions are met:

(1) Maximum fabrication-induced local strains do not exceed 5% regardless of the service temperature.

(2) For fabrication-induced strains greater than permitted in (1) above, written technical justification shall be included in the Design Report for not performing heat treatment subsequent to straining, or for the use of an alternate heat treatment procedure to that specified in (b) below. The justification shall provide assurance that the resultant material property capabilities are adequate for the intended service (fatigue, creep rupture, impact toughness, etc.) and shall include consideration of property variability through the material section. This option is not permitted for certain materials if the components are subjected (during Level A, B, and C Service Loadings, or for design conditions when only design conditions are specified) to short-time, high-temperature excursions that result in accumulated temperature exposures exceeding the maximum permissible values shown in Figure HCB-4215-1. This option is not permitted for ferritic material. This option is also not permitted for any austenitic material that is subjected to greater than 20% strain.

(3) The roll-threaded portion of bolting material is exempt from the heat treatment requirement.

(b) When required, the post-fabrication heat treatment shall be in accordance with (1) and (2) below.

(1) For ferritic materials, the post-fabrication heat treatment shall consist of exposure to temperatures listed in Division 1, Table NC-40221.1-1, as applicable, for the appropriate alloy P-Number. Holding times shall also be in accordance with the appropriate table based on the material thickness at the point of maximum strain. This heat treatment shall be included in the material certification per Division 1, Article NC-2211, as applicable, and the forming qualifications as required by Division 1, Article NC-40213 and applicable weld procedure qualifications. Alternatively, the base material and welds may be reheat treated and reheat treated in accordance with the applicable material specification and requirements in Division 1, Article NC-2400. Reheat treatment may entail appropriate cooling from hot working temperatures above the upper critical temperature of the respective material provided required material property levels are achieved.

(2) For austenitic materials, the post-fabrication heat treatment shall consist of the heat treatment specified in the base material specification except that Alloy 800H shall be heat treated at 2,050°F (1,120°C) minimum. The final grain size of Alloy 800H shall not be finer than micrograin size #5 as defined in ASTM E112.
HCB-4400
HCB-4420
HCB-4427  Shape and Size of Fillet Welds

(a) Fillet welds may vary from convex to concave. Except as permitted in (b) below, the shape and size of the weld shall be in accordance with the requirements of Division 1, Fig. NC-4427-1. A fillet weld in any single continuous weld may be less than the specified fillet weld dimension by not more than $\frac{1}{16}$ in. (1.5 mm), provided that the total undersize portion of the weld does not exceed 10% of the length of the weld. Individual undersize weld portions shall not exceed 2 in. (50 mm) in length. In making socket welds, a gap as shown in Division 1, Fig. NC-4427-1 shall be provided prior to welding. The gap need not be present nor be verified after welding. For sleeve type joints without internal shoulder, the gap shall be between the butting ends of the pipe or tube.

(b) Socket welds smaller than those specified in Division 1, Fig. NC-4427-1 may be used provided the requirements of Division 1, Article NC-3000 are met.

(c) The designer shall evaluate whether assembly of socket welds should allow for an axial gap after welding that will allow free thermal growth of the male coupling within the socket without bottoming out during the intended service. If a gap is deemed necessary, it shall be verified in accordance with the rules for the examination of Class B components for elevated temperature service (Article HCB-5000).

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Figure HCB-4215-1
Permissible Time/Temperature Conditions for Material That Has Been Cold Worked >5% and <20% and Subjected to Short-Time, High-Temperature Transients

GENERAL NOTE: The sum of time at every temperature shall determine a point within the design region of the figure for the specific material. For multiple temperature/time combinations, the linear summation of life fraction shall not exceed 1.0, the material limit.
ARTICLE HCB-5000
EXAMINATION

HCB-5100 GENERAL REQUIREMENTS FOR EXAMINATION

All pressure-retaining material and material welded thereto shall meet the requirements of Division 1, Article NC 5000.

HCB-5160 COMPONENTS CONTAINING LETHAL OR HAZARDOUS SUBSTANCES

For those components containing lethal substances or other hazardous substances such as sodium, all permitted weld joints at the pressure boundary shall be fully radiographed.

Editor: Replace "NC" highlighted with "NCD".
ARTICLE HCB-6000
TESTING

HCB-6100 GENERAL REQUIREMENTS

The requirements of Division 1, Article NC-6000 shall be met, except as modified herein.

HCB-6110 Scope of Pressure Testing

All pressure-retaining components, appurtenances and completed systems shall be pressure tested except as specified in (a) through (d) below. Portions of systems that are exempt shall be identified in the Design Specification and the Data Report Form N-5 (see Section III Appendices, Mandatory Appendix V). The Design Specification shall be available to the Authorized Nuclear Inspector when the balance of the system is pressure tested.

(a) Bolts, studs, nuts, washers, and gaskets are exempt.
(b) The following portions of piping systems whose only function is to transport fluids to and from spray ponds, lakes, reservoirs, or tanks that are open to the atmosphere are exempt:
   (1) piping downstream of the last isolation valve preceding the pipe discharge to the spray pond, lake, reservoir, or tank
   (2) piping upstream of the intake pump inlet isolation valve
   (c) Where systems discharge into Class B vessels, only that portion of the system external to the vessel is required to be pressure tested.
   (d) Under the special conditions of HCB-6630 and HCB-6640, a helium mass spectrometer test (per the requirements of Section V, Article 10 for an allowable volumetric leakage rate that shall be defined in the Design Specification) may replace the required pressure test.

HCB-6600 ALTERNATIVE TESTS OF CLOSURE WELDS AND ACCESS HATCHES

Closure welds for access hatches in vessels and closure welds for connecting piping subassemblies may be tested by a helium mass spectrometer test as an alternative to the pressure test requirements of Division 1, NC-6110 provided the conditions of (a) and (b) below are met.

(a) The closure welds to which the alternative test procedure has been applied shall be identified on the Data Report.
(b) The closure welds to which the alternative test procedure has been applied shall be identified on the Data Report.

HCB-6640 ALTERNATIVE TESTS AT SPECIALLY DESIGNED WELDED SEALS

Welds of specially designed welded seals may be tested by a helium mass spectrometer test in lieu of the pressure test requirements of Division 1, NC-6110 provided the following:

(a) The welds of the seal, and the welds joining the seal to the component or supporting structure, cannot be visually examined during pressure testing due to access restrictions.
(b) The welds and the alternative test procedures have been mutually agreed to by the Owner and Certificate Holder, and the requirements appear in the Design Specification and are reported in the Certificate Holder’s Data Report Form.
ARTICLE HCB-7000
OVERPRESSURE PROTECTION

HCB-7100 REQUIREMENTS

All pressure-retaining material and material welded thereto shall meet the requirements of Division 1, Article NC-7000, except as modified herein.

(a) This Article provides Class B overpressure protection rules for those pressure boundary components, which having been designated by the Owner (Divisions 1 and 2, NCA-1140 and NCA-3220) as a group of items requiring such protection, are not covered by Division 1, Article NC-7000 rules because some of the components are expecting service temperatures above those currently allowed under the rules of Division 1, Subsection NC.

(b) Whereas the rules of Division 1, Article NC-7000 are oriented toward water and steam-cooled reactor systems, the rules of this Article envision a wider variety of coolant fluids.

(c) All references to other Division 1, Article NC-7000 paragraphs are to be interpreted as referring to the Division 1, Article NC-7000 paragraphs as modified by this Article.

(d) As with Division 1, Article NC-7000, the rules of this Article presume that all system conditions, including transients, are accurately described in the Design Specifications for the components being protected.

(e) In the evaluation of the effects of overpressure events, structural loadings shall include, but not be limited to, the types of events listed in (1) through (7) below.

(1) System overpressure due to a closed valve, a blocking object, or a solid core of metal coolant
(2) Overpressure due to the addition of heat to an isolated portion of the system
(3) Overpressure due to nuclear transient effects
(4) Overpressure due to failure of a system component, including the effects of leaks from adjacent systems and possible resulting chemical reactions
(5) Overpressure resulting from operator error
(6) Overpressure due to constant pressure in combination with a rising over-temperature condition
(7) Overpressure due to pump overspeed

HCB-7110 SCOPE

(a) A system shall be protected from the consequences arising from the application of conditions of pressure and coincident temperature that would cause either the Design Pressure or the Service Limits specified in the Design Specification to be exceeded.

(b) Pressure relief devices are required when the operating conditions considered in the Overpressure Protection Report would cause the Service Limits specified in the Design Specification to be exceeded.

(c) Protection of components in the system from the effects of pressure increases of extremely short duration, such as water hammer resulting from the rapid closing of a valve, is beyond the scope of this Article. These effects shall be included in the Design Specification. Some examples of events whose overpressure transients are not considered in detail by the rules of this Article are

(1) Rapid closure of a check valve leading to fluid shock conditions in a local region
(2) Earthquake motions inducing sloshing of fluids contained in large tanks
(3) Nuclear incidents inducing a severe pressure spike in a local region
(4) Rapid closure of a valve during high flow rate conditions introducing pressure shocks

Note that each of the above events may lead to loss of coolant in systems utilizing nonreclosing overpressure relief devices.

HCB-7140

HCB-7143 Draining of Pressure Relief Devices

(a) A pressure relief device installation shall be fitted with a drain at its lowest point where liquid or residue can collect if such liquid or residue could interfere with proper relieving operation.

(b) If the design of a pressure relief device permits liquid or residue to collect on the discharge side of the disk and could interfere with proper relieving operation, the device shall be fitted with a drain to minimize the collection of liquid or residue.

(c) Such drains shall discharge to a controlled thermal dissipation or discharge storage system, such as those provided for pressure relief devices.

HCB-7200

HCB-7220 CONTENT OF REPORT

The Overpressure Protection Report shall define the protected systems and the integrated overpressure protection provided. As a minimum, the report shall include the following:
(a) identification of specific Article HCB-7000, Edition and Addenda, and applicable Code Cases used in the design of the overpressure protection system.

(b) drawings showing arrangement of protected systems including the pressure relief devices.

(c) the analysis of the effect of the range of operating conditions, including the effect of discharge piping back pressure.

(d) an analysis of the conditions that give rise to the maximum pressure or vacuum relieveing requirements, except when the basis for establishing relieving capacity is the loss of the heat sink of the protected system when the thermal input to the system is at a maximum.

(e) the relief capacity required to prevent a pressure or vacuum rise in any component from exceeding the limitations of Division 1, NC-7500.

(f) the operating controls or safety controls of the protected system upon which the anticipated required relief capacity of (d) and the maximum pressure, vacuum, and temperature of (c) are predicted.

(g) the redundancy and independence of the pressure relief devices and their associated pressure or vacuum sensors and controls employed to preclude a loss of overpressure protection in the event of a failure of any pressure relief device, sensing element, associated control, or external power sources.

(h) the extent that an individual component can be isolated from the overall system overpressure protection and the analysis of the conditions under which additional individual overpressure protection is necessary.

(i) the design secondary pressure including a justification of the value identified in the Design Specification for pressure relief devices.

(j) the analysis of pressure transient conditions, including those associated with the response time of pressure or vacuum relief valves, taking into account the effect of coolant fluid, including liquid, gas, and two-phase flow.

(k) consideration of set pressure and blow down limitations, taking into account opening pressure tolerances and overpressure of the pressure relief device.

(l) consideration of burst pressure tolerance and manufacturing design range of the rupture disk device.

(m) verification that pressure relief devices are not required, if applicable. Verification shall include reference to each component’s Design Report and applicable requirements in Article HCB-3000 that demonstrate the calculated stress levels do not exceed the Service Limits specified in the component Design Specification for all system service loadings.

(n) the effects of any thermal dissipation of discharge storage system on the pressure relief devices.

(a) the disposition of effluent from pressure relief devices for both primary and secondary reactor coolant fluids.

(p) an analysis of the transient conditions and operating conditions that give rise to the maximum pressure and temperature, except where the basis for establishing relieving capacity is the loss of 100% of the heat sink of the nuclear power system when the thermal output of the nuclear reactor is at 100% of its rated power.

Rupture disk devices certified in accordance with Division 1, NC-7720 and NC-7750 are subject to the following:

(a) Rupture disk devices may be used as the sole pressure relief devices, except for main steam or liquid service (Division 1, NC-7625).

(b) Rupture disk devices may be used on the inlet side of pressure relief valves only when such valves are of the full bore type (Division 1, NC-7623).

(c) Rupture disk devices may be used in conjunction with pressure relief valves on the outlet side (Division 1, NC-7624).

(d) Rupture disk devices shall use materials of construction approved for Class B pressure boundaries in elevated temperature service as applicable.

When a rupture disk is used in conjunction with a pressure relief valve, the space between the rupture disk and the associated pressure relief valve shall be vented and/or drained (e.g., connected to a controlled disposal system). This space shall be provided with means to monitor its internal pressure during service periods.
ARTICLE HCB-I-2000
MAXIMUM NUMBER OF ALLOWABLE CYCLES WITH \( f = 1 \)

The maximum number of cycles, \( N_1 \), permissible with \( f = 1 \) is determined from Table HCB-I-2000-2.

For temperatures intermediate to the values given in Table HCB-I-2000-2, the corresponding value of \((N_1)_{i}\) shall be obtained using the equation below:

\[
\ln[(N_1)_{i}] = \ln(N_1) + \left( \frac{\ln(N_1)_{2} - \ln(N_1)_{1}}{T_2 - T_1} \right) (T_i - T_1)
\]

where

\((N_1)_{1} = N_1\) value for temperature \(T_1\) from Table HCB-I-2000-2

\((N_1)_{2} = N_1\) value for temperature \(T_2\) from Table HCB-I-2000-2

\(T_1 = \) temperature value in Table HCB-I-2000-2 immediately below \(T_i\)

\(T_2 = \) temperature value in Table HCB-I-2000-2 immediately above \(T_i\)

\(T_i = \) intermediate temperature

NOTE: \( T_1 < T_i < T_2 \) and \( T_1 \) and \( T_2 \) are adjacent values in Table HCB-I-2000-2.

<table>
<thead>
<tr>
<th>Table HCB-I-2000-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stress Range Reduction Factor</td>
</tr>
<tr>
<td>Full Temperature Cycles, ( N )</td>
</tr>
<tr>
<td>0 through ( N_1 )</td>
</tr>
<tr>
<td>( N_1 ) through 1.69( N_1 )</td>
</tr>
<tr>
<td>1.69( N_1 ) through 3.05( N_1 )</td>
</tr>
<tr>
<td>3.05( N_1 ) through 5.95( N_1 )</td>
</tr>
<tr>
<td>5.95( N_1 ) through 12.86( N_1 )</td>
</tr>
<tr>
<td>12.86( N_1 ) through 32( N_1 )</td>
</tr>
<tr>
<td>32( N_1 ) through 411( N_1 )</td>
</tr>
<tr>
<td>411( N_1 ) through 3,125( N_1 )</td>
</tr>
<tr>
<td>&gt; 3,125( N_1 )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table HCB-I-2000-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Number of Cycles, ( N_1 ), Permissible With ( f = 1 )</td>
</tr>
<tr>
<td>Maximum Service Temperature, °F (°C)</td>
</tr>
<tr>
<td>Material</td>
</tr>
<tr>
<td>Carbon steels</td>
</tr>
<tr>
<td>Low alloy steels</td>
</tr>
<tr>
<td>Cast austenitic stainless steels</td>
</tr>
<tr>
<td>304 SS (wrought)</td>
</tr>
<tr>
<td>316 SS (wrought)</td>
</tr>
<tr>
<td>Other wrought austenitic stainless steels</td>
</tr>
<tr>
<td>Alloy 800H</td>
</tr>
<tr>
<td>Other high nickel alloys</td>
</tr>
</tbody>
</table>

Editor: Replace "NC" highlighted with "NCD".
ARTICLE HCB-I-3000
EQUIVALENT CYCLE

If a range of temperature varies in time, the total number of equivalent cycles (based on the full temperature range) may be calculated as

$$N = \sum n_i^5 N_i$$

where

$$n_i = \frac{\Delta T_i}{\Delta T_E}$$

or the calculated thermal expansion stresses for the full temperature change.

$$N_i = \text{number of cycles for the } i^{th} \text{ temperature change}$$

$$|\Delta T_1| = |\Delta T_2| = |\Delta T_3|$$

$$T_a = T_a$$ for the $$i^{th}$$ cycle (Division 1, NB-3653.1)

$$T_b = T_b$$ for the $$i^{th}$$ cycle (Division 1, NB-3653.1)

$$\Delta T_E = \text{maximum temperature range for all Service Level A, B, and C events [see HCB-3634(b)]}$$

$$\Delta T_i = \text{temperature range for the } i^{th} \text{ cycle}$$

The terms $$K_3$$ and $$C_3$$ are defined in Division 1, NB-3680. The terms $$E_{ab}, \alpha_a, \alpha_b, T_a, \text{ and } T_b$$ are defined in Division 1, NB-3653.1. The terms $$S_c$$ and $$S_h$$ are defined in Division 1, NC-3611.2.

Editor: Replace "NC" highlighted with "NCD".
### Table HCB-II-2000-1
Allowable Stress Values for Ferritic Steel Class B Components (Cont'd)

<table>
<thead>
<tr>
<th>Nominal Composition</th>
<th>Group No.</th>
<th>Product Form</th>
<th>Spec. No.</th>
<th>Grade or Type</th>
<th>Specified Minimum Strengths, $S_y/S_u$</th>
<th>Applicable Line in Figure HCB-III-1000-1</th>
<th>SI Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>2%Cr-1Mo</td>
<td>A1</td>
<td>Fitting</td>
<td>SA-234</td>
<td>WP22</td>
<td>1 205/415 (10)(12)</td>
<td>B 100 100 100 100 100 100 94</td>
<td>399</td>
</tr>
<tr>
<td>2%Cr-1Mo</td>
<td>A1</td>
<td>Fitting</td>
<td>SA-234</td>
<td>WP22W</td>
<td>1 205/415 (10)(12)</td>
<td>B 100 100 100 100 100 100 94</td>
<td>427</td>
</tr>
<tr>
<td>2%Cr-1Mo</td>
<td>A1</td>
<td>Smls. tube</td>
<td>SA-213</td>
<td>T22</td>
<td>205/415 (10)</td>
<td>B 100 100 100 100 100 100 94</td>
<td>454</td>
</tr>
<tr>
<td>2%Cr-1Mo</td>
<td>A1</td>
<td>Wld. pipe</td>
<td>SA-691</td>
<td>2%Cr</td>
<td>205/415 (10)</td>
<td>B 100 100 100 100 100 100 94</td>
<td>482</td>
</tr>
<tr>
<td>2%Cr-1Mo</td>
<td>A1</td>
<td>Smls. pipe</td>
<td>SA-335</td>
<td>P22</td>
<td>205/415 (10)</td>
<td>B 100 100 100 100 100 100 94</td>
<td>510</td>
</tr>
<tr>
<td>2%Cr-1Mo</td>
<td>A1</td>
<td>Forging</td>
<td>SA-336</td>
<td>F22</td>
<td>205/415 (10)</td>
<td>B 100 100 100 100 100 100 94</td>
<td>538</td>
</tr>
<tr>
<td>2%Cr-1Mo</td>
<td>A1</td>
<td>Fitting</td>
<td>SA-369</td>
<td>FP22</td>
<td>205/415 (10)</td>
<td>B 100 100 100 100 100 100 94</td>
<td>566</td>
</tr>
<tr>
<td>2%Cr-1Mo</td>
<td>A1</td>
<td>Plate</td>
<td>SA-387</td>
<td>22</td>
<td>205/415 (10)</td>
<td>B 100 100 100 100 100 100 94</td>
<td>593</td>
</tr>
<tr>
<td>2%Cr-1Mo</td>
<td>A1</td>
<td>Casting</td>
<td>SA-217</td>
<td>WC9</td>
<td>275/485 (2)(3)(10)</td>
<td>B 114 111 108 103 98 91 83</td>
<td>621</td>
</tr>
<tr>
<td>2%Cr-1Mo</td>
<td>A1</td>
<td>Fitting</td>
<td>SA-182</td>
<td>F22</td>
<td>3 310/515 (10)</td>
<td>B 121 119 117 113 109 103</td>
<td>649</td>
</tr>
<tr>
<td>2%Cr-1Mo</td>
<td>A1</td>
<td>Fitting</td>
<td>SA-336</td>
<td>F22</td>
<td>3 310/515 (10)</td>
<td>B 121 119 117 113 109 103</td>
<td></td>
</tr>
<tr>
<td>2%Cr-1Mo</td>
<td>A1</td>
<td>Plate</td>
<td>SA-387</td>
<td>22</td>
<td>3 310/515 (10)</td>
<td>B 121 119 117 113 109 103</td>
<td></td>
</tr>
<tr>
<td>2%Cr-1Mo</td>
<td>A1</td>
<td>Forging</td>
<td>SA-336</td>
<td>F22</td>
<td>3 310/515 (10)</td>
<td>B 121 119 117 113 109 103</td>
<td></td>
</tr>
<tr>
<td>2%Cr-1Mo</td>
<td>A1</td>
<td>Plate</td>
<td>SA-387</td>
<td>22</td>
<td>3 310/515 (10)</td>
<td>B 121 119 117 113 109 103</td>
<td></td>
</tr>
<tr>
<td>2%Cr-1Mo</td>
<td>A1</td>
<td>Forging</td>
<td>SA-182</td>
<td>F22</td>
<td>3 310/515 (10)</td>
<td>B 121 119 117 113 109 103</td>
<td></td>
</tr>
<tr>
<td>9Cr-1Mo</td>
<td>B1</td>
<td>Smls. tube</td>
<td>SA-213</td>
<td>T9</td>
<td>205/415</td>
<td>B 94 88 85 83 79 75 69</td>
<td></td>
</tr>
<tr>
<td>9Cr-1Mo</td>
<td>B1</td>
<td>Smls. pipe</td>
<td>SA-335</td>
<td>P9</td>
<td>205/415</td>
<td>B 94 88 85 83 79 75 69</td>
<td></td>
</tr>
<tr>
<td>9Cr-1Mo</td>
<td>B1</td>
<td>Forging pipe</td>
<td>SA-369</td>
<td>FP9</td>
<td>205/415</td>
<td>B 94 88 85 83 79 75 69</td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:**

1. The following are the abbreviations used for Product Form:
   - (a) Wld. — Welded
   - (b) Smls. — Seamless
   - (c) Forg. — Forged

2. Statically and centrifugally cast products meeting the requirements of Division 1, NC-2571(a) and NC-2571(b), and cast pipe fittings, pumps, and valves with inlet piping connections of NPS 2 (DN 50) and less shall receive a casting quality factor of 1.00. Other casting quality factors shall be in accordance with the following:

   **Method of Examination**
   - (a) Visual 0.80
   - (b) Magnetic Particle 0.85
   - (c) Liquid Penetrant 0.85
   - (d) Radiography 1.00
   - (e) Ultrasonic 0.80
   - (f) Magnetic Particle or Liquid Penetrant 1.00
     — plus —
     Ultrasonic or Radiography

3. Normalized and Tempered, only.


---

**Replace with "NCD-2571.1(a)"**

**Replace with "NCD-2571.1(b)"**
Table HCB-II-2000-3  
Allowable Stress Values for Austenitic Steel Class B Components (Cont'd)

<table>
<thead>
<tr>
<th>Nominal Composition</th>
<th>P-No.</th>
<th>Group No.</th>
<th>Product Form (Note 1)</th>
<th>Spec. No.</th>
<th>Grade or Type</th>
<th>Specified Minimum Strengths, $S_0/S_{Sy}$</th>
<th>Applicable Line in Figure HCB-III-1000-1</th>
<th>SI Units</th>
</tr>
</thead>
</table>
| 18Cr-10Ni-Ti        | 8     | 1         | Smls. tube           | SA-213   | TP321H        | ...                                           | 205/515 (5)            | E        | 107  105  105  104  103  103  101  96  87  
| 18Cr-10Ni-Ti        | 8     | 1         | Plate                | SA-240   | 321H         | ...                                           | 205/515 (5)            | E        | 107  105  105  104  103  103  101  96  87  
| 18Cr-10Ni-Ti        | 8     | 1         | Wild. pipe           | SA-312   | TP321H        | ...                                           | 205/515 (3)(5)          | E        | 107  105  105  104  103  103  101  96  87  
| 18Cr-10Ni-Ti        | 8     | 1         | Smls. pipe           | SA-312   | TP321H        | ...                                           | 205/515 (5)            | E        | 107  105  105  104  103  103  101  96  87  
| 18Cr-10Ni-Ti        | 8     | 1         | Plate                | SA-376   | 321H         | ...                                           | 205/515 (5)            | E        | 107  105  105  104  103  103  101  96  87  
| 18Cr-10Ni-Ti        | 8     | 1         | Fitting              | SA-403   | WP321H        | ...                                           | 205/515 (3)            | E        | 107  105  105  104  103  103  101  96  87  
| 18Cr-10Ni-Ti        | 8     | 1         | Bar                  | SA-479   | 321H         | ...                                           | 205/515                | E        | 107  105  105  104  103  103  101  96  87  

NOTES:

(1) The following are the abbreviations used for Product Form:
   (a) Wld. — Welded
   (b) Smls. — Seamless
   (c) Forg. — Forged

(2) At temperatures above 100°F (40°C), the allowable stress values may exceed 62 1/2% and may also reach 90% yield strength (0.2% offset) at temperature. This may result in a permanent strain of as much as 0.1%. When this amount of deformation is not acceptable, the designer shall reduce the design stress to obtain an acceptable deformation. Section II, Part D, Subpart 1, Table Y-2 lists multiplying factors that, when applied to the yield strength values shown in Section II, Part D, Subpart 1, Tables Y-1 and Y-2 will give an allowable stress that will result in lower levels of 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) These $S$ values do not include a weld efficiency factor. For materials welded without filler metal, ultrasonic examination in accordance with Division 1, NC-2550 or eddy current examination in accordance with Division 1, NC-2550 or eddy current examination in accordance with Division 1, NC-2550 shall provide a longitudinal weld efficiency factor of 1.00. Materials (welded with filler metal) meeting the requirements of Division 1, NC-2560 shall receive a weld efficiency factor of 1.00. Other weld efficiency factors shall be in accordance with the following:

<table>
<thead>
<tr>
<th>Type of Joint</th>
<th>Efficiency Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Butt Weld</td>
<td>0.80</td>
</tr>
<tr>
<td>But, without Filler Material</td>
<td>0.85</td>
</tr>
<tr>
<td>Double Butt Weld</td>
<td>0.90</td>
</tr>
<tr>
<td>Single or Double Butt Weld with Radiography</td>
<td>1.00</td>
</tr>
</tbody>
</table>

(4) For Class B, these $S$ values do not include a casting quality factor. Statically and centrifugally cast products meeting the requirements of Division 1, NC-2570 shall receive a casting quality factor of 1.00. Statically and centrifugally cast products meeting the requirements of Division 1, NC-2571(a) and NC-2571(b) and cast pipe, fittings, pumps, and valves with inlet piping connections of NPS 2 (DN 50) and less, shall receive a casting quality factor of 1.00. Other casting quality factors shall be in accordance with the following:

<table>
<thead>
<tr>
<th>Method of Examination</th>
<th>Quality Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Visual</td>
<td>0.80</td>
</tr>
<tr>
<td>(b) Magnetic Particle</td>
<td>0.85</td>
</tr>
<tr>
<td>(c) Liquid Penetrant</td>
<td>0.85</td>
</tr>
<tr>
<td>(d) Radiography</td>
<td>1.00</td>
</tr>
<tr>
<td>(e) Ultrasonic</td>
<td>1.00</td>
</tr>
<tr>
<td>(f) Magnetic Particle or Liquid Penetrant</td>
<td>1.00</td>
</tr>
</tbody>
</table>

(5) For external pressure chart references, see Section II, Part D, Subpart 3 or Division 1, Fig. NC-3133.8-1 as applicable.
### Table HCB-II-3000-1
Allowable Stress Values for Ferritic Steel Class B Components (Cont’d)

<table>
<thead>
<tr>
<th>Nominal Composition</th>
<th>Group No.</th>
<th>Product Form</th>
<th>Spec. No.</th>
<th>Grade or Type Class</th>
<th>Specified Minimum Strengths, (S_y/S_u), ksi (MPa)</th>
<th>Notes</th>
<th>Allowable Stress Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>(C-\frac{1}{2}Mo)</td>
<td>3 1</td>
<td>Forg. pipe</td>
<td>SA-369</td>
<td>FP1</td>
<td>30/55 (205/380)</td>
<td>(9)</td>
<td></td>
</tr>
<tr>
<td>(C-\frac{1}{2}Mo)</td>
<td>3 1</td>
<td>Casting</td>
<td>SA-217</td>
<td>WC1</td>
<td>36/65 (240/450)</td>
<td>(2)(3)(9)</td>
<td></td>
</tr>
<tr>
<td>(C-\frac{1}{2}Mo)</td>
<td>3 2</td>
<td>Plate</td>
<td>SA-204</td>
<td>A</td>
<td>37/65 (255/450)</td>
<td>(9)</td>
<td></td>
</tr>
<tr>
<td>(C-\frac{1}{2}Mo)</td>
<td>3 2</td>
<td>Forg.</td>
<td>SA-182</td>
<td>F1</td>
<td>40/70 (275/485)</td>
<td>(9)</td>
<td></td>
</tr>
<tr>
<td>(C-\frac{1}{2}Mo)</td>
<td>3 2</td>
<td>Plate</td>
<td>SA-204</td>
<td>B</td>
<td>40/70 (275/485)</td>
<td>(9)</td>
<td></td>
</tr>
<tr>
<td>(C-\frac{1}{2}Mo)</td>
<td>3 2</td>
<td>Plate</td>
<td>SA-204</td>
<td>C</td>
<td>43/75 (295/515)</td>
<td>(9)</td>
<td></td>
</tr>
</tbody>
</table>

**Mn–\frac{1}{2}Mo**

| \(3\frac{1}{2}Ni-\frac{1}{2}Mo-\frac{1}{2}Cr-V\) | 3 3   | Forging     | SA-508    | 2 1 | 50/80 (345/550) |                        |            |
| \(3\frac{1}{2}Ni-\frac{1}{2}Mo-\frac{1}{2}Cr-V\) | 3 3   | Plate       | SA-533    | C   | 50/80 (345/550) |                        |            |

**1Cr–\frac{1}{2}Mo**

| 1Cr–\frac{1}{2}Mo | 4 1   | Plate       | SA-387    | 12 1 | 33/55 (230/380) |                        |            |

**1Cr–\frac{1}{2}Mo**

| 1Cr–\frac{1}{2}Mo | 4 1   | Smls. tube  | SA-213    | T12  | 32/60 (220/415) |                        |            |
| 1Cr–\frac{1}{2}Mo | 4 1   | Smls. pipe  | SA-335    | P12  | 32/60 (220/415) |                        |            |
| 1Cr–\frac{1}{2}Mo | 4 1   | Forg. pipe  | SA-369    | FP12 | 32/60 (220/415) |                        |            |

**9Cr–\frac{1}{1}Mo**

| 9Cr–\frac{1}{1}Mo | 5A 1  | Fitting     | SA-234    | WP22W | 30/60 (205/415) |                        |            |

**21/4Cr–1Mo**

| 21/4Cr–1Mo | 5A 1  | Smls. tube  | SA-213    | T22  | 30/60 (205/415) |                        |            |

**9Cr–1Mo**

| 9Cr–1Mo | 5B 1  | Smls. pipe  | SA-335    | P9   | 30/60 (205/415) |                        |            |

**9Cr–1Mo**

| 9Cr–1Mo | 5B 1  | Forg. pipe  | SA-369    | FP9  | 30/60 (205/415) |                        |            |

**NOTES:**

(1) The following are the abbreviations used for Product Form:

(a) Wld. — Welded
(b) Smls. — Seamless
(c) Forg. — Forged

(2) Statically and centrifugally cast products meeting the requirements of Division 1, NC-2571(a) and NC-2571(b), and cast pipe fittings, pumps, and valves with inlet piping connections of NPS 2 (DN 50) and less, shall receive a casting quality factor of 1.00. Other casting quality factors shall be in accordance with the following:

<table>
<thead>
<tr>
<th>Method of Examination</th>
<th>Quality Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual</td>
<td>0.80</td>
</tr>
<tr>
<td>Magnetic particle</td>
<td>0.85</td>
</tr>
</tbody>
</table>

Replace with "NCD-2571.1(a)"
Replace with "NCD-2571.1(b)"
<table>
<thead>
<tr>
<th>Nominal Composition</th>
<th>P-No.</th>
<th>Group No.</th>
<th>Product Form [Note (1)]</th>
<th>Spec. No.</th>
<th>Grade or Type</th>
<th>Class</th>
<th>Specified Strengths, $S_y/S_u$, ksi (MPa)</th>
<th>Notes</th>
<th>Allowable Stress Values [Note (2)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>16Cr–12Ni–2Mo–N</td>
<td>8</td>
<td>1</td>
<td>Smls. tube</td>
<td>SA-213</td>
<td>TP316N</td>
<td>...</td>
<td>30/75 (205/515)</td>
<td>(3)(7)(8)(12)</td>
<td>See Section II, Part D, Subpart 1, Table 1A, but disregard the Notes.</td>
</tr>
<tr>
<td>16Cr–12Ni–2Mo–N</td>
<td>8</td>
<td>1</td>
<td>Plate</td>
<td>SA-240</td>
<td>316N</td>
<td>...</td>
<td>30/75 (205/515)</td>
<td>(3)(7)</td>
<td></td>
</tr>
<tr>
<td>16Cr–12Ni–2Mo–N</td>
<td>8</td>
<td>1</td>
<td>Weld. pipe</td>
<td>SA-312</td>
<td>TP316N</td>
<td>...</td>
<td>30/75 (205/515)</td>
<td>(7)(11)</td>
<td></td>
</tr>
<tr>
<td>16Cr–12Ni–2Mo–N</td>
<td>8</td>
<td>1</td>
<td>Smls. pipe</td>
<td>SA-312</td>
<td>TP316N</td>
<td>...</td>
<td>30/75 (205/515)</td>
<td>(7)</td>
<td></td>
</tr>
<tr>
<td>16Cr–12Ni–2Mo–N</td>
<td>8</td>
<td>1</td>
<td>Smls. pipe</td>
<td>SA-376</td>
<td>TP316N</td>
<td>...</td>
<td>30/75 (205/515)</td>
<td>(7)</td>
<td></td>
</tr>
<tr>
<td>18Cr–10Ni–Ti</td>
<td>8</td>
<td>1</td>
<td>Forging</td>
<td>SA-182</td>
<td>F321</td>
<td>...</td>
<td>30/70 (205/485)</td>
<td>(7)(9)</td>
<td></td>
</tr>
<tr>
<td>18Cr–10Ni–Ti</td>
<td>8</td>
<td>1</td>
<td>Forging</td>
<td>SA-965</td>
<td>F321</td>
<td>...</td>
<td>30/70 (205/485)</td>
<td>(7)(8)</td>
<td></td>
</tr>
<tr>
<td>18Cr–10Ni–Ti</td>
<td>8</td>
<td>1</td>
<td>Forging</td>
<td>SA-182</td>
<td>F321</td>
<td>...</td>
<td>30/75 (205/515)</td>
<td>(7)(9)</td>
<td></td>
</tr>
<tr>
<td>18Cr–10Ni–Ti</td>
<td>8</td>
<td>1</td>
<td>Smls. tube</td>
<td>SA-213</td>
<td>TP321</td>
<td>...</td>
<td>30/75 (205/515)</td>
<td>(5)(7)</td>
<td></td>
</tr>
<tr>
<td>18Cr–10Ni–Ti</td>
<td>8</td>
<td>1</td>
<td>Plate</td>
<td>SA-240</td>
<td>321</td>
<td>...</td>
<td>30/75 (205/515)</td>
<td>(5)(7)(8)</td>
<td></td>
</tr>
<tr>
<td>18Cr–10Ni–Ti</td>
<td>8</td>
<td>1</td>
<td>Weld. pipe</td>
<td>SA-312</td>
<td>TP321</td>
<td>...</td>
<td>30/75 (205/515)</td>
<td>(5)(7)(8)(11)</td>
<td></td>
</tr>
<tr>
<td>18Cr–10Ni–Ti</td>
<td>8</td>
<td>1</td>
<td>Smls. pipe</td>
<td>SA-376</td>
<td>TP321</td>
<td>...</td>
<td>30/75 (205/515)</td>
<td>(5)(7)</td>
<td></td>
</tr>
<tr>
<td>18Cr–10Ni–Ti</td>
<td>8</td>
<td>1</td>
<td>Fitting</td>
<td>SA-403</td>
<td>WP321</td>
<td>...</td>
<td>30/75 (205/515)</td>
<td>(7)(12)</td>
<td></td>
</tr>
<tr>
<td>18Cr–10Ni–Ti</td>
<td>8</td>
<td>1</td>
<td>Bar</td>
<td>SA-479</td>
<td>321</td>
<td>...</td>
<td>30/75 (205/515)</td>
<td>(7)(8)</td>
<td></td>
</tr>
<tr>
<td>18Cr–10Ni–Ti</td>
<td>8</td>
<td>1</td>
<td>Forging</td>
<td>SA-182</td>
<td>F321H</td>
<td>...</td>
<td>30/70 (205/485)</td>
<td>(9)</td>
<td></td>
</tr>
<tr>
<td>18Cr–10Ni–Ti</td>
<td>8</td>
<td>1</td>
<td>Forging</td>
<td>SA-182</td>
<td>F321H</td>
<td>...</td>
<td>30/75 (205/515)</td>
<td>(9)</td>
<td></td>
</tr>
<tr>
<td>18Cr–10Ni–Ti</td>
<td>8</td>
<td>1</td>
<td>Weld. pipe</td>
<td>SA-213</td>
<td>TP321H</td>
<td>...</td>
<td>30/75 (205/515)</td>
<td>(5)(11)</td>
<td></td>
</tr>
<tr>
<td>18Cr–10Ni–Ti</td>
<td>8</td>
<td>1</td>
<td>Plate</td>
<td>SA-240</td>
<td>321H</td>
<td>...</td>
<td>30/75 (205/515)</td>
<td>(5)</td>
<td></td>
</tr>
<tr>
<td>18Cr–10Ni–Ti</td>
<td>8</td>
<td>1</td>
<td>Weld. pipe</td>
<td>SA-312</td>
<td>TP321H</td>
<td>...</td>
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<td>(5)(11)</td>
<td></td>
</tr>
<tr>
<td>18Cr–10Ni–Ti</td>
<td>8</td>
<td>1</td>
<td>Smls. pipe</td>
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<td>30/75 (205/515)</td>
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<td>18Cr–10Ni–Ti</td>
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<td>SA-376</td>
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<td>...</td>
<td>30/75 (205/515)</td>
<td>(5)</td>
<td></td>
</tr>
<tr>
<td>18Cr–10Ni–Ti</td>
<td>8</td>
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<td>Fitting</td>
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<td>...</td>
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<td>8</td>
<td>1</td>
<td>Bar</td>
<td>SA-479</td>
<td>321H</td>
<td>...</td>
<td>30/75 (205/515)</td>
<td>(3)(12)</td>
<td></td>
</tr>
</tbody>
</table>

NOTES:
(1) The following are the abbreviations used for Product Form:
(a) Wld. — Welded
(b) Smls. — Seamless
(2) At temperatures above 100°F (40°C), the allowable stress values may exceed 62 1/2% and may also reach 90% yield strength (0.2% offset) at temperature. This may result in permanent deformation. When this deformation is not acceptable, the designer shall reduce the design stress to obtain an acceptable deformation. Section II, Part D, Subpart 1, Table Y-2 lists multiplying factors that, when applied to the yield strength values shown in Section II, Part D, Subpart 1, Table Y-1 will give an allowable stress that will result in lower levels of 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) These $S_y$ values do not include a weld efficiency factor. For materials welded without filler metal, ultrasonic examination or eddy current examination in accordance with Division 1, NC-2550 shall provide a longitudinal weld efficiency factor of 1.00. Materials (welded with filler metal) meeting the requirements of Division 1, NC-2560 shall receive a weld efficiency factor of 1.00. Other weld efficiency factors shall be in accordance with the following:

<table>
<thead>
<tr>
<th>Type of joint</th>
<th>Efficiency Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single butt weld</td>
<td>0.80</td>
</tr>
<tr>
<td>Butt, without filler material</td>
<td>0.85</td>
</tr>
<tr>
<td>Double butt weld</td>
<td>0.90</td>
</tr>
<tr>
<td>Single or double butt weld with radiography</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Editor: Replace "NC" highlighted with "NCD".

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NOTES (CONT’D):

(4) For Class B, these $S$ values do not include a casting quality factor. Statically and centrifugally cast products meeting the requirements of Division 1, NC-2570 shall receive a casting quality factor of 1.00. Statically and centrifugally cast products meeting the requirements of Division 1, NC-2571(a) and NC-2571(b) and cast pipe, fittings, pumps, and valves with inlet piping connections of NPS 2 (DN 50) and less shall receive a casting quality factor of 1.00. Other casting quality factors shall be in accordance with the following:

<table>
<thead>
<tr>
<th>Method of Examination</th>
<th>Quality Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Visual</td>
<td>0.80</td>
</tr>
<tr>
<td>(b) Magnetic particle</td>
<td>0.85</td>
</tr>
<tr>
<td>(c) Liquid penetrant</td>
<td>0.85</td>
</tr>
<tr>
<td>Radiography</td>
<td>1.00</td>
</tr>
<tr>
<td>Ultrasonic or Radiography</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Replace with "NCD-2571.1(a)"

(5) For external pressure chart references, see Section II, Part D, Subpart 3 or Division 1, Fig. NC-3133.8-1 as applicable.

(6) Note no longer used.

(7) At temperatures above 1,000°F (538°C), these stress values apply only when the carbon content is 0.04% or higher.

(8) For temperatures above 1,000°F (538°C), these stress values apply only if the material has been heat treated by heating it to a minimum temperature of 1,900°F (1,040°C) and quenching in water or rapidly cooling by other means.

(9) 5 in. (125 mm) and under.

(10) At temperatures above 800°F (425°C) these stress values apply only when the carbon content is 0.04% or higher.

(11) Stress values for Section VIII, Division 1 already apply the weld factors required by Note (3).

(12) When stress values are not listed under this SA specification in Section II, Part D, then the values for other specifications in the material grouping (i.e., same alloy, same tensile property requirements at room temperature) may be used.
Editor: For Information

The following part of the proposal is for changes to Section III, Nonmandatory Appendix KK
KK-1122  Division 5 Classification

Section III does not establish nuclear safety classification. Section III does develop design and construction rules for various component classes. Division 5 offers Class A, Class B, Class SM, and Class SN rules. Class A and Class B rules are analogous to Class 1 and Class 2 rules while Class SM is analogous to Class CS in Division 1. Division 5 also offers Class SN rules that address the nonmetallic core component rules that exist in Subsection HH, Subpart A (for graphite) and Subpart B (for composite materials).

KK-1200  DESIGN SPECIFICATION FORMAT

KK-1210  GENERAL

Design Specifications should be as uniform throughout the nuclear industry as is reasonably attainable. The format of this Appendix is presented as a guide to uniformity and is divided into major categories as follows:

KK-1211  Metallic Components

(a) Generic Requirements applicable to all metallic components (Article KK-2000).
(b) Specific Requirements applicable to each major component type (Articles KK-3000 through KK-9000, inclusive).
(c) Included in both the Generic and Specific Requirements are those considerations outside the scope of Division 5 (functionality and regulatory requirements) that have an effect on construction but are not required by Division 5 to be a part of the Design Specification.

KK-1212  Nonmetallic Core Components

Article KK-10000 addresses the unique needs for the Design Specification(s) developed for nonmetallic core components.

KK-1220  NOMENCLATURE, DEFINITIONS, AND SYMBOLS

Nomenclature, definitions, and symbols should be in agreement with those established in the applicable Article. Should a conflict exist between Articles, the Design Specification should be clear as to what is intended in each case.

KK-1300  SCOPE OF DESIGN SPECIFICATION

The Design Specification should contain in sufficient detail the information that Division 5 requires to be provided. Functionality and regulatory requirements that are beyond the jurisdiction of Division 5 are not covered by the Code-required certification of the Design Specification. Subsection HA (including the referenced portions of Division 1, Subsection NCA) and the appropriate construction Subsections of Division 5 establish the remaining Design Specification scope.

Editor, insert subparagraph:
"(d) References to Division 1, Subsection NCD apply to the applicable Class 2 rules in NCD."
KK-2122 Design Loadings and Service Loadings

KK-2122.1 Design Loadings. Division 5 addresses three types of Design Loadings for metallic components.

(a) Design Pressure. NCA-2142.1(a) and NB/NC/NF/NG-3112.1 or HBB/HGB-3113.1 provide the required definitions for Design Pressure. For core support structures, Design Pressure Difference is defined in NG-3112.1 or HGB-3113.1.

(b) Design Temperature. NCA-2142.1(b) and NB/NC/NF/NG-3112 or HBB/HGB-3113.1 provide the requirements for Design Temperature. The Design Temperature should be used in computations involving the Design Pressure or Design Pressure Difference (when appropriate) and coincidental Design Mechanical Loads. The actual metal temperature at the point under consideration should be used in all computations where the use of the actual service pressure is required. Where a component is heated by tracing, induction coils, jacketing, or by internal heat generation, the effect of such heating should be incorporated in the establishment of the Design Temperature.

(c) Design Mechanical Loads. The specified Design Mechanical Loads [NCA-2142.1(c) and NB/NC/NF/NG-3112 or HBB/HGB-3113.1] should be selected so that when combined with the effects of Design Pressure or Design Pressure Difference (when appropriate), they represent the most severe coincident loadings for which the Level A Service Limits on primary stress are applicable.

The determination of most severe coincident loadings may result in specification of pairs of design conditions since the one most severe combination may not be readily predicted. The specification may specify the maximum Design Mechanical Load for any situation which, when taken with the Design Pressure or Design Pressure Difference (when appropriate), would result in the worst combination of design conditions even though they may not be coincident.

The Design Mechanical Loads that are considered are somewhat dependent on the component, its location, its attachment to other components, and for a Class B component, whether Service Loadings are to be specified [refer to KK-2112.3 and NCA-2142(a)].

KK-2122.2 Service Loadings. When the Design Specification or applicable Subsection of Division 5 requires computations to demonstrate compliance with specified Service Limits, the Design Specification should provide information from which Service Loadings may be identified (pressure, temperature, mechanical loads, cycles, or transients).
KK-2123 Design and Service Limits

KK-2123.1 Design Limits. The limits for Design Loadings should meet the requirements of the appropriate Subsection of Division 5. These are specified under Article 3000 of the appropriate Subsection [NCA-2142.4(a)].

KK-2123.2 Service Limits. In order to properly specify Service Limits for the various types of loadings, the Owner or Owner’s designee should recognize the basis for the establishment of those Limits. The Design Specification should designate the appropriate Service Limit [NCA-2142.4(b)] to be associated with each Service Loading or combination of Service Loadings.

(a) Level A and B Service Limits. For Class A components and for Class B low temperature service vessels designed to NC-3200 requirements, Level A and B Service Limits are provided in order to evaluate the effects of system operating loads (normal (Level A) and upset (Level B)) on the fatigue life of the component. For a fatigue analysis, the loads applicable to the component being considered should be described in terms of quantities that the designer may use [Mandatory Appendix XIII, XIII-3520]. The variation with respect to time of pressure, temperature, flow rate, etc., as well as the number of times these changes occur in the life of the component, is needed. In this regard, a service cycle is defined in Mandatory Appendix XIII, XIII-1300(ac) as: "...the initiation and establishment of new conditions followed by a return to the conditions that prevailed at the beginning of the cycle." Thus, as an example, the conditions associated with plant startup do not constitute a service cycle. Startup and shutdown together constitute a service cycle, and if there are \( n_s \) startups in the Design Specification, there should be the same number of shutdowns.

Figure KK-2123.2-1 is an illustration of the time-dependent load information that the designer needs. (Note that it provides only the startup portion of a service cycle.) Refer to KK-6124 for the Class B piping requirements.

For all other Class B components and supports, including piping supports, it is not necessary to define each service cycle in detail since no fatigue analysis is required. It is important for the designer to know the maximum loading condition on the component for these Service Limits.

Level B Service Limits are also provided in order to evaluate the effect of plant upset operating loads on the structural integrity of a component for events that are still expected to occur a sufficient number of times to potentially affect both the fatigue life and the structural integrity of the component via high primary stresses. Occurrence of stresses associated with Level B Limits are established such that the component may be assured of performing as expected through the event as well as afterwards. The Owner should review the selection of this Limit for compatibility with established system safety criteria.

(b) Level C Service Limits. Level C Service Limits are provided in order to evaluate the effect of plant emergency operating loads on the structural integrity of a component for situations that are not anticipated to occur for a sufficient number of times to affect fatigue life and for structural discontinuities. Since the occurrence of plant faulted operating loads, the Design Specification should designate the appropriate Service Limit in accordance with NCA-2142.4(d)(2) and the appropriate Subsection.

KK-2124 Test Loadings and Test Limits

Loads due to tests beyond those allowed by Division 5 [NCA-2142.3(b)] should be classified in the appropriate Service Limit in accordance with NCA-2142.4(d)(2) and the appropriate Subsection.

KK-2125 Load Combinations

In order to provide a complete definition of service loads, the combination of specific events should be considered. Since these combinations are a function of specific systems that make up a part of a specific type of nuclear facility, Division 5 does not directly address this other than to provide different stress limits for various loadings. Specific guidance is provided in the approved Safety Analysis Report (SAR) or other similar documentation for the plant.

KK-2126 Deformation Limits

The Code does not provide specific deformation limits other than those that would be associated with a given allowable stress. If control of deformation is a requirement, the deformation limits should be provided.

KK-2130 MATERIALS

KK-2131 General Requirements

The Design Specification should provide information relative to materials as listed in (a) through (j).

(a) any hydrostatic testing or service temperature limits
(b) any reductions to design stress intensity values, allowable stress, or fatigue curves necessitated by environmental conditions

(c) any restrictions on cladding materials

(d) materials that are acceptable from the standpoint of environment and location

(e) any restrictions on heat treating

(f) any requirements with respect to cleanliness

(g) impact test requirements (KK-2132)

(h) any corrosion or erosion allowances

(i) postweld heat treatment times applied to the material or item after it is completed should be specified (NB/NC/NF/NG-4622)

(j) for Class A elevated temperature service use, only those material listed in Subsection HB, Subpart B are permitted

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**Editor:** Replace "NC" highlighted by "NCD".

**KK-2132 Impact Tests**

For those cases where Design Specification requires testing of the pressure-retaining component or the support structure, the test temperature should be specified and the test results shall become part of the appropriate documentation.

**KK-2133 Fracture Mechanics Data**

When the methods of Nonmandatory Appendix G are to be used to provide protection against nonductile fracture for ferritic materials that have specified minimum yield strengths at room temperature greater than 50 ksi (345 MPa) but not exceeding 90 ksi (620 MPa), the Design Specification should include additional fracture mechanics data for base metal, weld metal, and heat-affected
In accordance with Paragraph 2111(b), materials of higher yield strengths are to be used in conditions where radiation may affect the material properties, the effect of radiation on the $K_{lc}$ curves should be determined for the material prior to its use in construction.

**KK-2140 FABRICATION**

The Design Specification should specify any unusual restrictions on fabrication processes or techniques that would be deleterious to the suitability of the component in the expected service environment.

**KK-2150 TESTING**

**KK-2151 Pneumatic Test**

The Design Specification should specify if a pneumatic test should be used in lieu of hydrostatic testing for those components and appurtenances required to be pressure tested in accordance with the rules of Division 5 (NB/NC-6111 and NB/NC-6112 or HBB/HCB-6100).

**KK-2152 Restriction on Testing**

Any restrictions on the use of the test fluid should be provided (NB/NC-6112 or HBB/HCB-6100). When selecting a fluid for the test, it should be determined that the test fluid does not have deleterious effects and that the test fluid may be safely used at the pressure and temperature specified for the test.

**KK-2153 Bellows-Type Expansion Joints**

Any requirements that supplement hydrostatic or pneumatic testing of bellows-type expansion joints should be included.

**KK-2154 Leak Tightness**

Leak tightness requirements for areas, such as permanent seals, seats, and gasketed joints for pressure-retaining components or appurtenances, should be included (NB/NC-6224 or HBB-6215/HCB-6100).

**KK-2155 Additional Testing**

If testing in addition to pressure testing is required, the loads due to such testing should be classified in accordance with NCA-2142.3(b) and the appropriate Subsection.

**KK-2160 OVERPRESSURE PROTECTION**

**KK-2161 General Requirements**

**KK-2161.1 Scope.** For steady state or transient conditions of pressure and coincident temperature that are in excess of Design or Service Loadings and their combinations and associated limits specified in the Design Specifications, system overpressure protection is required for vessels, piping, pumps, and valves in service and subjected to the consequences of the application of these conditions (refer to NB/NC/HBB/HCB-7110).

**KK-2161.2 Integrated Overpressure Protection.** It should be recognized that the overpressure protection of pressure-retaining components in a system require consideration of the pressure transients that may be imposed on the systems during all service loadings and testing conditions described in the component Design Specifications (refer to NB/NC-7120).

**KK-2162 Design Secondary Pressure**

The design secondary pressure should be specified in the Design Specification [refer to NB/NC-7111(d)].

**KK-2163 Maximum Anticipated Pressure and Temperature**

The Design Specification should specify the maximum anticipated pressure and coincident temperature among any systems components under the operating conditions of the system as a consequence of any transients occurring either within the system or in associated systems that may affect the system for which overpressure protection is intended (refer to NB/NC/HBB-7300). Service conditions such as at startup and shutdown may require protection against nonductile failure [NB-3210(d), NG-3211(d), HBB-3241, or HGB-3211(d)] at pressures lower than the component design pressure.

**KK-2164 Pressure Relief Valve Operating Requirements**

**KK-2164.1 Blowdown Requirements.** The Design Specification may specify blowdown requirements with a greater tolerance than the values stated in NB/NC-7500.

**KK-2164.2 Set Point Tolerance.** The Design Specification may specify a set point tolerance greater than the value stated in NB/NC-7500.

**KK-2165 Pressure Relief Valve Operating Characteristics (Refer to ANSI N278.1)**

As applicable, the following pressure relief valve operating characteristics should be specified in the Design Specification when overpressure protection is dependent upon these factors:

(a) set pressure
(b) set pressure range
(c) set pressure tolerance
(d) discharge capacity with due allowance for the effect of the back pressure on the capacity
(e) accumulation
(f) blowdown
(g) static and dynamic back pressure, minimum and maximum
(h) response time (maximum time delay between attainment of set pressure or reception of the energizing signal by the solenoid and valve lift)
KK-2166  **Rupture Disk Devices**

Rupture disk device burst pressure tolerance and manufacturing design range should be specified in the Design Specification.

KK-2220  **ACTIVE PUMPS OR VALVES**

The Design Specification should indicate if the specified pump or valve should perform a mechanical motion during the course of accomplishing a system safety function during or following the specified plant event. Such a pump or valve is designated as an active component.

KK-2300  **REGULATORY REQUIREMENTS**

In the process of preparing a Design Specification, it is important to refer to and rely on the requirements contained in SAR (or other similar) documents since they provide the basis for complying with existing regulatory requirements. Conflicts between a Design Specification and these documents could lead to construction of items not in compliance with the license requirements. For example, in the United States, a reference list of regulatory documents is available at http://www.nrc.gov/.

KK-2400  **ADDITIONAL ELEVATED TEMPERATURE REQUIREMENTS**

For Division 1 metallic components, the requirements associated with developing a Design Specification are found in Subsection NCA and the applicable Division 1 Subsections. For Division 5, the same is true but there are many additional requirements necessary to be considered when developing a Design 5 Specification.

The Division 5 General Requirements found in Subsection HA, Subpart A should be reviewed for Design Specification insights as well as the General Requirements in Subsection NCA since Subsection HA, Subpart A references most of the requirements in Subsection NCA. This is a reasonable approach since the goal is the same — to construct a nuclear reactor facility, although under the Division 5 scope, the reactor is a high temperature reactor. Therefore, Subsection HA, Subpart A provides those insights needed to adjust to a high temperature reactor design.

In addition, the applicable construction subsections in Division 5 also need to be considered, for both low temperature service and for elevated temperature service. Hence, the developer of a Design Specification needs to be aware of the applicable Division 1 Subsection requirements found in Subsections NB/NC/NF/NG since the Division 5 Subsections (Subsection HB, Subpart A, Subsection HC, Subpart A, Subsection HF, Subpart A, and Subsection HG, Subpart A) reference Subsections NB/NC/NF/NG, respectively, for low temperature service construction rules, with some exceptions/enhancements as stated in those Subpart A rules. Elevated temperature service construction rules are found in Division 5, Subsection HB, Subpart B; Subsection HC, Subpart B; and Subsection HG, Subpart B for Class A, Class B, and Class SM metallic components, respectively.

Since the Design Specification requirements for elevated temperature service have been utilized less than those for low temperature service, Table KK-2400-1 has been generated for the convenience of the Code user. This table identifies the pertinent paragraphs from those elevated temperature service Subsections that specify Design Specification requirements. In the process of preparing a Design Specification, it is important to refer to this list to assure proper consideration of all Division 5 requirements have been addressed.

KK-2410  **OPTION OF ALTERNATIVE CRITERIA FOR ELEVATED TEMPERATURE SERVICE**

There are numerous considerations that should be considered as part of a design evaluation for high temperature reactor components subjected to elevated temperature service. In order to allow the experienced design engineer to properly evaluate the significant safety aspects when determining acceptable component designs, Division 5 has relied upon the Design Specification as the means to address these wide variety of safety aspects.

For example, when considering deformation-controlled limits such as strain limits, creep-fatigue rules, and buckling and instability limits, the requirements found in Non-mandatory Appendix HBB-T are not mandatory. Any alternate requirements to be applied for deformation-controlled stress limits should, as an owner responsibility, be included in the Design Specification for the component (HBB/HGB-3252). This approach was taken to provide the ongoing flexibility to address unique design situations and/or take advantage of new technology developments. However, compliance with the limits of Appendix HBB-T is an acceptable approach for demonstrating compliance with Division 5, Class A or Class SM components subjected to elevated temperature service.
ARTICLE KK-4000
SPECIFIC PUMP REQUIREMENTS

KK-4100      DESIGN SPECIFICATION
            REQUIREMENTS

In addition to the Design Specification requirements indicated in Article KK-2000, Generic Requirements, including any appropriate elevated temperature service requirements indicated in KK-2400, the Design Specification for pumps should also include the requirements of this Article.

KK-4110      GENERAL REQUIREMENTS
            Covered by KK-2110.

KK-4120      DESIGN
KK-4121      Loads From Connected Piping

The forces and moments produced by the connected piping on each pump inlet and outlet should be included (NB/NC-3415).

KK-4122      Seismic Loadings

NB/NC-3417 provide the requirements for consideration of seismic loading.

KK-4200      FUNCTIONALITY REQUIREMENTS
            FOR PUMPS

KK-4210      GENERAL REQUIREMENTS
KK-4211      Applicability

The inclusion of functionality requirements in the Design Specifications should be based on the functional requirements of the pump being specified. These requirements should be specified only if the pumps are considered to be active pumps.

KK-4220      DESIGN

The Design Specification should include all applicable and pertinent information considered important to the functionality of the pump.

KK-4230      QUALIFICATION
KK-4231      Methods

The method of pump qualification, if any, for functionality should be defined in the Design Specification. Qualification by analysis, test, or combinations thereof should be specified. Available codes or standards that cover these areas should be referred to and used to the maximum extent possible.

KK-4232      Analysis

Acceptable methods of analysis should be specified. The following areas, as a minimum, should be addressed:

(a) required analysis
(b) load combinations, including deadweight, thermal loads, nozzle loads, seismic loads, etc.
(c) allowable stresses for the various loading conditions

KK-4233      Testing

Acceptable methods of testing should be specified. The following areas, as a minimum, should be addressed:

(a) required tests and test sequences
(b) imposed loads and pump function during tests
(c) acceptance criteria

KK-4240      FUNCTIONALITY PRODUCTION TESTS

Any special functionality tests to be conducted on production pumps should be specified in the Design Specification.

KK-4250      DOCUMENTATION

Documentation requirements for functional qualification or production tests should be specified.

Editor: Replace "NC" highlighted by "NCD".
ARTICLE KK-5000
SPECIFIC VALVE REQUIREMENTS

KK-5110 GENERAL REQUIREMENTS
Covered by KK-2110.

KK-5120 DESIGN
KK-5121 Class A Valves

KK-5121.1 Pipe Reactions for Valves Designed to Alternative Design Rules. NB-3512.2 or HBB-3500 provide the requirements concerning pipe reactions.

KK-5121.2 Seismic Loadings. NB/HBB-3524 provide the requirements concerning seismic loadings.

KK-5121.3 Level C Service Limits. NB/HBB-3526 provide the requirements concerning valve function during loading for which Level C Service Limits are specified.

KK-5121.4 Pipe Reaction Stress. NB-3526.2 or HBB-3500 provide the requirements concerning pipe reaction stress computation for Level C Service Limits.

KK-5121.5 Level D Service Limits. NB-3527 or HBB-3500 provide the requirements concerning valve function during loadings for which Level D Service Limits are specified.

KK-5121.6 Hydrostatic Tests. NB-3531.2(c) provides the requirements concerning alternative test pressures, seat leakages, and test durations.

KK-5121.7 Body Contours at Weld Ends. NB-3544.8 or HBB-3544 provide the requirements concerning alternative body contours at weld ends of valves.

KK-5121.8 Bypass Piping. The Design Specification should state which organization is responsible for the bypass piping design, if the responsible organization is not the piping system designer [NB-3546.3(b) or HBB-3546].

KK-5122 Class B Valves

KK-5122.1 Design Rules. The Design Specification should specify whether the standard design rules of NC-3512 or the alternative design rules of NC-3513 are permitted to be used.

KK-5122.2 Hydrostatic Tests. The Design Specification should specify the appropriate hydrostatic test requirements provided in NC-3512.1(a)(4) or NC-3531 as appropriate with the special hydrostatic test requirements for pressure relief valves provided in NC-3593.1, if needed.

KK-5200 FUNCTIONALITY REQUIREMENTS FOR VALVES

KK-5210 INTRODUCTION

Functionality requirements are outside the scope of Division 5 [NCA-2142(b)]; however, the Owner or Owner’s designee is required to specify any valve functionality requirements in the Design Specification [NB-3592.2(d) or HBB-3511/HBB-3526].

KK-5220 DESIGN

The Design Specification should include all applicable and pertinent information required. A document pertaining to this information is ANSI N278.1. Additional information not covered in ANSI N278.1, but considered important to the functionality of the valve should also be included. NB/HBB-3524 and NC-3521(c)/NC-3594(c) provide guidance for analysis of valves with extended masses.

KK-5230 QUALIFICATION

KK-5231 Methods

The method of valve qualification, if any, for functionality should be defined in the Design Specification. Qualification by analysis, test, or combinations thereof should be specified. Available Codes or Standards that cover these areas should be referenced and used to the maximum extent possible.

KK-5232 Analysis

Acceptable methods of analysis should be specified. The following areas, as a minimum, should be addressed: (a) required analysis
ARTICLE KK-6000
SPECIFIC PIPING REQUIREMENTS

KK-6100 DESIGN SPECIFICATION REQUIREMENTS

In addition to the Design Specification requirements indicated in Article KK-2000, Generic Requirements, including any appropriate elevated temperature service requirements indicated in Article KK-2400, the Design Specification for piping should include the requirements of this Article.

KK-6110 Covered by KK-2110.

KK-6120 DESIGN

KK-6121 Seismic

For piping, the loadings, movements, anchor motions, and number of cycles due to seismic events should be given. The associated Service Loadings that occur with, or as a result of, the specified seismic events should be stated.

KK-6122 Other Dynamic Loads

Dynamic loadings, such as those resulting from sudden valve or pump operation, should be given. As a minimum, the information needed to determine this loading should be given (such as pressures, temperatures, flow rates, valve operating times).

KK-6123 Peak Pressure

In categorizing Service Loadings into appropriate Service Limits, the Design Specification should include the peak pressure.

KK-6124 Fatigue Consideration for Class B Piping

The requirements for defining cyclic service loadings in the Design Specification for fatigue evaluations varies for low temperature service and for elevated temperature service.

KK-6124.1 Low Temperature Service. For Class B piping subjected to low temperature service, it is not necessary to define each service cycle in detail. However, the maximum range of conditions and the total number of occurrences of all service cycles to which the piping system will be subjected should be specified [NC 3611.2(e)]. For example, the minimum temperature conditions could be 40°F (5°C) while the maximum is 456°F (235°C). If all other service cycles did not impose a temperature condition less than the minimum or greater than the maximum, it is not required to be specified, unless the total number of occurrences of all service cycles exceeds 7,000. In this case, the range of temperature and the number of occurrences for each service cycle should be specified. In determining the total number of service cycles, all service cycles should be considered including those that impose a temperature condition less than the maximum range of temperature.

KK-6124.2 Elevated Temperature Service. For Class B piping subjected to elevated temperature service, the evaluation procedure considering creep requires the equivalent number of cycles to be obtained from Mandatory Appendix HCB-I, Article HCB-I-2000. In addition, the equivalent cycle definition in Article HCB-I-3000 refers back to the temperature gradient definitions in NB-3653.1 and NB-3653.2 that require consideration of peak stresses from nonlinear through-wall temperature gradients, mandating a detailed cyclic service definition.