902 Battelle Boulevard
P.O. Box 999, MSIN K7-68
Richland, WA 99352
(509) 375-6668
bruce.mcdowell@pnnl.gov
www.pnnl.gov

September 4, 2020

Ms. Lucieann Vechioli Feliciano
Contracting Officer's Representative
Office of New Reactors
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Ms. Vechioli Feliciano:

SUBJECT: FINAL TECHNICAL REPORT FOR LETTER OF TECHNICAL DIRECTION (LTD) 3 FOR NRC TASK ORDER NUMBER NRC-HQ-25-17-T-0005, "NON-LIGHT WATER REACTOR POLICY AND TECHNICAL GUIDANCE SUPPORT (CAC 001227)," UNDER THE ENTERPRISE WIDE AGREEMENT (EWA) – PNNL PROJECT 66419

Pacific Northwest National Laboratory (PNNL) completed the LTD 3, Task 5 deliverable, final technical report, under Task Order Number NRC-HQ-25-17-T-0005. The report provides the evaluation of the selected portions of the ASME Code and/or Code Cases.

Enclosed is the Final Technical Report deliverable and is available on EARRTH: Final_Assessments

If you have any questions about this submittal, please contact Nicole LaHaye at 509-372-6349 or Bruce McDowell at 509-375-6668.

Sincerely,

Bruce K. McDowell
Project Manager
Energy & Environmental Directorate
Pacific Northwest National Laboratory

cc: John Segala, NRC
Jim Hammelman, NRC
Jordan Hoellman, NRC
Joseph Sebrosky, NRC
Mallecia Sutton, NRC
Luba Hamilton, PNNL
Nicole LaHaye, PNNL
Tara O'Neil, PNNL

FINAL Technical Letter Report

Pacific Northwest National Laboratory Technical Input for the Nuclear Regulatory Commission Review of the 2017 Edition of ASME Section III, Division 5, "High Temperature Reactors"

September 2020

PREPARED FOR:

U.S. NUCLEAR REGULATORY COMMISSION
CONTRACT NO. NRC-HQ-25-14-D-0001
TASK ORDER NO. NRC-HQ-25-17-T-0005

PREPARED BY:

[Pacific Northwest National Laboratory]
[P.J. Sakalaukus, M.R. Mitchell, T.M. Brewer C.P. Baker, J.M. Harrison, E.J. Berglin, N.L. LaHaye, B.K. McDowell]
[Engineering Mechanics Corporation of Columbus, OH]
[F.W. Brust, G. Wilkowski, P. Krishnaswamy]
[Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission]
[M. Gordon, R. Iyengar, P. Raynaud]

TABLE OF ACRONYMS

III-1	ASME BPVC Section III, Division 1
III-1-NB	III-1 Subsection NB
III-1-NC	III-1 Subsection NC
III-1-NG	III-1 Subsection NG
III-1-NF	III-1 Subsection NF
III-5	ASME BPVC Section III, Division 5
III-5-HBB	III-5 Subsection HB, Subpart B
III-5-HCB	III-5 Subsection HC, Subpart B
III-5-HGB	III-5 Subsection HG, Subpart B
III-A	ASME BPVC Section III, Appendices
II-D	ASME BPVC Section II, Part D
ADAMS	Agencywide Documents Access and Management System
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BPVC	Boiler and Pressure Vessel Code
°C	Degrees Celsius
°F	Degrees Fahrenheit
NDE	Nondestructive examination
NRC	U.S. Nuclear Regulatory Commission
ORNL	Oak Ridge National Laboratory
PNNL	Pacific Northwest National Laboratory
RG	Regulatory Guide

EXECUTIVE SUMMARY

The Nuclear Regulatory Commission (NRC) intends to ensure its licensing reviews are performed commensurate with its safety and security mission and requested Pacific Northwest National Laboratory (PNNL) perform a technical review of the American Society of Mechanical Engineers (ASME) Boiler & Pressure Vessel Code (BPVC) Section III, Division 5 (III-5) in accordance with the guidance found in two recent NRC examples:

- The NRC Transformation Team, which provided their findings in SECY-18-0060, "Achieving Modern Risk-Informed Regulation," dated June 8, 2018 (ADAMS Package Accession Number ML18110A186), and
- An NRC memo from Frederick Brown, Director, Office of New Reactors, titled "Expectations for New Reactor Reviews," dated August 29, 2018 (ADAMS Accession Number ML18240A410). This memo is further described below.

One of the expectations in the Brown memo is to base the NRC's regulatory findings on the principle of "reasonable assurance of adequate protection" (of public health and safety), not on absolute certainty or risk avoidance. This is the legal standard for the NRC's licensing decisions. The memo discusses considerations for the terms "reasonable" and "adequate."

The Regulatory Guide (RG) that will endorse the use of III-5 will be based on the finding that the rules provide reasonable assurance of adequate protection. In accordance with the memo, new or novel designs or design features may need additional review and/or requirements. Furthermore, any technical areas that are not addressed by III-5 and would lead to a demonstrably increased likelihood or consequence of failure should be considered.

Another area of the memo is the consideration of margin. If the Code is sufficiently conservative in a given area such that it provides significant margin to relevant limits and sufficient data exists to support the Code values, then the review in that area should be reduced. In contrast, where the Code includes lesser margin and less supporting data, then the review in that area should be increased to ensure the staff has an adequate basis for endorsing the Code and any associated conditions. In any case, the review must either conclude that the Code provides reasonable assurance of adequate protection, or that the NRC cannot endorse that section of the Code and the basis for concluding so.

Since RG 1.87 explicitly states that Section III Code Cases (1592, 1593, 1594, 1595, and 1596) may be used in conjunction with ASME BPVC Section III, Division 1 (III-1), Subsection NB (III-1-NB), the Articles of III-5 Subsection HB, Subpart B (III-5-HBB) was compared by PNNL to the related areas of III-1-NB and applicable Section III Code Cases, e.g., Code Case 1592 was compared to HBB-3000, as an approach to validate the information present in III-5-HBB. In the same manner, the Articles under review by PNNL from III-5 Subsection HC, Subpart B (III-5-HCB) and III-5 Subsection HG, Subpart B (III-5-HGB) was compared to III-1, Subsection NC (III-1-NC) and Subsection NG (III-1-NG), respectively.

Having reviewed III-5 against the Code Cases and Related Code Sections, PNNL recommends that the ASME BPVC sections under review be accepted with a few conditions discussed in the document.

TABLE OF CONTENTS

1. INTRODUCTION

1.1. Background

The absence of a code of construction endorsed by the U.S. Nuclear Regulatory Commission (NRC) for nuclear reactors operating above 425°C (800°F) is a significant obstacle for advanced non-light water reactor designs. Review and approval of an elevated temperature code of construction during a licensing review of a new nuclear power plant would result in substantial cost and a longer schedule.

In a letter dated June 21, 2018 (Agencywide Documents Access and Management System [ADAMS] Accession No. ML18184A065), the American Society of Mechanical Engineering (ASME) requested the NRC review and endorse the 2017 edition of ASME Boiler & Pressure Vessel Code (BPVC) Section III, Division 5 (III-5), “High Temperature Reactors.” The request was based on letters from both industry consortia and individual companies interested in developing advanced non-light water reactor designs. The NRC responded in a letter dated August 16, 2018 (ADAMS Accession No. ML18211A571) that the NRC is initiating efforts to endorse (with conditions, if necessary) the 2017 edition of III-5 in a new Regulatory Guide (RG) as one way of meeting the NRC’s regulatory requirements.

To support the review and endorsement effort, the NRC requested the technical support of Pacific Northwest National Laboratory (PNNL). This report documents PNNL’s technical input for the NRC’s review of the 2017 edition of III-5. This report will be used as part of the NRC’s review and support the findings in the associated RG.

2. OVERVIEW

2.1. Review Approach

The NRC wants to ensure its licensing reviews are performed commensurate with its safety and security mission and requested PNNL to perform a technical review in accordance with the guidance in two recent NRC examples. One example is the NRC Transformation Team, which provided their findings in SECY-18-0060, “Achieving Modern Risk-Informed Regulation,” dated June 8, 2018 (ADAMS Package Accession Number ML18110A186). Another example is an NRC memo from Frederick Brown, Director, Office of New Reactors, titled, “Expectations for New Reactor Reviews,” dated August 29, 2018 (ADAMS Accession No. ML18240A410). This memo is further described below.

One of the expectations in the memo is to base the NRC’s regulatory findings on the principle of “reasonable assurance of adequate protection” (of public health and safety) but not on absolute certainty or risk avoidance. This is the legal standard for the NRC’s licensing decisions. The memo discusses considerations for the terms “reasonable” and “adequate.”

The RG that will endorse the use of III-5 will be based on the finding that the rules provide reasonable assurance of adequate protection. In accordance with the memo, new or novel designs or design features may need additional review and/or requirements. Furthermore, any technical areas that are not addressed by III-5 and would lead to a demonstrably increased likelihood or consequence of failure should be considered.

Another area of the memo is the consideration of margin. Note that the ASME BPVC including all sections and divisions will be collectively called the “Code” in locations where a specific section or division does not need to be called out and a general reference to the Code is only needed. If the Code is sufficiently conservative in a particular area such that it provides significant margin to relevant limits, and sufficient data exists to support the Code values, then the review in that area should be reduced. In contrast, where the Code includes lesser margin and less supporting data, then the review in that area should be increased to ensure the staff has an adequate basis for endorsing the Code and any associated conditions. In any case, the review must either conclude that the Code provides reasonable assurance of adequate protection or that the NRC cannot endorse that section of the Code and the basis for concluding so.

Similarly, the memo discusses making safety evaluations more succinct and including only the information necessary to meet the NRC staff’s safety findings. Therefore, this report provides a concise basis for its conclusions, while also maintaining clarity and completeness. This report focuses on why and how PNNL reached its conclusions without unnecessary historical or tangential information.

The NRC performed research to establish the scope of the review. This research includes a historical review on previous high-temperature design rules and NRC approvals. The NRC’s specific historical findings will be fully documented in the final RG or another accompanying NRC document. The specific historical findings relevant to this report are discussed below.

This report considers the adequacy of the technical basis provided in the Code, including the quality and quantity of underlying data within the context of the selected safety margins. This report also considers previous NRC historical findings, current operating experience, and international experience including similar design rules, as applicable.

PNNL will conduct the Code review by reviewing the pertinent portions of III-5 outlined in Table 1, relevant Code Cases, and supporting documentation.

Because RG 1.87 explicitly states that Section III Code Cases (1592, 1593, 1594, 1595, and 1596) may be used in conjunction with ASME BPVC Section III, Division 1, (III-1) Subsection NB (III-1-NB), the Articles of III-5 Subsection HB, Subpart B (III-5-HBB), which are under review by PNNL as outlined in Table 1, will be compared to the related areas of III-1-NB as an approach to validate the information present in III-5 HBB. In the same manor, the Articles under review by PNNL from III-5 Subsection HC, Subpart B (III-5-HCB) and III-5 Subsection HG, Subpart B (III-5-HGB) will be compared to III-1, Subsection NC (III-1-NC) and Subsection NG (III-1-NG), respectively.

At this point, PNNL will have an in-depth understanding of which portions of III-5 are outside of the approved Code Cases and/or cannot be justified with the use of III-1. If PNNL finds areas in III-5 that cannot be justified with III-1 or Code Cases, PNNL will review any referenced documents cited in III-5, investigate other areas of the Code (e.g., ASME BPVC Sections I, VIII), and review any additional standards that may be applicable (ASME Standards Technology Reports, American Petroleum Institute high-temperature standards, etc.).

PNNL will document the summary of the investigation to at most the subparagraph level (e.g., HBB-3111.1) consisting of the major subdivisions of a paragraph only for the areas under review by PNNL as outlined in Table 1 and will present this in **Section 3 Technical Review Synopsis**. Furthermore, PNNL will document the full investigation to the lowest level required to adequately justify the Code for the areas under review by PNNL as outlined in Table 1 and will present this in **Section 4 Technical Review Detail**. PNNL's review will stipulate whether the paragraphs of III-5 should be accepted as written, accepted as written with notes provided, or not accepted.

Table 1: Review Assignments

Task B, General Requirements, Low Temperature Metallic Components, and Supports:

ASME Code Section	Reviewer
General Requirements, Metallic Materials (Subsection HAA)	NRC Staff
Class A Metallic Pressure Boundary Components, Low Temperature Service (HBA)	NRC Staff
Class B Metallic Pressure Boundary Components (HCA)	NRC Staff
Class A and Class B Metallic Supports, Low Temperature Service (HFA)	NRC Staff
Class A Metallic Core Support Structures, Low Temperature Service (HGA)	NRC Staff

Task C, Elevated Temperature Metallic Components:

ASME Code Section	Reviewer
Class A Metallic Pressure Boundary Components, Elevated Temperature Service (HBB)	
1000 Introduction	NRC Staff
2000 Material	ORNL
3000 Design	PNNL
4000 Fabrication and Installation	PNNL
5000 Examination	PNNL
6000 Testing	PNNL
7000 Overpressure Protection	NRC Staff
8000 Nameplates, Stamping With the Certification Mark, and Reports	NRC Staff
Mandatory Appendix HBB-I-14 Tables and Figures	ORNL
Mandatory Appendix HBB-II Use of SA-533 Type B, Class 1 Plate and SA-508 Grade 3, Class 1 Forgings and Their Weldments for Limited Elevated Temperature Service	NUMARK
Nonmandatory Appendix HBB-T Rules for Strain, Deformation, and Fatigue Limits at Elevated Temperatures	NUMARK
Nonmandatory Appendix HBB-U Guidelines for Restricted Material Specifications to Improve Performance in Certain Service Applications	ORNL
Nonmandatory Appendix HBB-Y Guidelines for Design Data Needs for New Materials	Not reviewed
Class B Metallic Pressure Boundary Components, Elevated Temperature Service (HCB)	
1000 Introduction	NRC Staff
2000 Material	ORNL
3000 Design	PNNL
4000 Fabrication and Installation	PNNL
5000 Examination	PNNL
6000 Testing	PNNL
7000 Overpressure Protection	NRC Staff
8000 Nameplates, Stamping With the Certification Mark, and Reports	NRC Staff
Mandatory Appendix HCB-I Stress Range Reduction Factor for Piping	NUMARK
Mandatory Appendix HCB-II Allowable Stress Values for Class B Components	NUMARK
Mandatory Appendix HCB-III Time–Temperature Limits for Creep and Stress-Rupture Effects	NUMARK
Class A Metallic Core Support Structures, Elevated Temperature Service (HGB)	
1000 Introduction	NRC Staff
2000 Material	ORNL
3000 Design	PNNL
4000 Fabrication and Installation	PNNL
5000 Examination	PNNL
8000 Nameplates, Stamping With the Certification Mark, and Reports	NRC Staff
Mandatory Appendix HGB-I Rules for Strain, Deformation, and Fatigue Limits at Elevated Temperatures	PNNL
Mandatory Appendix HGB-II Rules for Construction of Core Support Structures, Extended for Restricted Service at Elevated Temperature, Without Explicit Consideration of Creep and Stress-Rupture	PNNL
Mandatory Appendix HGB-III Buckling and Instability	PNNL
Mandatory Appendix HGB-IV Time–Temperature Limits	PNNL

Task D, Graphite and Composites:

ASME Code Section	Reviewer
General Requirements, Graphite and Composite Materials (HAB)	
1000 Introduction 2000 Classification of Graphite Core Components 3000 Responsibilities and Duties 4000 Quality Assurance 5000 Authorized Inspection 7000 Reference Standards 8000 Certificates and Data Reports 9000 Glossary	NRC Staff
Mandatory Appendix HAB-I Certificate Holder's Data Report Forms, Instructions, and Application Forms for Certificates of Authorization	NRC Staff
Class A Nonmetallic Core Components, Graphite Materials (HHA)	
1000 Introduction 2000 Material 3000 Design 4000 Fabrication and Installation 5000 Examination	NUMARK
8000 Nameplates, Stamping With the Certification Mark, and Reports	NRC Staff
Mandatory Appendix HHA-I Graphite Material Specifications	NUMARK
Mandatory Appendix HHA-II Requirements for Preparation of a Material Data Sheet	NUMARK
Mandatory Appendix HHA-III Requirements for Generation of Design Data for Graphite Grades	NUMARK

Task E, Code Cases

Code Case	Code Case Title	Reviewer
N-861	Satisfaction of Strain Limits for Division 5 Class A Components at Elevated Temperature Service Using Elastic-Perfectly Plastic Analysis	NUMARK
N-862	Calculation of Creep-Fatigue for Division 5 Class A Components at Elevated Temperature Service Using Elastic-Perfectly Plastic Analysis	NUMARK
N-822	Application of the ASME Certification Mark	NRC Staff
N-837	Alternative to the Registered Professional Engineer Requirements	NRC Staff
N-852	Application of the ASME NPT Stamp	NRC Staff

2.2. Historical Basis

The NRC researched previous high-temperature design rules and NRC approvals to establish the scope of the review. These reviews included historical RGs, Code Cases, construction permit safety evaluation reports, and pre-application safety evaluation reports. The NRC found that the following ASME Code Cases were accepted for use, with conditions, in NRC Regulatory Guide 1.87, Guidance for Construction of Class 1 Components in Elevated-Temperature Reactors (Supplement to ASME Section III Code Cases 1592, 1593, 1594, 1595, and 1596), Revision 1, dated June 1975.

- ASME Code Case 1592, Class 1 Components in Elevated Temperature Service Section III, Division 1, Revision 0, dated April 29, 1974.

- ASME Code Case 1593, Fabrication and Installation of Elevated Temperature Components Section Ill, Class 1, Revision 0, dated November 5, 1973
- ASME Code Case 1594, Examination of Elevated Temperature Nuclear Components Section Ill, Class 1, Revision 0, dated November 5, 1973
- ASME Code Case 1595, Testing of Elevated Temperature Nuclear Components Section III, Class 1, Revision 0, dated November 5, 1973
- ASME Code Case 1596, Protection Against Overpressure or Elevated Temperature Components Section Ill, Class 1, Revision 0, dated November 5, 1973

This report uses these Code Cases as a basis for the review of the 2017 edition of III-5.

2.3. Review Scope

The specific portions of the Code (Subsection, Article, Code Case, etc.) that are reviewed and the reviewing organization are listed in Table 1.

Some assignments have additional detail provided related to supporting another contractor's review. For example, the contractor listed for III-5, Subsection HB, Subpart B (III-5-HBB), Article 2000, Material is responsible for documenting the assessment for Article 2000. However, during their review they may need to support the contractor that is responsible for reviewing III-5-HBB, Article 3000, Design.

Similarly, contractors may need to review information within other portions of the Code to support their assignments. For example, the contractor responsible for Article 3000 may need to review information in Article 2000. Concerns should be discussed with the responsible contractor. This means the Article 3000 contractor is not responsible for any part of the documentation for Article 2000, although the Article 3000 review may impact the Article 2000 review and documentation.

2.4. Report Organization

This technical report uses the same nomenclature as the ASME BPVC. The organization of ASME BPVC Section III, Division 5 is summarized below.

ASME Code Section III consists of Divisions. Divisions are broken down into Subsections. Subsections are divided into Articles, subarticles, subsubarticles, paragraphs, and, where necessary, subparagraphs and subsubparagraphs.

Articles are designated by the applicable letters indicated above for Subsections followed by Arabic numbers, such as NB-1000. Where possible, Articles dealing with the same topics are given the same number in each Subsection, except NCA.

Subarticles are numbered in units of 100, such as NB-1100.

Subsubarticles are numbered in units of 10, such as NB-2130, and generally have no text. When a number such as NB-1110 is followed by text, it is considered a paragraph.

Paragraphs are numbered in units of 1, such as NB-2121.

Subparagraphs, when they are major subdivisions of a paragraph, are designated by adding a decimal followed by one or more digits to the paragraph number, such as NB-1132.1. When they are minor subdivisions of a paragraph, subparagraphs may be designated by lowercase letters in parentheses, such as NB-2121(a).

Subsubparagraphs are designated by adding lowercase letters in parentheses to the major subparagraph numbers, such as NB-1132.1(a). When further subdivisions of minor subparagraphs are necessary, subsubparagraphs are designated by adding Arabic numerals in parentheses to the subparagraph designation, such as NB-2121(a)(1).

3. TECHNICAL REVIEW SYNOPSIS

This section summarizes PNNL's review of Section III, Division 5, Subsection HB, Subpart B, Articles HBB-3000 through HBB-6000; Subsection HC, Subpart B, Articles HCB-3000 through HCB-6000; Subsection HG, Subpart B Articles HGB-3000 through HGB-5000; and Mandatory Appendices HGB-I, HGB-II, HGB-III, and HGB-IV.

General Notes:

Normal, Upset, Emergency, and Faulted are now Level A, Level B, Level C, and Level D, respectively.

Class 1 components from Sec. III, Div. 1 are analogous to Class A components from Sec. III, Div. 5.

Class 2 components from Sec. III, Div. 1 are analogous to Class B components from Sec. III, Div. 5.

3.1. SUBSECTION HB, CLASS A METALLIC PRESSURE BOUNDARY COMPONENTS, SUBPART B, ELEVATED TEMPERATURE SERVICE

3.1.1. ARTICLE HBB-3000, DESIGN

HBB-3100, GENERAL REQUIREMENTS FOR DESIGN

HBB-3110, SCOPE, ACCEPTABILITY, AND LOADINGS

HBB-3111, Scope

It is recommended that paragraph HBB-3111 be accepted as written because it is fundamentally identical to paragraph -3111 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3111.1, Acceptability

It is recommended that subparagraph HBB-3111.1 be accepted as written because it is fundamentally identical to subparagraph -3111.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3111.2, Loadings

It is recommended that subparagraph HBB-3111.2 be accepted as written because it is fundamentally identical, except for subsubparagraph HBB-3111.2(g), to subparagraph -3111.2 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is recommended that subsubparagraph HBB-3111.2(g) be accepted as written. This is an acceptable addition and the applicant will develop the detailed methods to account for the design loads as part of the Design Report.

HBB-3112, Design Parameters
It is recommended that paragraph HBB-3112 be accepted as written because it is fundamentally identical to paragraph -3112 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3112.1, Specified Pressure
It is recommended that subparagraph HBB-3112.1 be accepted as written because it is fundamentally identical to subparagraph -3112.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3112.2, Specified Temperature
It is recommended that subparagraph HBB-3112.2 be accepted as written because it is fundamentally identical to subparagraph -3112.2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3112.3, Specified Mechanical Load Forces
It is recommended that subparagraph HBB-3112.3 be accepted as written because it is fundamentally identical to subparagraph -3112.3 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3113, Loading Categories
It is recommended that paragraph HBB-3113 be accepted as written because it is fundamentally identical to paragraph -3113 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3113.1, Design Loadings
It is recommended that subparagraph HBB-3113.1 be accepted as written because it is fundamentally identical to subparagraph -3113.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3113.2, Service Loadings
It is recommended that subparagraph HBB-3113.2 be accepted as written because it is fundamentally identical to subparagraph -3113.2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3113.3, Level A Service Loadings
It is recommended that subparagraph HBB-3113.3 be accepted as written because it is fundamentally identical to subparagraph -3113.3 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3113.4, Level B Service Loadings (From Incidents of Moderate Frequency)
It is recommended that subparagraph HBB-3113.4 be accepted as written because it is fundamentally identical to subparagraph -3113.4 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3113.5, Level C Service Loadings (From Infrequent Incidents)
It is recommended that subparagraph HBB-3113.5 be accepted as written because it is fundamentally identical to subparagraph -3113.5 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3113.6, Level D Service Loadings (From Limiting Faults)
It is recommended that subparagraph HBB-3113.6 be accepted as written because it is fundamentally identical to subparagraph -3113.6 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3113.7, Test Loadings
It is recommended that subparagraph HBB-3113.7 be accepted as written because it is fundamentally identical to subparagraph -3113.7 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3114, Load Histogram

HBB-3114.1, Level A and B Service Events
It is recommended that subparagraph HBB-3114.1 be accepted as written because it is fundamentally identical to subparagraph -3114.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3114.2, Level C Service Events
It is recommended that subparagraph HBB-3114.2 be accepted as written because it is fundamentally identical to subparagraph -3114.2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3120, SPECIAL CONSIDERATIONS

HBB-3121, Corrosion
It is recommended that paragraph HBB-3121 be accepted as written because HBB-3121 is identical to paragraph NB-3121, which has been approved for III-1 use by 10 CFR 50.55a with the 2017 Edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HBB-3122, Cladding
It is recommended that the general requirements for design paragraph HBB-3122 be accepted as written; the basis for acceptance is that HBB-3122 simply points to HBB-3227.8, which is identical to subparagraph 3227.8 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3123, Welding

HBB-3123.1, Dissimilar Welds
It is recommended that subparagraph HBB-3123.1 be accepted as written because HBB-3123.1 is identical to NB-3123.1, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR

56156. Additionally, it cautions the applicant on the use of dissimilar metals having different coefficients of thermal expansion as part of the general requirements for design in order to avoid difficulties in service. The applicant will develop the detailed methods to account for dissimilar welds as part of the Design Report.

HBB-3123.2, Fillet Welded Attachments

It is recommended that subparagraph HBB-3123.2 be accepted as written because this paragraph states the fillet welded attachment requirements are contained in subparagraph HBB-3356.2, where it is evaluated, which is fundamentally identical to subparagraph -3356.2, except for the added requirement of HBB-3356.2(c), of Code Case 1592, which has been approved for use through NRC RG 1.87. See subparagraph HBB-3356.2 for information on HBB-3356.2(c).

HBB-3124, Environmental Effects

It is recommended that paragraph HBB-3124 be accepted as written because it is identical to NB-3124, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HBB-3125, Configuration

It is recommended that the general requirements for design paragraph HBB-3125 be accepted as written because it is identical to NB-3125 which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. It directs the applicant to account for accessibility to permit the in-service examinations required by ASME BPVC Section XI for components governed by this construction code. The applicant will demonstrate a suitable configuration to perform the examination requirements as part of the Design Report.

HBB-3130, GENERAL DESIGN RULES

HBB-3131, Scope

It is recommended that paragraph HBB-3131 be accepted as written because it is fundamentally identical to paragraph -3131 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3132, Dimensional Standards for Standard Products

It is recommended that the general requirement for design paragraph HBB-3132 be accepted as written because it is identical to NB-3132 which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. This paragraph directs the applicant to use the approved dimensional standard documents and applicable editions from Table NCA-7100-1, which is also approved for III-1 use by 10 CFR 50, when the standard or specification is referenced in III-5-HBB. Additionally, it stipulates that these standards do not replace the requirements of stress analysis by any design article for a specific component.

HBB-3133, Size Restrictions in Nozzle, Branch, Piping, and Other Connections

It is recommended that the general requirement for design paragraph HBB-3133 be accepted as written because it points to Table HBB-3133-1, which imposes more conservative size

restrictions than NB-3133, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

It is recommended that Table HBB-3133-1 be accepted as written. This table lists the referenced sections of III-5-HBB for the creep service condition that differ from the approved sections of III-1-NB for the non-creep service condition. See Section 4, HBB-3133 for further detail.

Note:

> For socket welded fittings used in pressure-retaining joints in accordance with 10 CFR 50.55a(b)(1)(ii), applicants and licensees may not apply the Section III provisions for welds with leg size less than 1.09* t_n, where t_n is the nominal pipe thickness.

HBB-3134, Leak Tightness
It is recommended that paragraph HBB-3134 be accepted as written because it is fundamentally identical to paragraph -3134 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3135, Attachments
It is recommended that paragraph HBB-3135 be accepted as written because it is fundamentally identical to paragraph -3135 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3136, Reinforcement for Openings
It is recommended that paragraph HBB-3136 be accepted as written. HBB-3136 has conservatively omitted the language that allowed post-weld heat treatment to not be performed on nozzles and branch connections and directs the applicant to the use the more detailed rules of HBB-3330 and HBB-3646. HBB-3136 is acceptable because it directs the applicant to use vessel design (HBB-3330) and piping design (HBB-3646), which cover the use of nozzles and branch connections.

HBB-3137, Design Considerations Related to Other Articles of the Code

HBB-3137.1, Design Considerations for Static Pressure Testing
It is recommended that subparagraph HBB-3137.1 be accepted as written because it is fundamentally identical to subparagraph -3137.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3137.2, Design Considerations for Overpressure Protection of the System
It is recommended that subparagraph HBB-3137.2 be accepted as written because it is fundamentally identical to subparagraph -3137.2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3138, Elastic Follow-up

It is recommended that all subparagraphs and subsubparagraphs under paragraph HBB-3138 be accepted as written because it is fundamentally identical to paragraph -3138 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3139, Welding

HBB-3139.1, Abrupt Changes in Mechanical Properties at Weld and Compression Contact Junctions

It is recommended that subparagraph HBB-3139.1 be accepted as written because it is fundamentally identical to paragraph -3139 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3139.2, Weld Design

It is recommended that the general requirement for design subparagraph HBB-3139.2 be accepted as written. This requirement directs the applicant to comply with the rules of III-1 NB-3350, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, for all welds except as modified in HBB-3400, HBB-3500, or HBB-3600.

HBB-3200, DESIGN BY ANALYSIS

HBB-3210, DESIGN CRITERIA

HBB-3211, Requirements for Acceptability

It is recommended that paragraph HBB-3211 be accepted as written because it is fundamentally identical to paragraph -3211 of Code Case 1592, which has been approved for use through NRC RG 1.87. HBB-3211(c) references the correct 2017 Code location, which is expected to be incorporated by reference according to 83 FR 56156. Additionally, Code Case 1592 subparagraphs -3211(d) and -3211(e) have been summarized and combined as subparagraph HBB-3211(d) of the 2017 Code.

HBB-3212, Basis for Determining Stress, Strain, and Deformation Quantities

It is recommended that paragraph HBB-3212 be accepted as written. This paragraph is fundamentally identical to paragraph -3212 of Code Case 1592, which has been approved for use through NRC RG 1.87. HBB-3212(a) references the correct 2017 Code location, which is expected to be incorporated by reference according to 83 FR 56156. Subparagraph HBB-3212(c) refers to a Class A (Class 1 for III-1 use) material (9Cr-1Mo-V) allowed per the material requirements of III-5-HBB, Article HBB-2000 and III-1-NB, Article NB-2000.

Note:

> Subparagraph HBB-3212(c) gives several unique characteristics that an applicant must consider when 9Cr-1Mo-V is used in high-temperature applications. The use of this material is governed by the requirements and recommendations of Oak Ridge National Laboratory (ORNL)'s report on HBB-2000 *Material*.

HBB-3213, Terms Relating to Analysis

It is recommended that paragraph HBB-3213 be accepted as written because it is fundamentally identical to paragraph -3213 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3213.1, Stress Intensity

It is recommended that subparagraph HBB-3213.1 be accepted as written because it is fundamentally identical to subparagraph -3213.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3213.2, Gross Structural Discontinuity

It is recommended that subparagraph HBB-3213.2 be accepted as written because it is fundamentally identical to subparagraph -3213.2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3213.3, Local Structural Discontinuity

It is recommended that subparagraph HBB-3213.3 be accepted as written because it is fundamentally identical to subparagraph -3213.3 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3213.4, Normal Stress

It is recommended that subparagraph HBB-3213.4 be accepted as written because it is fundamentally identical to subparagraph -3213.4 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3213.5, Shear Stress

It is recommended that subparagraph HBB-3213.5 be accepted as written because it is fundamentally identical to subparagraph -3213.5 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3213.6, Membrane Stress

It is recommended that subparagraph HBB-3213.6 be accepted as written because it is fundamentally identical to subparagraph -3213.6 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3213.7, Bending Stress

It is recommended that subparagraph HBB-3213.7 be accepted as written because it is fundamentally identical to subparagraph -3213.7 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3213.8, Primary Stress

It is recommended that subparagraph HBB-3213.8 be accepted as written because it is fundamentally identical, except for the added sentence and table reference, to subparagraph -3213.8 of Code Case 1592, which has been approved for use through NRC RG 1.87. The added sentence and the reference to Table HBB-3217-1 are accurate; therefore, this is recommended to be accepted. See Section 4, HBB-3213.8 for further detail.

HBB-3213.9, Secondary Stress

It is recommended that subparagraph HBB-3213.9 be accepted as written because it is fundamentally identical to subparagraph -3213.9 of Code Case 1592, which has been approved for use through NRC RG 1.87. See Section 4, HBB-3213.9 for further detail.

HBB-3213.10, Local Primary Membrane Stress

It is recommended that subparagraph HBB-3213.10 be accepted as written. The expansion of the local primary membrane stress definition from -3213.10 of Code Case 1592 to III-5 HBB-3213.10 is fundamentally identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(n) of the 2017 Code and NB-3213.10 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HBB-3213.11, Peak Stress

It is recommended that subparagraph HBB-3213.11 be accepted as written because it is fundamentally identical to subparagraph -3213.11 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3213.13, Thermal Stress

It is recommended that subparagraph HBB-3213.13 be accepted as written, because it is fundamentally identical to subparagraph -3213.13 of Code Case 1592, which has been approved for use through NRC RG 1.87. The expansion of the thermal stress definition from -3213.13 to HBB-3213.13 is fundamentally identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(aj) of the 2017 Code and NB-3213.13 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

Note:

> The reference to subparagraph HBB-T-1331(d) is acceptable because NUMARK recommends that paragraph HBB-T-1331 be accepted based on the summary given in Section 3, HBB-T-1331 *General Requirements* and the accompanying arguments in Section 4.

HBB-3213.15, Service Cycle

It is recommended that subparagraph HBB-3213.15 be accepted as written because it is fundamentally identical to subparagraph -3213.15 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3213.16, Strain Cycle

It is recommended that subparagraph HBB-3213.16 be accepted as written, because it is fundamentally identical to subparagraph -3213.16 of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

The reference to paragraph HBB-T-1413 is acceptable because NUMARK recommends that paragraph HBB-T-1413 be accepted based on the summary given in Section 3, HBB-T-1413 *Equivalent Strain Range* and the accompanying arguments in Section 4.

HBB-3213.17, Fatigue Strength Reduction Factor

It is recommended that subparagraph HBB-3213.17 be accepted as written because it is fundamentally identical to subparagraph -3213.17 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3213.18, Free End Displacement

It is recommended that subparagraph HBB-3213.18 be accepted as written because it is fundamentally identical to subparagraph -3213.19 of Code Case 1592, which has been approved for use through NRC RG 1.87. Because paragraph HBB-3213 is solely a listing of definitions, the exact order and placement within this paragraph are irrelevant and do not detract from the actual definition provided by the Code.

HBB-3213.20, Deformation

It is recommended that subparagraph HBB-3213.20 be accepted as written. The definition given in this subparagraph defines a common engineering term and is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(d) of the 2017 Code and NB-3213.20 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HBB-3213.21, Inelasticity

It is recommended that subparagraph HBB-3213.21 be accepted as written. The definition given in this subparagraph defines a common engineering term and is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(j) of the 2017 Code and NB-3213.21 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HBB-3213.22, Creep

It is recommended that subparagraph HBB-3213.22 be accepted as written. The definition given in this subparagraph defines a common engineering term and is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(c) of the 2017 Code and NB-3213.22 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HBB-3213.23, Plasticity

It is recommended that subparagraph HBB-3213.23 be accepted as written. The definition given in this subparagraph, excluding the last sentence involving 9Cr-1Mo-V, defines a common engineering term and is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix

XIII, XIII-1300(x) of the 2017 Code and NB-3213.23 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

Note:

> The definition in subparagraph HBB-3213.23 states for 9Cr-1Mo-V, time-independent plasticity at higher temperatures occurs only in limiting cases where strain rates are high relative to creep rates. The use of this material is governed by the requirements and recommendations of ORNL's report on HBB-2000 *Material*.

HBB-3213.24, Plastic Analysis

It is recommended that subparagraph HBB-3213.24 be accepted as written. The definition given in this subparagraph, excluding the sentence regarding the use of 9Cr-1Mo-V, defines a common engineering analysis method and is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(t) of the 2017 Code and NB-3213.24 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

Note:

> The definition in subparagraph HBB-3213.24 states for 9Cr-1Mo-V, plastic analysis must generally account for rate dependence and creep effects. The use of this material is governed by the requirements and recommendations of ORNL's report on HBB-2000 *Material*.

HBB-3213.25, Plastic Analysis – Collapse Load

It is recommended that subparagraph HBB-3213.25 be accepted as written because it is an updated revision of -3213.21 of Code Case 1592, which has been approved for use through NRC RG 1.87. The definition given in this subparagraph defines a common engineering analysis and is fundamentally identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(u) of the 2017 Code and is identical to what is found in NB-3213.25 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HBB-3213.26, Plastic Instability Load

It is recommended that subparagraph HBB-3213.26 be accepted as written. The definition given in this subparagraph defines a common engineering term and is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(w) of the 2017 Code and NB-3213.26 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HBB-3213.27, Limit Analysis

It is recommended that subparagraph HBB-3213.27 be accepted as written. The definition given in this subparagraph defines a common engineering analysis and is fundamentally identical to

what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(k) of the 2017 Code and is identical to what is found in NB-3213.27 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HBB-3213.28, Limit Analysis – Collapse Load

It is recommended that subparagraph HBB-3213.28 be accepted as written because it is fundamentally identical to the first and last sentence of paragraph -3213.21 of Code Case 1592 which has been approved for use through NRC RG 1.87. Because paragraph HBB-3213 is solely a listing of definitions, the exact order and placement within this paragraph are irrelevant and have no bearing on the actual definition provided by the Code. Additionally, the remaining text from -3213.21 that is not in HBB-3213.28 does not detract from the definition of how a limit analysis is used to compute the maximum carrying load or collapse load.

HBB-3213.29, Calculated Collapse Load – Lower Bound

It is recommended that subparagraph HBB-3213.29 be accepted as written because it is fundamentally identical to subparagraph -3213.22 of Code Case 1592, which has been approved for use through NRC RG 1.87. Because paragraph HBB-3213 is solely a listing of definitions, the exact order and placement within this paragraph are irrelevant and do not detract from the actual definition provided by the Code.

HBB-3213.30, Plastic Hinge

It is recommended that subparagraph HBB-3213.30 be accepted as written. The definition given in this subparagraph defines a common engineering term and is fundamentally identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(v) of the 2017 Code and NB-3213.30 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HBB-3213.31, Strain Limiting Load

It is recommended that subparagraph HBB-3213.31 be accepted as written. The definition given in this subparagraph defines a common engineering term and is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(af) of the 2017 Code and NB-3213.31 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HBB-3213.32, Test Collapse Load

It is recommended that subparagraph HBB-3213.32 be accepted as written. The definition given in this subparagraph defines a common engineering term and is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(ai) of the 2017 Code and NB-3213.32 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HBB-3213.33, Ratcheting

It is recommended that subparagraph HBB-3213.33 be accepted as written because it is fundamentally identical to subparagraph -3213.23 of Code Case 1592, which has been approved for use through NRC RG 1.87. Because paragraph HBB-3213 is solely a listing of definitions, the exact order and placement within this paragraph are irrelevant and do not detract from the actual definition provided by the Code.

HBB-3213.34, Shakedown

It is recommended that subparagraph HBB-3213.34 be accepted as written because it is fundamentally identical to subparagraph -3213.18 of Code Case 1592, which has been approved for use through NRC RG 1.87. Because paragraph HBB-3213 is solely a listing of definitions, the exact order and placement within this paragraph are irrelevant and do not detract from the actual definition provided by the Code.

HBB-3213.35, Design Information on the Nameplate

It is recommended that subparagraph HBB-3213.35 be accepted as written because it is fundamentally identical to subparagraph -3213.24 of Code Case 1592, which has been approved for use through NRC RG 1.87. Because paragraph HBB-3213 is solely a listing of definitions, the exact order and placement within this paragraph are irrelevant and do not detract from the actual definition provided by the Code.

HBB-3213.36, Use-Fraction

It is recommended that subparagraph HBB-3213.36 be accepted as written because it is fundamentally identical to subparagraph -3213.25 of Code Case 1592, which has been approved for use through NRC RG 1.87. Because paragraph HBB-3213 is solely a listing of definitions, the exact order and placement within this paragraph are irrelevant and do not detract from the actual definition provided by the Code.

HBB-3213.37, Fatigue Damage

It is recommended that subparagraph HBB-3213.37 be accepted as written because it is fundamentally identical to subparagraph -3213.26 of Code Case 1592, which has been approved for use through NRC RG 1.87. Because paragraph HBB-3213 is solely a listing of definitions, the exact order and placement within this paragraph are irrelevant and do not detract from the actual definition provided by the Code.

HBB-3213.38, Creep Damage

It is recommended that subparagraph HBB-3213.38 be accepted as written because it is fundamentally identical to subparagraph -3213.27 of Code Case 1592, which has been approved for use through NRC RG 1.87. Because paragraph HBB-3213 is solely a listing of definitions, the exact order and placement within this paragraph are irrelevant and do not detract from the actual definition provided by the Code.

HBB-3213.39, Creep-Fatigue Interaction

It is recommended that subparagraph HBB-3213.39 be accepted as written because it is fundamentally identical to subparagraph -3213.28 of Code Case 1592, which has been approved for use through NRC RG 1.87. Because paragraph HBB-3213 is solely a listing of

definitions, the exact order and placement within this paragraph are irrelevant and do not detract from the actual definition provided by the Code.

HBB-3214, Stress Analysis

It is recommended that paragraph HBB-3214 be accepted as written because it is fundamentally identical to paragraph -3214 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3214.1, Elastic Analysis

It is recommended that subparagraph HBB-3214.1 be accepted as written because it is fundamentally identical to subparagraph -3214.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3214.2, Inelastic Analysis

It is recommended that subparagraph HBB-3214.2 be accepted as written. Subparagraph -3214.2 explicitly states that inelastic analysis may be necessary, does not contain any methods or instructions on how to perform an inelastic analysis, and requires justification for any method used be included in the Design Report. The recommendation for acceptance of subparagraph HBB-3214.2 is based on the third written paragraph, which states, “The basis for choosing the selected methods and relations used should be included in the Design Report.”

Note:

> The stress analysis in subparagraph HBB-3214.2 states for 9Cr-1Mo-V, decoupling of plastic and creep strains in the classical constitutive framework is generally a poor representation of the true material behavior. Unified constitutive equations, which do not distinguish between rate-dependent plasticity and time-dependent creep, represent the rate dependence and softening that occur, particularly at higher temperatures. The use of this material is governed by the requirements and recommendations of ORNL’s report on HBB-2000 *Material*.
>
> The reference to “rules and limits” in Nonmandatory Appendix HBB-T and subparagraph HBB-T-1510(g) is acceptable because NUMARK states in the introduction of Section 3.1 *Nonmandatory Appendix HBB-T Rules for Strain, Deformation, and Fatigue Limits at Elevated Temperatures*, “Our technical recommendation finds the limits of HBB-T are an acceptable approach for demonstrating compliance with the design requirements for Division 5 Class A components although the owner may use other methods as justified in the design report (NCA-3550).”

HBB-3214.3, Mechanical and Physical Properties

It is recommended that subparagraph HBB-3214.3 be accepted as written, because it is fundamentally identical to subparagraph -3214.3 of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

> The reference to the mechanical and physical properties in Mandatory Appendix HBB-I-14 is acceptable. The use of these mechanical and physical properties is governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.
>
> The reference to the mechanical and physical properties in Nonmandatory Appendix HBB-T is acceptable. The use of these mechanical and physical properties is governed by the requirements and recommendations of NUMARK's report on Nonmandatory Appendix HBB-T *Rules for Strain, Deformation, and Fatigue Limits at Elevated Temperatures*.

HBB-3215, Derivation of Stress Intensities

It is recommended that paragraph HBB-3215 be accepted as written because it is fundamentally identical to paragraph -3215 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3216, Derivation of Stress Differences and Strain Differences

It is recommended that paragraph HBB-3216 be accepted as written because it is fundamentally identical to paragraph -3216 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3217, Classification of Stresses

It is recommended that paragraph HBB-3217 be accepted as written because it is fundamentally identical to paragraph -3217 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that Table HBB-3217-1 be accepted as written. Table HBB-3217-1 is fundamentally identical to Table -3217-1 of Code Case 1592, except for the added note and the expansion on the vessel component – Nozzles, which has been approved for use through NRC RG 1.87. It is recommended that these additions to Table HBB-3217-1 be accepted as written because the addition of Vessel Component – Nozzles (HBB-3227.5) is similar to Table NB-3217-1 Vessel Component-Nozzles (NB-3227.5), which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. See Section 4, HBB-3217 for further detail.

Note:

> Table HBB-3217-1, cladding type of stress should be peak stress, as described in the 2017 edition of Sec. III Appendices, Appendix XIII, Table XIII-2600-1.

It is recommended that Table HBB-3217-2 be accepted as written because it is fundamentally identical to Table -3217-2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3220, DESIGN RULES AND LIMITS FOR LOAD-CONTROLLED STRESSES IN STRUCTURES OTHER THAN BOLTS

HBB-3221, General Requirements

It is recommended that paragraph HBB-3221 be accepted as written, because it is fundamentally identical, with additional information, to -3221 of Code Case 1592, which has been approved for use through NRC RG 1.87. The additional information included in HBB-3221 is recommended as acceptable. See Section 4, HBB-3221 for further detail.

Note:

For HBB-3221(a), the allowable stress intensity values found in the 2017 edition of ASME BPVC Section II, Part D (II-D), Subpart 1, Tables 2A and 2B at or below the continuous operating temperature defined for III-1 use are acceptable. These tables from II-D are approved for use by reference in III-1-NB, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Additionally, the allowable stress intensity values found in Tables HBB-I-14.1(a) through HBB-I-14.13C are acceptable. The use of these tables is governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

For HBB-3221(b)(1) S_m, any value for the time independent allowable design stress intensity, S_m, found using the criteria from the 2017 edition of II-D at or below the continuous operating temperature defined for III-1 is acceptable for use, because the 2017 edition of the ASME BPVC is expected to be incorporated by reference according to 83 FR 56156. The use of S_m values extended beyond the III-1 continuous use temperature and the adjustment to account for long-time service at elevated temperature as discussed in HBB-2160(d) is acceptable and is governed by the requirements and recommendations of ORNL's report on HBB-2000 *Material*.

For HBB-3221(b)(1) S_{mt}, the value for the stress intensity, S_{mt}, found from Figures HBB-I-14.3A through HBB-I-14.3E and in Tables HBB-I-14.3A through HBB-I-14.3E and the adjustment to account for long-time service at elevated temperature as discussed in HBB-2160(d) are acceptable. The acceptance of HBB-2160(d) and HBB-I-14 tables and figures is governed by the requirements and recommendations of ORNL's report on HBB-2000 *Material* and Mandatory Appendix HBB-I-14 *Tables and Figures*.

For HBB-3221(b)(1) S_o, the value for the maximum allowable stress, S_o, given in Table HBB-I-14.2 is acceptable for use and governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

For HBB-3221(b)(1) S_t, creep rupture test at various temperature and stress levels must be performed to obtain the full creep curve data for the material in question. This is required to determine the limits established in (a) through (c) in order to determine the time-dependent allowable stress value for Service Loadings, S_t. Literature values should

not be used. The limits established in (a) through (c) for S_t are acceptable for calculating the time-dependent allowable stress value for Service Loadings when compared to those imposed in Code Case 1592.

For HBB-3221(b)(1) S_y, the value for the yield strength, S_y, above the continuous use temperature for III-1 use given in II-D and in Table HBB-I-14.5 is acceptable for use and governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

For HBB-3221(b)(2), the value for allowable limits of S_{mt} and S_t on the weldments taken as the minimum from Tables HBB-I-14.3A through HBB-I-14.3E and Tables HBB-I-14.4A through HBB-I-14.4E, respectively, or 80% of the ratio of weld metal to base metal creep rupture strength from Tables HBB-I-14.10A-1 through HBB-I-14.0E-1 times the minimum stress to rupture from Tables HBB-I-14.6A through HBB-I-14.6F is acceptable for use and governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

Additionally, the adjustment to account for long-time service at elevated temperature as discussed in HBB-2160(d) is acceptable and is governed by the requirements and recommendations of ORNL's report on HBB-2000 *Material*.

Figure HBB-3221-1, Flow Diagram for Elevated Temperature Analysis
It is recommended that Figure HBB-3221-1 be accepted. See Section 4, Figure HBB-3221-1 for further detail.

Load-Controlled Stress Limits:

It is recommended that the Design Limits entry be accepted as written because it is fundamentally identical to this entry in Figure 3220-1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that the Levels A and B Service Limits entry and Level C Service Limits entry be accepted as written, because they are fundamentally identical to this entry in Figure 3220-1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that the Level D Limits entry be accepted as written, because it is fundamentally identical to this entry in Figure 3220-1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

For Levels A, B, and C Service Limits, the variable K in Figure HBB-3221-1 is the section factor and is discussed in greater detail in Section 4, HBB-3223. Specifically, the applicant may use a section factor for the cross section being investigated for Level A and B Service Limits but must use a section factor value between 1.0 and 1.5 for the Level C Service Limit. The factor of 1.5 is the value used in Code Case 1592 and the

upper limit per HBB-3224(c). A K value of 1.5 will give equivalent allowables to what is presented in Code Case 1592.

It is recommended that the Level D Limits entry be accepted as written, because it is fundamentally identical to this entry in Figure 3220-1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

For the Level D Service Limits, the two entries that have been changed to App. F in Table HBB-3221-1 are correct as written. ASME BPVC Section III, Appendices, Nonmandatory Appendix F is where the applicant would locate the Level D Service Limits for inelastic analysis for Collapse Load, C_L, and Plastic Instability Load.

Strain and Deformation Limits:

It is recommended that the Design Limits entry be accepted as written. Figure 3220-1 of Code Case 1592 does not impose strain and deformation limits for the design, while Figure HBB-3221-1 requires that the time independent buckling be checked. Adding the requirement to investigate buckling is conservative and will bolster safety of the design. The use of III-1 NB-3133 is acceptable for use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Additionally, the use of HBB-T-1500 is acceptable for use and is governed by the requirements and recommendations of NUMARK's report on subarticle HBB-T-1500 *Buckling and Instability*.

It is recommended that the Levels A, B, and C Limits entry be accepted as written. This entry is fundamentally identical to Figure 3220-1 of Code Case 1592. Additionally, the reference to Nonmandatory Appendix HBB-T is acceptable for use and is governed by the requirements and recommendations of NUMARK's report on Nonmandatory Appendix HBB-T *Rules for Strain, Deformation, and Fatigue Limits at Elevated Temperatures*.

It is recommended that the Level D Limits entry be accepted as written because it is fundamentally identical to this entry in Figure 3220-1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3222, Design and Service Limits

HBB-3222.1, Design Limits

It is recommended that subparagraph HBB-3222.1 be accepted as written because it is fundamentally identical to subparagraph -3222.1 of Code Case 1592, which has been approved for use through NRC RG 1.87. The additional requirement of HBB-3222.1(c) to account for adequate buckling strength is conservative and uses the approved rules of III-1 NB-3133, which is acceptable for use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

Note:

> The ASME Code Reconciliation document provided by the NRC indicates that the “or equal to” sign was added to the equations in this subparagraph. Upon review of Code Case 1592, it has been determined that this statement is incorrect and that the “less than or equal to” sign is present in the equations of -3221.1.

HBB-3222.2, Level A Service Limits

It is recommended that subparagraph HBB-3222.2 be accepted as written because it is fundamentally identical to subparagraph -3222.2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3223, Level A and B Service Limits

It is recommended that paragraph HBB-3223 be accepted as written, because it is fundamentally identical to paragraph -3223 of Code Case 1592, which has been approved for use through NRC RG 1.87. See Section 4, HBB-3223 for further detail.

Note:

> The ASME Code Reconciliation document provided by the NRC indicates that the “or equal to” sign was added to the equation (3) in this paragraph. Upon review of Code Case 1592, it has been determined that this statement is incorrect and that the “less than or equal to” sign is present in the equation (3) of -3223.

HBB-3224, Level C Service Limits

It is recommended that paragraph HBB-3224 be accepted as written. HBB-3224 is fundamentally identical to paragraph -3224 of Code Case 1592, which has been approved for use through NRC RG 1.87. See Section 4, HBB-3224 for further detail.

Note:

> The ASME Code Reconciliation document provided by the NRC indicates that the “or equal to” sign was added to the equations in this paragraph. Upon review of Code Case 1592, it has been determined that this statement is incorrect and that the “less than or equal to” sign is present in the equations of -3224.
>
> The definition of t_{im}, and the next written paragraph state the value for t_{im} must be taken from graphs of S_t-vs-time and point to Figures HBB-I-14.4A through HBB-I-14.4E. The use of Figures HBB-I-14.4A through HBB-I-14.4E is acceptable and is governed by the requirements and recommendations of ORNL’s report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

Figures HBB-3224-1 and HBB-3224-2 are accepted as shown. Note that these figures summarize the use fraction information from HBB-3224 and HBB-3225 for membrane and membrane plus bending onto Figures HBB-3224-1 and HBB-3224-2, respectively. See Section 4, HBB-3224 for further detail.

Note:

The applicable temperature curves from Figure HBB-I-14.4 for Level C and Figure HBB-I-14.6 for Level D use-fractions are acceptable for use and are governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

HBB-3225, Level D Service Limits

It is recommended that paragraph HBB-3225 be accepted as written because the information from Code Case 1592 has been incorporated and updated in HBB-3225. See Section 4, HBB-3225 for further detail.

Note:

The values for R and S_r taken from Tables HBB-I-14.10A-1 through HBB-I-14.10E-1 and Tables HBB-I-14.6A through HBB-I-14.6F, respectively, are acceptable for use and are governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

The definition of t_{ir} and the next written paragraph state the value for t_{ir} must be taken from a graph of minimum stress-to-rupture versus time and point to Figures HBB-I-14.6A through HBB-I-14.6F. Figures HBB-I-14.6A through HBB-I-14.6F are acceptable for use and are governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

The definition of t_{ibr} states the value is determined by Figures HBB-I-14.6A through HBB-I-14.6F. Figures HBB-I-14.6A through HBB-I-14.6F are acceptable for use and are governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

The yield strength, tensile strength, and strength reduction factors from Tables HBB-I-14.5, HBB-3225-1, HBB-3225-2, HBB-3225-3A, HBB-3225-3B and HBB-3225-4 are acceptable for use and are governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures* and HBB-2000 *Material*.

HBB-3226, Pressure Testing Limitations

It is recommended that paragraph HBB-3226 be accepted as written because it is fundamentally identical to paragraph -3226 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3227, Special Stress Limits

It is recommended that paragraph HBB-3227 be accepted as written because it is fundamentally identical to paragraph -3227 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3227.1, Bearing Loads

It is recommended that subsubparagraph HBB-3227.1(a) be accepted as written because it is fundamentally identical, excluding the additional information, to the first part of subsubparagraph -3227.1(a) of Code Case 1592, which has been approved for use through NRC RG 1.87. The additional information is acceptable and is recommended as being accepted as written. See Section 4, HBB-3227.1 for further detail.

Note:

> The use of S_y at temperatures above the III-1 maximum temperature limits found in Mandatory Appendix HBB-1-14 is acceptable and is governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

HBB-3227.2, Pure Shear

It is recommended that subparagraph HBB-3227.2 be accepted as written because it is fundamentally identical to subparagraph -3227.2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3227.3, Progressive Distortion of Nonintegral Connections

It is recommended that subparagraph HBB-3227.3 be accepted as written because it is fundamentally identical to subparagraph -3227.3 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3227.4, Triaxial Stresses

It is recommended that subparagraph HBB-3227.4 be accepted as written because it is fundamentally identical to subparagraph -3227.4 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3227.5, Nozzle Piping Transition

It is recommended that subparagraph HBB-3227.5 be accepted as written because it is fundamentally identical to subparagraph -3227.5 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3227.7, Requirements for Specially Designed Welded Seals

It is recommended that subparagraph HBB-3227.7 be accepted as written because it is fundamentally identical to subparagraph -3227.7 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3227.8, Cladding

It is recommended that subparagraph HBB-3227.8 be accepted, except for subsubparagraph HBB-3227.8(d), as written because it is fundamentally identical to subparagraph -3227.8 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that subsubparagraph HBB-3227.8(d) be rejected as written and supplemented with the requirements of XIII-3710 *Bearing Loads* (2017 edition) because this error has been identified and corrected in the 2017 edition of Sec. III Appendices, Mandatory Appendix XIII.

HBB-3230, STRESS LIMITS FOR LOAD-CONTROLLED STRESSES ON BOLTS

HBB-3231, General Requirements

It is recommended that paragraph HBB-3231 be accepted as written because it is fundamentally identical to paragraph -3231 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3232, Design Limits for Bolts at Elevated Temperatures

It is recommended that paragraph HBB-3232 be accepted as written because it is fundamentally identical to paragraph -3232 of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

> The use of Table HBB-I-14.12 is acceptable and is governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

HBB-3233, Level A and B Service Limits for Bolts at Elevated Temperatures

HBB-3233.1, Average Stress

It is recommended that subparagraph HBB-3233.1 be accepted as written because it is fundamentally identical to subparagraph -3233.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

> The use of Figures HBB-I-14.3A through HBB-I-14.13C is acceptable and is governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

HBB-3233.2, Maximum Stress in the Cross Section

It is recommended that subparagraph HBB-3233.2 be accepted as written because it is fundamentally identical to subparagraph -3233.2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

> The use of Figures HBB-I-14.3A through HBB-I-14.13C is acceptable and is governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

HBB-3233.3, Maximum Stress in the Bolt Periphery

It is recommended that subparagraph HBB-3233.3 be accepted as written because it is fundamentally identical to subparagraph -3233.3 of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

The use of Figures HBB-I-14.3A through HBB-I-14.13C is acceptable and is governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

HBB-3233.4, Nonductile Fracture

It is recommended that subparagraph HBB-3233.4 be accepted as written because it is fundamentally identical to subparagraph -3233.4 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3234, Level C Service Limits

It is recommended that paragraph HBB-3234 be accepted as written because it is fundamentally identical to paragraph -3234 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3235, Level D Service Limits

It is recommended that paragraph HBB-3235 be accepted as written because it is fundamentally identical to paragraph -3235 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3240, SPECIAL REQUIREMENTS FOR ELEVATED TEMPERATURE COMPONENTS

HBB-3241, Nonductile Fracture

It is recommended that paragraph HBB-3241 be accepted as written because it is fundamentally identical to paragraph -3241 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3250, LIMITS ON DEFORMATION-CONTROLLED QUANTITIES

HBB-3251, General Requirements

It is recommended that paragraph HBB-3251 be accepted as written because it is fundamentally identical to paragraph -3251 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3252, Criteria

It is recommended that paragraph HBB-3252 be accepted as written because it is fundamentally identical to paragraph -3252 of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

The use of Nonmandatory Appendix HBB-T is acceptable and is governed by the requirements and recommendations of NUMARK's report on Nonmandatory Appendix HBB-T *Rules for Strain, Deformation, and Fatigue Limits at Elevated Temperatures*.

HBB-3300, VESSEL DESIGNS

HBB-3310, GENERAL REQUIREMENTS

HBB-3311, Acceptability
It is recommended that paragraph HBB-3311 be accepted as written because it is fundamentally identical to paragraph -3311 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3330, OPENING AND REINFORCEMENT

HBB-3331, General Requirements for Openings
It is recommended that paragraph HBB-3331 be accepted as written, except for HBB-3331(b), because it is fundamentally identical to paragraph -3331 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is recommended that HBB-3331(b) be accepted as written. See Section 4, HBB-3331 for further detail.

Note:

> The ASME Code Reconciliation document provided by the NRC indicates that the HBB-3331(c) is new unreviewed text. Upon review of Code Case 1592, it has been determined that HBB-3331(c) is fundamentally identical to -3331(b) and that HBB-3331(b) is new unreviewed information.

HBB-3332, Reinforcement Requirements for Openings in Shells and Formed Heads
It is recommended that paragraph HBB-3332 be accepted as written because it is fundamentally identical to paragraph -3332 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3333, Reinforcement Requirements for Openings in Flat Heads
It is recommended that paragraph HBB-3333 be accepted as written because it is fundamentally identical to paragraph -3333 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3334, Limits of Reinforcement
It is recommended that paragraph HBB-3334 be accepted as written because it is fundamentally identical to paragraph -3334 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3335, Metal Available for Reinforcement
It is recommended that paragraph HBB-3335 be accepted as written because it is fundamentally identical to paragraph -3335 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3336, Strength of Reinforcing Material
It is recommended that paragraph HBB-3336 be accepted as written because it is fundamentally identical to paragraph -3336 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3337, Attachment of Nozzles and Other Connections

HBB-3337.1, General Requirements
It is recommended that subparagraph HBB-3337.1 be accepted as written because it is fundamentally identical to subparagraph -3337.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3337.2, Full Penetration Welded Nozzles
It is recommended that subparagraph HBB-3337.2 be accepted as written because it is fundamentally identical to subparagraph -3337.2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3337.3, Partial Penetration Welded Nozzles
It is recommended that subparagraph HBB-3337.3 be accepted as written because it is fundamentally identical to subparagraph -3337.3 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3338, Evaluation of Strain and Creep-Fatigue Limits in Openings

HBB-3338.1, General
It is recommended that subparagraph HBB-3338.1 be accepted as written. Paragraph -3338 of Code Case 1592 states that the rules of NB-3338 apply when creep phenomena are insignificant and paragraph -3250 applies when creep effects are significant. Subsubarticle -3250 is identical to HBB-3250 and only directs the applicant to account for creep effects with no specific indication of how to complete this task. HBB-3338.1 details two applicable methods for determining deformation-controlled stresses, and these methods are fundamentally identical to information found NB-3338.1, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Therefore, the information contained in paragraph -3338 of Code Case 1592 is accounted for in subparagraph HBB-3338.1.

HBB-3338.2, Stress Index Method
It is recommended that subparagraph HBB-3338.2 be accepted as written. Subparagraph HBB-3338.2 points to NB-3338, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, as an acceptable Code location for the stress indices and rules to satisfy strain and creep-fatigue limits.

Note:

> The use of strain and creep-fatigue limits from HBB-T-1320, HBB-T-1330, and HBB-T-1430 is acceptable and is governed by the requirements and recommendations of NUMARK's report on Nonmandatory Appendix HBB-T *Rules for Strain, Deformation, and Fatigue Limits at Elevated Temperatures*.

HBB-3339, Alternative Rules for Nozzle Design

It is recommended that paragraph HBB-3339 be accepted as written. HBB-3339 expands the requirements of paragraph -3339 of Code Case 1592 by requiring the wall thickness t_r be defined by III-5-HBB instead of allowing it to be defined by III-1-NB. Additionally, HBB-3339 aligns itself with NB-3339 by dictating NB-3339 is an acceptable alternative to the rules of HBB-3332 through HBB-3336 and HBB-3338, which is analogous to what is stated in NB-3339, i.e., alternative to the rules of NB-3332 through NB-3336 and NB-3338, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HBB-3339.1, Stress Indices

It is recommended that subparagraph HBB-3339.1 be accepted as written. HBB-3339.1 indicates that the stress indices and rules of NB-3339.7, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, may be used with an elastic or simplified inelastic analysis to satisfy the strain and creep-fatigue limits. This is an acceptable approach and is in line with what is stated in paragraph -3339 of Code Case 1592.

Note:

> The use of strain and creep-fatigue limits from HBB-T-1320, HBB-T-1330, and HBB-T-1430 are acceptable and are governed by the requirements and recommendations of NUMARK's report on Nonmandatory Appendix HBB-T *Rules for Strain, Deformation, and Fatigue Limits at Elevated Temperatures*.

HBB-3350, DESIGN OF WELDED CONSTRUCTION

HBB-3351, Welded Joint Category

It is recommended that paragraph HBB-3351 be accepted as written because it is fundamentally identical to paragraph -3351 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that Figure HBB-3351-1 be accepted as shown because it is fundamentally identical to Figure -3351-1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3351.1, Category A

It is recommended that subparagraph HBB-3351.1 be accepted as written because it is fundamentally identical to subparagraph -3351.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3351.2, Category B

It is recommended that subparagraph HBB-3351.2 be accepted as written because it is fundamentally identical to subparagraph -3351.2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3351.3, Category C

It is recommended that subparagraph HBB-3351.3 be accepted as written because it is fundamentally identical to subparagraph -3351.3 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3351.4, Category D

It is recommended that subparagraph HBB-3351.4 be accepted as written because it is fundamentally identical to subparagraph -3351.4 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3352, Permissible Types of Welded Joints

It is recommended that subparagraphs HBB-3352(a) through HBB-3352(g) be accepted as written because these are fundamentally identical to subparagraphs -3352(a) through -3352(g), respectively, of Code Case 1592, which has been approved for use through NRC RG 1.87. It is recommended that subparagraph HBB-3352(h) be accepted as written. See Section 4, HBB-3352 for further detail.

It is recommended that Figure HBB-3352-1 be accepted as shown because it is fundamentally identical to Figure -3352-1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3353, Design of Welded Construction at Elevated Temperatures

It is recommended that paragraph HBB-3353 be accepted as written because it is fundamentally identical to paragraph -3353 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3354, Structural Attachment Welds

It is recommended that subparagraph HBB-3354 be accepted as written because it is fundamentally identical, except for the additional information, to paragraph -3354 of Code Case 1592, which has been approved for use through NRC RG 1.87. The additional information is acceptable and is recommended as acceptable. See Section 4, HBB-3354 for further detail.

Note:

> The use of HBB-2121(h) is acceptable and is governed by the requirements and recommendations of ORNL's report on HBB-2000 *Material*.

It is recommended that Figure HBB-3354-1 be accepted as shown because it visually depicts what is stated in HBB-3354(b).

HBB-3355, Welding Grooves

It is recommended that paragraph HBB-3355 be accepted as written because it is fundamentally identical to paragraph -3355 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3356, Fillet Welds

HBB-3356.1, At Pressure Loaded Joints
It is recommended that subparagraph HBB-3356.1 be accepted as written because it is fundamentally identical to the first part of paragraph -3356 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3356.2, At Structural Attachment Joints
It is recommended that subsubparagraphs HBB-3356.2(a) and HBB-3356.2(b) be accepted as written because they are fundamentally identical to the remaining part of paragraph -3356 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is recommended that subsubparagraph HBB-3356.2(c) be accepted as written. See Section 4, HBB-3356.2 for further detail.

Note:

> For socket welded fittings used in accordance with 10 CFR 50.55a(b)(1)(ii), applicants and licensees may not apply the Section III provisions for welds with leg size less than 1.09* t_n, where t_n is the nominal pipe thickness.

HBB-3357, Thermal Treatment
It is recommended that paragraph HBB-3357 be accepted as written because it is fundamentally identical to paragraph -3357 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3360, SPECIAL VESSEL REQUIREMENTS

HBB-3361, Category A or B Joints Between Sections of Unequal Thickness
It is recommended that paragraph HBB-3361 be accepted as written because it is fundamentally identical to paragraph -3361 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that Figure HBB-3361-1 be accepted as shown because it is fundamentally identical to Figure -3361-1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3362, Bolted Flange Connections
It is recommended that paragraph HBB-3362 be accepted as written because it is fundamentally identical to paragraph -3362 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3363, Access Openings
It is recommended that paragraph HBB-3363 be accepted as written because it is fundamentally identical to paragraph -3363 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3364, Supports
It is recommended that paragraph HBB-3364 be accepted as written because it is fundamentally identical to paragraph -3364 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3400, DESIGN OF CLASS A PUMPS

HBB-3410, GENERAL REQUIREMENTS

HBB-3410.1, Scope
It is recommended that subparagraph HBB-3410.1 be accepted as written because it is fundamentally identical to subparagraph -3410.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3410.2, Definitions
It is recommended that subparagraph HBB-3410.2 be accepted as written because it is fundamentally identical to subparagraph -3410.2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that Figure HBB-3410.2-1 be accepted as shown because it is fundamentally identical to Figure -3410.2-1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that Figure HBB-3410.2-2 be accepted as shown because it is fundamentally identical to Figure -3410.2-2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3411, Acceptability of Large Pumps
It is recommended that paragraph HBB-3411 be accepted as written because it is fundamentally identical to paragraph -3411 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3412, Acceptability of Small Pumps
It is recommended that paragraph HBB-3412 be accepted as written because it is fundamentally identical to paragraph -3412 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3413, Alternative Design Rules
It is recommended that paragraph HBB-3413 be accepted as written because it is fundamentally identical to paragraph -3413 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3420, DESIGN CONSIDERATIONS

HBB-3421, Design Requirements

HBB-3421.1, Loadings
It is recommended that subparagraph HBB-3421.1 be accepted as written because it is fundamentally identical to subparagraph -3421.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3421.2, Piping Under External Pressure
It is recommended that subparagraph HBB-3421.2 be accepted as written because it is fundamentally identical to subparagraph -3421.2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3421.3, Piping Under Internal Pressure
It is recommended that subparagraph HBB-3421.3 be accepted as written because it is fundamentally identical to subparagraph -3421.3 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3421.4, Piping Connections Using Partial Penetration Welds
It is recommended that subparagraph HBB-3421.4 be accepted as written because it is fundamentally identical to subparagraph -3421.4 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3421.5, Bolting – Radially Split Configurations
It is recommended that subparagraph HBB-3421.5 be accepted as written because it is fundamentally identical to subparagraph -3421.5 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3421.6, Bolting – Axially Split Configurations
HBB-3421.6 does not exist in the 2017 Code. However, Code Case 1592 has a subparagraph -3421.6 that states, “bolting in axially split configurations may be designed in accordance with the procedure given in -3430 for Type G pumps when creep effects are not present and elastic analysis models are applicable.” Subsubarticle -3430 directs the applicant to NB-3430. From the 1971 Code (Winter 1972 Addenda), which was the Code in effect when Code Case 1592 was introduced, NB-3437, a paragraph under subsubarticle NB-3430, discusses the design of a Type G pump. However, upon review of subsubarticle NB-3440 of the 2017 Code, which is the current location for the information of NB-3430 from the 1971 Code, there is no Type G pump. Therefore, the omission of this subparagraph from III-5-HBB is acceptable.

HBB-3421.7, Supports
It is recommended that subparagraph HBB-3421.7 be accepted as written because it is fundamentally identical to subparagraph -3421.7 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3421.8, Axially Oriented Inlets and Outlets
It is recommended that subparagraph HBB-3421.8 be accepted as written because it is fundamentally identical to subparagraph -3421.8 of Code Case 1592, which has been approved for use through NRC RG 1.87. Additionally, Figure NB-3433-1 from the 1971 Code (Winter 1972 Addenda), which was the Code in effect when Code Case 1592 was introduced, is identical to the Figure NB-3441.3-2 of the 2017 Code.

HBB-3421.9, Radially Oriented Inlets and Outlets
It is recommended that subparagraph HBB-3421.9 be accepted as written because it is fundamentally identical to subparagraph -3421.9 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3421.10, Tangential Inlets and Outlets
It is recommended that subparagraph HBB-3421.10 be accepted as written because it is fundamentally identical to subparagraph -3421.10 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3421.11, Stress Analysis, Nozzle Loads, and Reinforcement
It is recommended that subparagraph HBB-3421.11 be accepted as written because it is fundamentally identical to subparagraph -3421.11 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that Figure HBB-3421.11-1 be accepted as shown because it is fundamentally identical to Figure -3421.11-1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3421.12, Earthquake Design Analysis
It is recommended that subparagraph HBB-3421.12 be accepted as written because it is fundamentally identical to subparagraph -3421.12 of Code Case 1592 which has been approved for use through NRC RG 1.87.

HBB-3421.13, Attachments
It is recommended that subparagraph HBB-3421.13 be accepted as written because it is fundamentally identical to subparagraph -3421.13 of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

> The use of Nonmandatory Appendix HBB-T is acceptable and is governed by the requirements and recommendations of NUMARK's report on Nonmandatory Appendix HBB-T *Rules for Strain, Deformation, and Fatigue Limits at Elevated Temperatures*.

HBB-3421.14, Appurtenances
It is recommended that subparagraph HBB-3421.14 be accepted as written because it is fundamentally identical to subparagraph -3421.14 of Code Case 1592, which has been approved for use through NRC RG 1.87. Additionally, the -3421.14 reference of NA-1240 from the 1971 Code, which was in effect when Code Case 1592 was introduced, is identical to the

HBB-3421.14 reference of NCA-1260 of the 2017 Code. The Code Case 1592 subparagraph -3421.14 reference appears to be incorrect as written and should instead have said NA-1240 because there are no requirements for documentation for appurtenances in NA-1231 of the 1971 Code.

HBB-3421.15, Pump Covers

It is recommended that subparagraph HBB-3421.15 be accepted as written because it is fundamentally identical to subparagraph -3421.15 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3421.17, Cladding

It is recommended that subparagraph HBB-3421.17 be accepted as written because it is fundamentally identical to subparagraph -3421.17 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3421.19, Cutwater Tip Stresses

It is recommended that subparagraph HBB-3421.19 be accepted as written because it is fundamentally identical to subparagraph -3421.19 of Code Case 1592, which has been approved for use through NRC RG 1.87. Additionally, Figure NB-3433-1 from the 1971 Code (Winter 1972 Addenda), which was in effect when Code Case 1592 was introduced, is identical to Figure NB-3441.3-2 of the 2017 Code. The Code Case 1592 reference to Figure NB-3422-1 is a typo and should read as Figure NB-3433-1. See Section 4, HBB-3421.19 for further detail.

HBB-3430, PUMP TYPES

It is recommended that paragraph HBB-3430 be accepted as written because it is fundamentally identical to subparagraph -3430(b) of Code Case 1592. It is recommended that the deletion of the special requirements of subparagraph -3430(a) be accepted. Subparagraph -3430(a) limits the use of III-1 NB-3430 to regions where creep behavior is negligible. The deletion of this statement is considered acceptable because the design requirements for centrifugal pumps would still be applicable for III-5-HBB use because the applicant would still be required to follow the general requirements of subarticle HBB-3400 for the design of Class A pumps.

HBB-3500, DESIGN OF CLASS A VALVES

HBB-3510, DESIGN REQUIREMENTS

HBB-3511, Acceptability

It is recommended that paragraph HBB-3511 be accepted as written because it is fundamentally identical to paragraph -3511 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3512, Stress Analysis

It is recommended that paragraph HBB-3512 be accepted as written because it is fundamentally identical to paragraph -3512 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3513, Wall Thickness Requirements for Design Conditions Analysis
HBB-3513 does not exist in the 2017 Code. However, Code Case 1592 has paragraph -3513 that gives an equation for the minimum wall thickness requirement for pressure retaining parts for the Design Limits analysis. The omission of this paragraph from III-5-HBB and accompanying Table -3513-1 is recommended as acceptable because this general requirement is inherently part of HBB-3512, which sends the applicant to III-1 NB-3500. NB-3500, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, has criteria for minimum thicknesses for pressure retaining parts.

HBB-3520

HBB-3524, Earthquake Design Analysis
It is recommended that paragraph HBB-3524 be accepted as written because it is fundamentally identical to paragraph -3524 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3526, Level C Service Limits
It is recommended that paragraph HBB-3526 be accepted as written because it is fundamentally identical to paragraph -3526 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3540

HBB-3544, Body Shape Rules
It is recommended that paragraph HBB-3544 be accepted as written because it is fundamentally identical to paragraph -3544 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3546, Other Valve Parts
It is recommended that paragraph HBB-3546 be accepted as written because it is fundamentally identical to paragraph -3546 of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

> The use of Tables HBB-I-14.1(a), HBB-I-14.1(b), and HBB-I-14.2 for the stress intensity limit of S_o is acceptable and is governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

HBB-3550, CYCLIC LOADING REQUIREMENTS
It is recommended that subsubarticle HBB-3550 be accepted as written because it is fundamentally identical to subsubarticle -3550 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3600, PIPING DESIGN

HBB-3610, GENERAL REQUIREMENTS

HBB-3611, Acceptability
It is recommended that paragraph HBB-3611 be accepted as written because it is fundamentally identical to paragraph -3611 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3612, Pressure-Temperature Ratings for Piping Components
It is recommended that paragraph HBB-3612 be accepted as written because it is fundamentally identical to paragraph -3612 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3620, DESIGN CONSIDERATIONS

HBB-3622, Dynamic Effects

HBB-3622.1, Impact
It is recommended that subparagraph HBB-3622.1 be accepted as written because it is fundamentally identical to subparagraph -3622.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3622.2, Earthquake
It is recommended that subparagraph HBB-3622.2 be accepted as written because it is fundamentally identical to subparagraph -3622.2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3622.3, Vibration
It is recommended that subparagraph HBB-3622.3 be accepted as written because it is fundamentally identical to subparagraph -3622.3 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3623, Weight Effects
It is recommended that paragraph HBB-3623 be accepted as written because it is fundamentally identical to paragraph -3623 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3624, Loadings, Displacements, and Restraints
It is recommended that paragraph HBB-3624 be accepted as written because it is fundamentally identical to paragraph -3624 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3626, Special Drainage Problems
It is recommended that paragraph HBB-3626 be accepted as written because it is fundamentally identical to paragraph -3626 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3627, Considerations for Liquid Metal Piping

HBB-3627.1, Location
It is recommended that subparagraph HBB-3627.1 be accepted as written because it is fundamentally identical to subparagraph -3627.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3627.2, Heat Tracing
It is recommended that subparagraph HBB-3627.2 be accepted as written because it is fundamentally identical to subparagraph -3627.2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3627.3, Filling and Draining
It is recommended that subparagraph HBB-3627.3 be accepted as written because it is fundamentally identical to subparagraph -3627.3 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3640, PRESSURE DESIGN OF COMPONENTS

HBB-3641

HBB-3641.1, Straight Pipe
It is recommended that subparagraph HBB-3641.1 be accepted as written because it is fundamentally identical to subparagraph -3641.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3642, Curved Segments of Pipe

HBB-3642.1, Pipe Bends
It is recommended that subparagraph HBB-3642.1 be accepted as written because it is fundamentally identical to subparagraph -3642.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that Table HBB-3642.1-1 be accepted as shown because it is fundamentally identical to Table -3642.1-1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3643, Intersections
It is recommended that paragraph HBB-3643 be accepted as written because it is fundamentally identical to paragraph -3643 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3643.1, General Requirements
It is recommended that subparagraph HBB-3643.1 be accepted as written because it is fundamentally identical to subparagraph -3643.1 of Code Case 1592, which has been approved for use through NRC RG 1.87. See Section 4, HBB-3643.1 for further detail.

HBB-3643.2, Branch Connections

It is recommended that subparagraph HBB-3643.2 be accepted as written because it is fundamentally identical to subparagraph -3643.2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

> For socket welded fittings used in pressure-retaining joints in accordance with 10 CFR 50.55a(b)(1)(ii), applicants and licensees may not apply the Section III provisions for welds with leg size less than 1.09* t_n, where t_n is the nominal pipe thickness.

HBB-3644, Miters

It is recommended that paragraph HBB-3644 be accepted as written because it is fundamentally identical to paragraph -3644 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3645, Attachments

It is recommended that paragraph HBB-3645 be accepted as written because it is fundamentally identical to paragraph -3645 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3646, Closures

It is recommended that paragraph HBB-3646 be accepted as written because it is fundamentally identical to paragraph -3646 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3647, Flanged Joints

It is recommended that paragraph HBB-3647 be accepted as written because it is fundamentally identical to paragraph -3647 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3648, Reducers

It is recommended that paragraph HBB-3648 be accepted as written because it is fundamentally identical to paragraph -3648 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3649, Pressure Design of Other Pressure-Retaining Components

It is recommended that paragraph HBB-3649 be accepted as written because it is fundamentally identical to paragraph -3649 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3649.1, Experimental Analysis

It is recommended that subparagraph HBB-3649.1 be accepted as written because it is fundamentally identical to subparagraph -3649.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3650, ANALYSIS OF PIPING COMPONENTS

HBB-3651, General Requirements

It is recommended that paragraph HBB-3651 be accepted as written because it is fundamentally identical , except for HBB-3651(c), to paragraph -3651 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is recommended that subparagraph HBB-3651(c) be accepted as written. See Section 4, HBB-3651 for further detail.

Note:

> The use of strain and creep-fatigue limits from HBB-T-1320, HBB-T-1330, and HBB-T-1430 are acceptable and are governed by the requirements and recommendations of NUMARK's report on Nonmandatory Appendix HBB-T *Rules for Strain, Deformation, and Fatigue Limits at Elevated Temperatures*.

HBB-3660, DESIGN OF WELDS

It is recommended that paragraph HBB-3660 be accepted as written because it is fundamentally identical to paragraph -3660 of Code Case 1592, which has been approved for use through NRC RG 1.87. See Section 4, HBB-3660 for further detail.

Note:

> For socket welded fittings used in pressure-retaining joints in accordance with 10 CFR 50.55a(b)(1)(ii), applicants and licensees may not apply the Section III provisions for welds with leg size less than 1.09* t_n, where t_n is the nominal pipe thickness.

HBB-3670, SPECIAL PIPING REQUIREMENTS

HBB-3671, Nonwelded Piping Joints

HBB-3671.1, Excluded Designs

It is recommended that subparagraph HBB-3671.1 be accepted as written because it is fundamentally identical to subparagraph -3671.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3671.6, Brazed Joints

It is recommended that subparagraph HBB-3671.6 be accepted as written because it is fundamentally identical to subparagraph -3671.6 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3671.7, Patented Joints

It is recommended that subparagraph HBB-3671.7 be accepted as written because it is fundamentally identical to subparagraph -3671.7 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3672, Expansion and Flexibility
It is recommended that paragraph HBB-3672 be accepted as written because it is fundamentally identical to paragraph -3672 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3674, Design of Piping Supports
It is recommended that paragraph HBB-3674 be accepted as written because it is fundamentally identical to paragraph -3674 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3676, Instrument Piping
HBB-3676 does not exist in the 2017 Code. However, Code Case 1592 has paragraph -3676 that is dedicated to "Instrument Piping." Paragraph -3676 makes reference to NB-3676, which does not exist in the 2017 Code. NB-3676 does exist in the 1971 Code, which was in effect when Code Case 1592 was introduced. Therefore, the omission of paragraph -3676 is recommended as acceptable because instrument piping is no longer part of III-1 use.

3.1.2. ARTICLE HBB-4000, FABRICATION AND INSTALLATION

HBB-4100, GENERAL REQUIREMENTS

HBB-4110, INTRODUCTION
It is recommended that paragraph HBB-4110 be accepted as written because it is fundamentally identical to the reply section of Code Case 1593, which has been approved for use through NRC RG 1.87. Note that Code Case 1593 erroneously references Section III "NB-400" instead of "NB-4000." This has been corrected in HBB-4110.

HBB-4200

HBB-4210

HBB-4212, Effects of Forming and Bending Processes
It is recommended that paragraph HBB-4212 be accepted as written. HBB-4212 incorporates Code Case 1593, which has been approved for use through NRC RG 1.87 and adds language that HBB-4212 supplements the rules of paragraphs NB-4212 and NB-4213, which are approved for ASME Code Section III, Division 1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HBB-4212 provides additional requirements to those in NB-4212 and NB-4213 that are more detailed than those listed in Code Case 1593. Subsequent to ASME Code approval of Code Case 1593, a substantial multi-year research effort was sponsored by the Department of Energy regarding the use of cold worked 304 and 316 stainless steels, as well as Nickel-Iron Chromium Alloy 800H, in high-temperature environments. The purpose of this research was to provide a database for subsequent use by individuals or groups within the ASME BPVC committees. The data produced as a result of this research effort was likely used as the basis for Figure HBB-4212-1, *Permissible Time/Temperature Conditions for Material Which Has Been Cold Worked >5% and <20% and Subjected to Short-Time High Temperature Transients.*

HBB-4240, SPECIAL JOINTS AND FITTINGS – ADDED RULES FOR DIVISION 1, NB-4240
It is recommended that paragraph HBB-4240 be accepted as written. HBB-4240 requires the evaluation of socket welds to determine if an axial gap is needed at the bottom of the socket to prevent the pipe from bottoming out during service due to thermal expansion. If a gap is determined necessary, then it must be verified by radiographic examination or by following special written procedures. While radiography is the most conservative method to measure the bottom clearance in a socket weld, verifying bottoming clearance by following special written procedures during fabrication is the most commonly used method to verify an axial gap at the pipe end/socket bottom interface.

HBB-4400

HBB-4420

HBB-4424, Surfaces of Welds
It is recommended that paragraph HBB-4424 be accepted as written. HBB-4424 states that as-welded surface geometry is permitted provided that the surface geometry is considered in the stress analysis in accordance with the rules for design of Class A elevated temperature components. The requirement to include the surface geometry in the stress analysis will ensure that the impact of as-welded surfaces will be appropriately accounted for by using the proper stress indices when performing analysis in accordance with HBB-3600.

3.1.3. ARTICLE HBB-5000, EXAMINATION

HBB-5100, GENERAL REQUIREMENTS FOR EXAMINATION

HBB-5110, GENERAL REQUIREMENTS
It is recommended that paragraph HBB-5110 be accepted as written because it is fundamentally identical to the reply section of Code Case 1594, which has been approved for use through NRC RG 1.87.

HBB-5130, EXAMINATION OF WELD EDGE PREPARATION SURFACES
It is recommended that paragraph HBB-5130 be accepted as written. HBB-5130 conservatively requires an additional level of component examination with acceptable nondestructive examination (NDE) methods for weld thickness greater than 1 inch.

HBB-5200, REQUIRED EXAMINATION OF WELDS

HBB-5210, CATEGORY A VESSEL WELDED JOINTS AND LONGITUDINAL WELDED JOINTS IN OTHER COMPONENTS
It is recommended that paragraph HBB-5210 be accepted as written. HBB-5210 incorporates section 1.0 of Code Case 1594 Revision 0, and Revision 1. Revision 0 of the Code Case was approved for use through NRC RG 1.87. Revision 1 of the Code Case, which was not included in a revision to NRC RG 1.87 after initial issue, provides for the use of additional inspection methodologies, while eliminating a statement that was not relevant but included in Revision 0. The requirement in Section 1.0(b)(2) to conduct radiography at orientations at least 30 degrees but not more than 150 degrees apart is not relevant. Radiography views through the object.

Radiographic examinations taken 180 degrees apart show the same material just from the opposite side. Thus, angles greater than 150 degrees would be at less than the original 30 degrees from the vertical initially required. HBB-5210 provides examination requirements that are better defined and more specific than Code Case 1594 in accordance with accepted NDE methods and examination volumes.

HBB-5220, CATEGORY B VESSEL WELDED JOINTS AND CIRCUMFERENTIAL WELDED JOINTS IN OTHER COMPONENTS

It is recommended that paragraph HBB-5220 be accepted as written. HBB-5220 incorporates section 2.0 of Code Case 1594 Revision 0, which has been approved for use through NRC RG 1.87. Paragraph HBB-5220 also includes clarifications included in Code Case 1594 Revision 1, which was prepared by ASME in 1975. NRC Reg Guide 1.87 issued in 1975 was not revised to incorporate the clarified inspection information. As such, subsubarticle HBB-5220 provides examination requirements that are better defined and more specific than Code Case 1594 in accordance with accepted NDE methods and examination volumes.

HBB-5230, CATEGORY C VESSEL WELDED JOINTS AND SIMILAR WELDED JOINTS IN OTHER COMPONENTS

It is recommended that paragraph HBB-5230 be accepted as written because the NDE methods and examination volumes identified are proven based on applicability to similar type welds. HBB-3351.3 describes category C welds as comprising welds connecting flanges, tube sheets, or flat heads to main shells and formed heads to transitions in diameter, nozzles, or communicating chambers. Effectively, any weld joint connecting one side plate to another side plate of a flat sided vessel. HBB-5230 provides expanded information on the requirements for proper NDE inspection of welds made under this paragraph over the information provided in NB-5230 (NB-5231) detailing methods required for configurations that would be difficult to properly inspect by some methods.

HBB-5240, CATEGORY D VESSEL WELDED JOINTS AND BRANCH AND PIPING CONNECTIONS IN OTHER COMPONENTS

It is recommended that HBB-5240 be accepted as written because it directs the applicant to substitute the rules of NB-5240 with HBB-5240.

HBB-5242, Butt-Welded Nozzles and Branch and Piping Connections

It is recommended that paragraph HBB-5242 be accepted as written because the NDE methods and examination volumes identified are proven based on applicability to similar type welds. These types of welds involve full penetration joining of metal in the installation or fabrication of flanges, nozzles, and piping connections. This paragraph provides expanded direction on inspection over the requirements of Code Case 1594 Section 3.0 for better guidance on the evaluation depending on sizes and configurations of the welds.

HBB-5243, Full Penetration Corner-Welded Nozzles and Branch and Piping Connections

It is recommended that paragraph HBB-5243 be accepted as written because the NDE methods and examination volumes identified are proven based on applicability to similar type welds. These types of welds involve full penetration joining of metal in the installation or fabrication of flanges, nozzles, and piping connections. This paragraph provides expanded direction on the

inspection over the requirements of Code Case 1594 Section 3.0 for better guidance on the evaluation depending on sizes and configurations of the welds.

HBB-5244, Deposited Weld Metal as Reinforcement for Openings and Attachment of Nozzles, Branch, and Piping Connections

It is recommended that paragraph HBB-5244 be accepted as written because the NDE methods and examination volumes identified are proven based on applicability to similar type welds. These types of welds involve full penetration joining of metal in the installation or fabrication of flanges, nozzles, and piping connections. This paragraph provides expanded direction on the inspection over the requirements of Code Case 1594 Section 3.0 for better guidance on the evaluation depending on sizes and configurations of the welds.

HBB-5245, Partial Penetration Welds

It is recommended that paragraph HBB-5245 be accepted as written because the NDE methods and examination volumes identified are proven based on applicability to similar type welds. These types of welds involve partial penetration joining of metal in the installation or fabrication of flanges, nozzles, and piping connections. These types of welds include fillet welds on small diameter applications. This paragraph provides expanded direction on the inspection over the requirements of Code Case 1594 Section 3.0 for better guidance on the evaluation depending on sizes and configurations of the welds.

HBB-5246, Full Penetration Category D Welds at Oblique Connections

Based on the NDE methods and examination volume identified, it is recommended that this section be accepted as written. While the 1973 Code Case 1594 did not permit the examinations defined in these paragraphs, the NDE methods identified provide surface and volumetric coverage. These types of welds involve full penetration joining of metal in the installation or fabrication of flanges, nozzles, and piping connections. This paragraph provides expanded direction on the inspection over the requirements of Code Case 1594 Section 3.0 for better guidance on the evaluation depending on sizes and configurations of the welds.

HBB-5260, FILLET, SOCKET, AND ATTACHMENT WELDS

HBB-5261, Fillet and Socket Welds

It is recommended that paragraph HBB-5261 be accepted as written because the NDE methods and examination volumes identified are proven based on applicability to similar type welds. HBB-5261 restricts the use of fillet and socket welds to small diameter joints. It further includes requirements for enhanced inspection over the requirements of NB-5261 to ensure that planned clearances exist after welding, which is not required by NB-5261. As a fillet or socket weld is a partial penetration weld, similar welds would include other small-diameter, partial-penetration welds.

HBB-5262, Permanent Structural Attachment Welds

It is recommended that paragraph HBB-5262 be accepted as written. HBB-5262 incorporates Section 4.0 of Code Case 1594, which has been approved for use through NRC RG 1.87 and it provides examination requirements that are better defined and more specific than Code Case 1594 with accepted NDE methods and examination volumes.

HBB-5263, Nonstructural and Temporary Attachments
It is recommended that paragraph HBB-5263 be accepted as written because it is fundamentally identical to Section 4.2 of Code Case 1594, which has been approved for use through NRC RG 1.87.

3.1.4. ARTICLE HBB-6000, TESTING

HBB-6100, GENERAL REQUIREMENTS
It is recommended that the general requirement of subarticle HBB-6100 be accepted as written. It explicitly states that HBB-6000 is to be used for testing of III-5 Class A components when metal temperatures exceed the allowable stress values given in II-D Subpart 1. As Section III, Division 5 does not cover the use of all of the materials in Section II, the additional temperatures and stress values would not be relevant to this Code.

HBB-6110, SCOPE OF TESTING

HBB-6111, General Hydrostatic and Pneumatic Test Media
It is recommended that paragraph HBB-6111 be accepted as written because it is fundamentally identical to paragraph 6111 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6112, Pressure Testing of Components and Appurtenances
It is recommended that subparagraph HBB-6112 be accepted as written because it is fundamentally identical to paragraph 6112, except for subparagraphs HBB-6112(f)-(g), of Code Case 1595, which has been approved for use through NRC RG 1.87. It is recommended that the general requirements of HBB-6112(f) and HBB-6112(g) be accepted as written. See Section 4, HBB-6112 for further detail.

HBB-6113, Pressure Testing of Systems
It is recommended that paragraph HBB-6113 be accepted as written because it is fundamentally identical to paragraph 6113 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6114, Time of Static Pressure Tests of Parts, Piping Subassemblies and Materials
HBB-6114 does not exist in the 2017 Code. However, Code Case 1595 has paragraph 6114 that is dedicated to “Time of Static Pressure Tests of Parts, Piping Subassemblies and Materials.” It is recommended that the omission of paragraph 6114 from the 2017 Code be accepted.

HBB-6115, Time of Pressure Test and Stamping of Components and Appurtenances
It is recommended that the general requirement of subparagraphs HBB-6115(a) through HBB-6115(e) be accepted as written. See Section 4 for further detail.

HBB-6116, Machining of Local Areas After Static Pressure Testing
It is recommended that HBB-6116 be accepted as written.

Subparagraphs HBB-6116(a) through HBB-6116(b) are fundamentally identical to the approach given in III-1 NB-6115 for Class 1 (Class A for III-5 use) components, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

Subparagraph HBB-6116(c) is recommended accepted as written. This paragraph mandates that the final wall thickness shall comply with the minimum wall thickness requirements defined in the rules for design of Class A components for elevated temperature service.

HBB-6117, Alternative Tests of Closure Welds and Access Hatches
It is recommended that paragraph HBB-6117 be accepted as written because it is fundamentally identical to subparagraphs 6116(a) and 6116(b) of Code Case 1595, which has been approved for use through NRC RG 1.87.

Note:

> HBB-6117(a) has deleted the requirement of Code Case 1595 6116(a)(1) that states, “pneumatic test pressures are too high for safety.” Use of a helium leak test as recommended by ASME is advisable due to the risks involved in a high-pressure pneumatic test. A Mass Spectrometer Leak Detector examination using helium can provide confidence that the boundary is fully secured with no leakage over the specified rate selected by the designer and included in the design documentation.

HBB-6118, Alternative Tests at Specially Designed Welded Seals
It is recommended that paragraph HBB-6118 be accepted as written because it is fundamentally identical to paragraph 6127 and subparagraph 6116(c) of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6120, PREPARATION FOR TESTING

HBB-6121, Exposure of Joints
It is recommended that paragraph HBB-6121 be accepted as written because it is fundamentally identical to paragraph 6121 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6122, Addition of Temporary Supports
It is recommended that paragraph HBB-6122 be accepted as written because it is fundamentally identical to paragraph 6122 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6123, Restraint or Isolation of Expansion Joints
It is recommended that paragraph HBB-6123 be accepted as written because it is fundamentally identical to paragraph 6123 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6124, Isolation of Equipment Not Subjected to Pressure Test
It is recommended that paragraph HBB-6124 be accepted as written because it is fundamentally identical to paragraph 6124 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6125, Treatment of Flanged Joints Containing Blinds
It is recommended that paragraph HBB-6125 be accepted as written because it is fundamentally identical to paragraph 6125 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6126, Precautions Against Test Medium Expansion
It is recommended that paragraph HBB-6126 be accepted as written because it is fundamentally identical to paragraph 6126 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6127, Requirements for Specially Designed Welded Seals
HBB-6127 does not exist in the 2017 Code. However, Code Case 1595 has paragraph 6127 that is dedicated to “Requirements for Specially Designed Welded Seals.” Paragraph 6127 has been moved to HBB-6118. Therefore, the omission of this paragraph from the 2017 Code is recommended as acceptable.

HBB-6200, HYDROSTATIC TESTS

HBB-6210, HYDROSTATIC TESTING PROCEDURE

HBB-6211, Provision of Air Vents at High Points
It is recommended that paragraph HBB-6211 be accepted as written because it is fundamentally identical to paragraph 6211 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6212, Test Medium and Test Temperature
It is recommended that paragraph HBB-6212 be accepted as written because it is fundamentally identical to paragraph 6212 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6213, Check of Test Equipment Before Applying Pressure
It is recommended that paragraph HBB-6213 be accepted as written because it is fundamentally identical to paragraph 6213 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6215, Examination for Leakage After Application of Pressure
It is recommended that paragraph HBB-6215 be accepted as written because it is fundamentally identical to paragraph 6215 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6220, HYDROSTATIC TEST PRESSURE REQUIREMENTS

HBB-6221, Minimum Required System Hydrostatic Test Pressure
It is recommended that paragraph HBB-6221 be accepted as written because it is fundamentally identical to paragraph 6221 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6222, Maximum Permissible Hydrostatic Test Pressure
It is recommended that paragraph HBB-6222 be accepted as written because it is fundamentally identical to paragraph 6222 of Code Case 1595 which has been approved for use through NRC RG 1.87. Note that HBB-6222(a) has replaced “NB-3226” with the more general form of “NB-3000.”

HBB-6223, Hydrostatic Test Pressure for Valves, Pumps, and for Components and Appurtenances Containing Brazed Joints
It is recommended that subparagraph HBB-6223(a) be accepted as written. This subparagraph requires pressure testing of pumps, if they are not designed by detailed stress analysis. This does not eliminate the requirement to pressure test the system as required. It is recommended that subparagraph HBB-6223(b) be accepted as written. See Section 4, HBB-6223 for further detail.

HBB-6224, Hydrostatic Test Pressure Holding Time
It is recommended that paragraph HBB-6224 be accepted as written because it is fundamentally identical to paragraph 6224 of Code Case 1595, which has been approved for use through NRC RG 1.87. HBB-6224 has added “other components covered by HBB-6223,” which is acceptable because HBB-6223 adds the additional requirement on the inlet and outlet portions of valves.

HBB-6300, PNEUMATIC TESTS

HBB-6310, PNEUMATIC TESTING PROCEDURES

HBB-6311, General Requirements
It is recommended that paragraph HBB-6311 be accepted as written because it is fundamentally identical to paragraph 6311 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6312, Test Medium and Test Temperature
It is recommended that paragraph HBB-6312 be accepted as written because it is fundamentally identical to paragraph 6312 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6313, Check of Test Equipment Before Applying Pressure
It is recommended that paragraph HBB-6313 be accepted as written because it is fundamentally identical to paragraph 6313 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6314, Procedure for Applying Pressure

It is recommended that paragraph HBB-6314 be accepted as written because it is fundamentally identical to paragraph 6314 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6315, Examination for Leakage After Application of Pressure

It is recommended that paragraph HBB-6315 be accepted as written because it is fundamentally identical to paragraph 6315 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6320, PNEUMATIC TEST PRESSURE REQUIREMENTS

HBB-6321, Minimum Required System Pneumatic Test Pressure

Note that paragraph 6321 of Code Case 1595 stipulates that the requirements are the same as paragraph 6221 with a few terms replaced. Therefore, HBB-6321 is recommend as accepted for the same reasons as HBB-6221. See Section 4, HBB-6321 for further detail.

HBB-6322, Maximum Permissible Pneumatic Test Pressure

It is recommended that paragraph HBB-6322 be accepted as written because it is fundamentally identical to paragraph 6322 of Code Case 1595, which has been approved for use through NRC RG 1.87. Note that HBB-6322(a) has replaced “NB-3226” with the more general form of “NB-3000.”

HBB-6323, Pneumatic Test Pressure for Valves, Pumps, and for Components and Appurtenances Containing Brazed Joints

It is recommended that paragraph HBB-6323 be accepted as written because it is fundamentally identical to the paragraph 6323, except for HBB-6323(b) of Code Case 1595and the added statement in HBB-6323(a) “not designed by detailed stress analysis”, which has been approved for use through NRC RG 1.87. It is recommended that subparagraph HBB-6323(b) be accepted as written. See Section 4, HBB-6323 for further detail.

Note:

> It is recommended that the added statement “not designed by detailed stress analysis” be accepted. This statement allows for the computational analysis of the design of a pump to be used to evaluate the pressure-handling capacity.

HBB-6324, Pneumatic Test Pressure Holding Time

It is recommended that paragraph HBB-6324 be accepted as written because it is fundamentally identical to paragraph 6324 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6400, PRESSURE TEST GAGES

It is recommended that subarticle HBB-6400 be accepted as written because it is fundamentally identical to subarticle 6400 of Code Case 1595, which has been approved for use through NRC RG 1.87.

3.2. SUBSECTION HC, CLASS B METALLIC PRESSURE BOUNDARY COMPONENTS, SUBPART B, ELEVATED TEMPERATURE SERVICE

3.2.1. ARTICLE HCB-3000, DESIGN

HCB-3100, General Design
It is recommended that subarticle HCB-3100 be accepted as written because the subarticle stipulates that pressure-retaining material and material welded thereto shall meet the requirements of III-1 NC-3000, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, except as modified in HCB-3000.

HCB-3110

HCB-3114, Acceptability
It is recommended that the general design requirement of paragraph HCB-3114 be accepted as written. This paragraph states that an acceptable component design will meet the applicable requirements of NC-3100, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, the appropriate component rules from III-5-HCB (i.e., HCB-3300 (vessels), HCB-3400 (pumps), HCB-3500 (valves), or HCB-3600 (piping)), and/or any optional approved alternative methods that demonstrate compliance related to buckling, ratcheting, and creep-fatigue. Additionally, this will be demonstrated in the applicant's Design Report.

HCB-3115, Design Report and Certification
It is recommended that the general design requirement of paragraph HCB-3115 be accepted as written. HCB-3115 stipulates the requirement of the Design Report such as components at elevated temperature and states that the Design Report must be certified by a Certifying Engineer.

HCB-3140, BUCKLING INSTABILITY LOADINGS

HCB-3141, General Requirements
It is recommended that the general design requirement of paragraph HCB-3141 be accepted as written. HCB-3141(a) stipulates that for Class B (Class 2 for III-1-NC) components at elevated temperatures, the rules of NC-3133, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, shall apply for external pressure loadings if the conditions of Mandatory Appendix HCB-III are satisfied. Otherwise, the HCB-3141(b) directs the applicant to use the rules of HCB-3141, HCB-3142, and HCB-3143 for limits on buckling loads. Additionally, the approach used will be detailed in the applicant's Design Report.

Note:

The use of Mandatory Appendix HCB-III is acceptable and is governed by the requirements and recommendations of NUMARK's report on Mandatory Appendix HCB-III *Time-Temperature Limits for Creep and Stress-Rupture Effects*.

HCB-3141.1, Scope of Rules

It is recommended that the general design requirement of subparagraph HCB-3141.1 be accepted as written. HCB-3141.1 states that NC-3133, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, only pertains to specific geometrical configurations under specific loading conditions and does not consider the effects of creep due to long-term loadings at elevated temperatures or the effects of the other loads or geometries. This subparagraph directs the applicant to use the rules of HCB-3141, HCB-3142, and HCB-3143 for limits applicable to general configurations and loading conditions that may lead to buckling or instability due to time-dependent creep behavior of the material. Therefore, this is recommended as accepted and will be detailed in the applicant's Design Report.

HCB-3141.2, Load-Controlled and Strain-Controlled Buckling

It is recommended that the general design requirement of subparagraph HCB-3141.2 be accepted as written. This subparagraph simply states that for the limits of HCB-3140, a distinction is made between load-controlled buckling and strain-controlled buckling with an example and definition given.

HCB-3141.3, Interaction of Load-Controlled and Strain-Controlled Buckling

It is recommended that the general design requirement of subparagraph HCB-3141.3 be accepted as written because it conservatively states that when a combination of these loadings is present, then the larger Load Factor associated with load-controlled buckling shall be used.

HCB-3141.4, Effects of Initial Geometry Imperfections

It is recommended that the general design requirement of subparagraph HCB-3141.4 be accepted as written. HCB-3141.4(a) requires the effects of initial geometrical imperfections and tolerances be considered for time-independent and time-dependent calculations for load-controlled buckling according to the requirements of HCB-3142 and HCB-3143, respectively. HCB-3141.4(b) states that if significant geometrical imperfections are initially present, then effects of excessive deformation or strain caused by instability strain under pure strain-controlled buckling must be accounted for.

Note:

The applicant should also demonstrate in the Design Report that the instability strain under pure strain-controlled buckling due to the effects of geometrical imperfections and tolerances, whether initially present or induced by service, is acceptable when compared to the deformation and strain limits. This is in contrast to what is stated in HCB-3141.4(b).

HCB-3141.5, Stress-Strain Data

It is recommended that the general design requirement of subparagraph HCB-3141.5 be accepted as written because it stipulates that the expected minimum stress-strain curve for the material be used.

HCB-3142, Time-Independent Buckling Limits

It is recommended that the general design requirement of paragraph HCB-3142 be accepted as written. This paragraph states that the Load Factor for load-controlled buckling and the Strain Factor for strain-controlled buckling shall equal or exceed the value in Table HBB-T-1521-1 for the specified Design and Service Loadings to protect against instantaneous buckling.

Note:

> The applicant must justify the Load Factor and Strain Factor used in the Design Report. The values from Table HBB-T-1521-1 are acceptable and are governed by the requirements and recommendations of NUMARK's report on Nonmandatory Appendix HBB-T *Rules for Strain, Deformation, and Fatigue Limits at Elevated Temperatures*.

HCB-3143, Time-Dependent Buckling Limits

It is recommended that the general design requirement of paragraph HCB-3143 be accepted as written. This paragraph states that to protect against load-controlled time-dependent buckling, it must 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 in Table HBB-T-1522-1.

Note:

> The values from Table HBB-T-1522-1 are acceptable and are governed by the requirements and recommendations of NUMARK's report on Nonmandatory Appendix HBB-T *Rules for Strain, Deformation, and Fatigue Limits at Elevated Temperatures*.

HCB-3150, LIMITATIONS ON USE

It is recommended that the general design requirement of paragraph HCB-3150 be accepted as written. HCB-3150 stipulates various components that cannot be used unless the requirements of Mandatory Appendix HCB-III are satisfied.

Note:

> For socket welded fittings used in pressure-retaining joints in accordance with 10 CFR 50.55a(b)(1)(ii), applicants and licensees may not apply the Section III provisions for welds with leg size less than 1.09* t_n, where t_n is the nominal pipe thickness.
>
> The use of Mandatory Appendix HCB-III is acceptable and is governed by the requirements and recommendations of NUMARK's report on Mandatory Appendix HCB-III *Time-Temperature Limits for Creep and Stress-Rupture Effects*.

HCB-3160, COMPONENTS CONTAINING LETHAL OR HAZARDOUS SUBSTANCES

It is recommended that the general design requirement of paragraph HCB-3160 be accepted as written. Paragraph HCB-3160 gives the acceptable weld types for Categories A, B, C, and D

type welds. The definition for the type of welds is stated to come from NC-4262, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HCB-3300, VESSEL DESIGN

HCB-3310, GENERAL REQUIREMENTS

It is recommended that the general design requirement of paragraph HCB-3310 be accepted as written. HCB-3310 states that the requirements of III-1 NC-3300, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, are to be satisfied except as modified per HCB-3100. HCB-3310 also states that the rules of NC-3300 as modified by HCB-3100 do not explicitly address fatigue damage resulting from cyclic service and that the allowable stress values used in the design calculations at elevated temperatures shall be obtained from Mandatory Appendix HCB-II.

Note:

> It is recommended that the applicant follow the guidelines of Section III, Mandatory Appendix XIII, XIII-3500 to determine if a fatigue analysis due to cyclic operation at elevated temperatures is required and/or follow the procedures outlined for a fatigue analysis.
>
> The use of Mandatory Appendix HCB-II is acceptable and is governed by the requirements and recommendations of NUMARK's report on Mandatory Appendix HCB-II *Allowable Stress Values for Class B Components*.

HCB-3400, PUMP DESIGN

It is recommended that the general design requirement of subarticle HCB-3400 be accepted as written. HCB-3400 states that the requirements of III-1 NC-3400, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, are to be satisfied except as modified per HCB-3100. HCB-3310 also states that the rules of NC-3400 as modified by HCB-3100 do not explicitly address fatigue damage resulting from cyclic service and that the allowable stress values used in the design calculations at elevated temperatures shall be obtained from Mandatory Appendix HCB-II.

Note:

> It is recommended that the applicant follow the guidelines of Section III, Mandatory Appendix XIII, XIII-3500 to determine if a fatigue analysis due to cyclic operation at elevated temperatures is required and/or follow the procedures outlined for a fatigue analysis.
>
> The use of Mandatory Appendix HCB-II is acceptable and is governed by the requirements and recommendations of NUMARK's report on Mandatory Appendix HCB-II *Allowable Stress Values for Class B Components*.

HCB-3500, VALVE DESIGN

HCB-3510, GENERAL REQUIREMENTS

It is recommended that the general design requirement of paragraph HCB-3510 be accepted as written. HCB-3510 states that the requirements of III-1 NC-3500, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, are to be satisfied except as modified per HCB-3100. HCB-3510 also states that the rules of NC-3500 as modified by HCB-3100 do not explicitly address fatigue damage resulting from cyclic service and that the allowable stress values used in the design calculations at elevated temperatures shall be obtained from Mandatory Appendix HCB-II.

Note:

> It is recommended that the applicant follow the guidelines of Section III, Mandatory Appendix XIII, XIII-3500 to determine if a fatigue analysis due to cyclic operation at elevated temperatures is required and/or follow the procedures outlined for a fatigue analysis.
>
> The use of Mandatory Appendix HCB-II is acceptable and is governed by the requirements and recommendations of NUMARK's report on Mandatory Appendix HCB-II *Allowable Stress Values for Class B Components*.

HCB-3600, PIPING DESIGN

HCB-3630, GENERAL REQUIREMENTS

It is recommended that the general design requirement of paragraph HCB-3630 be accepted as written. This paragraph simply states that for elevated temperature Class B (Class 2 for III-1 use) piping designs, the rules for piping with negligible creep effects and for piping with creep effects must conform to the rules of HCB-3632 and HCB-3634, respectively.

HCB-3632, Piping with Negligible Creep Effects

It is recommended that the requirements of paragraph HCB-3632 be accepted as written. This paragraph replaces specific sections in III-1-NC, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, with general design requirements in III-5-HCB.

Note:

> The use of Mandatory Appendix HCB-II and Mandatory Appendix HCB-III are acceptable and are governed by the requirements and recommendations of NUMARK's report on Mandatory Appendix HCB-II *Allowable Stress Values for Class B Components* and Mandatory Appendix HCB-III *Time-Temperature Limits for Creep and Stress-Rupture Effects*.

HCB-3634, Piping with Creep Effects

It is recommended that the requirements of paragraph HCB-3634 be accepted as written. See Section 4, HCB-3634 for further detail.

Note:

The use of Mandatory Appendix HCB-II is acceptable and is governed by the requirements and recommendations of NUMARK's report on Mandatory Appendix HCB-II *Allowable Stress Values for Class B Components*.

The modification of the allowable stress value in Equation (10a) of NC-3653.2 is recommended acceptable for determining the stress range reduction factor, f, using Mandatory Appendix HCB-I. The use of Mandatory Appendix HCB-I is acceptable and is governed by the requirements and recommendations of NUMARK's report on Mandatory Appendix HCB-I *Stress Range Reduction Factor for Piping*.

3.2.2. ARTICLE HCB-4000, FABRICATION AND INSTALLATION

HCB-4100, GENERAL REQUIREMENTS
It is recommended that paragraph HCB-4100 be accepted as written. See Section 4, HCB-4100 for further detail.

Note:

The use of Mandatory Appendix HCB-III is acceptable and is governed by the requirements and recommendations of NUMARK's report on Mandatory Appendix HCB-III *Time-Temperature Limits for Creep and Stress-Rupture Effects*.

HCB-4160, COMPONENTS CONTAINING LETHAL OR HAZARDOUS SUBSTANCES
It is recommended that the general design requirement of paragraph HCB-4160 be accepted as written. HCB-4160 states that components containing lethal substances or other hazardous substances must be post-weld heat treated in accordance with HCB-4000 when the pressure boundary material includes carbon or low alloy steels. The approach given in HCB-4160 appears to be acceptable as welding and forming can induce residual stresses that can be relieved by heat treatment. This results in better defined design stresses for components containing lethal or hazardous substances.

HCB-4200

HCB-4210

HCB-4215, Additional Requirements for Forming and Bending Processes
It is recommended that paragraph HCB-4215 be accepted as written because it is fundamentally identical to paragraph HBB-4212. It is an acceptable approach to use the Class A pressure-retaining components construction Code for the Class B pressure-retaining components construction Code. See Section 4, HCB-4215 for further detail.

The rules of HCB-4215 provides additional requirements to those in NC-4212, and NC-4213. Furthermore, HCB-4215 provides more detailed and acceptable requirements than those listed in Code Case 1593. Subsequent to ASME Code approval of Code Case 1593, a substantial multi-year research effort was sponsored by the Department of Energy regarding the use of cold worked 304 and 316 stainless steels, as well as Nickel-Iron-Chromium Alloy 800H, for use in

high-temperature environments. The purpose of this research was to provide a database for subsequent use by individuals or groups within the ASME BPVC committees. The data produced as a result of this research effort was likely used as the basis for Figure HCB-4215-1 *Permissible Time/Temperature Conditions for Material Which Has Been Cold Worked >5% and <20% and Subjected to Short-Time High Temperature Transients.*

HCB-4400

HCB-4420

HCB-4427, Shape and Size of Fillet Welds
It is recommended that HCB-4427 be accepted as written. HCB-4427(a) and HCB-4427(b) are fundamentally identical to III-1-NC NC-4427(a) and NC-4227(b), which are approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. HCB-4427(c) is fundamentally identical to HBB-4240. It is an acceptable approach to use the Class A pressure-retaining components construction Code for the Class B pressure-retaining components construction Code.

Note:

> For socket welded fittings used in pressure-retaining joints in accordance with 10 CFR 50.55a(b)(1)(ii), applicants and licensees may not apply the Section III provisions for welds with leg size less than 1.09* t_n, where t_n is the nominal pipe thickness.

3.2.3. ARTICLE HCB-5000, EXAMINATION

HCB-5100, GENERAL REQUIREMENTS FOR EXAMINATION
It is recommended that subarticle HCB-5100 be accepted as written because the subarticle stipulates that pressure-retaining material and material welded thereto shall meet the requirements of III-1 NC-5000, which are approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HCB-5160, COMPONENTS CONTAINING LETHAL OR HAZARDOUS SUBSTANCES
It is recommended that paragraph HCB-5160 be accepted as written. Paragraph HCB-5160 is clear and concise that all permitted welds at the pressure boundaries shall be radiographed. The volume to be radiographed is the defined weld, and it is up to the designer to identify the type of permitted weld joints. This paragraph is more conservative than NC-5000 because all pressure boundary weld joints, regardless of the weld joint design, are required to be fully radiographed, i.e., 100 percent of the weld volume.

3.2.4. ARTICLE HCB-6000, TESTING

HCB-6100, GENERAL REQUIREMENTS
It is recommended that subarticle HCB-6100 be accepted as written because the subarticle stipulates that the requirements of III-1 NC-6000 be followed except as modified in HCB-6000. III-1-NC is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HCB-6110

HCB-6111, Scope of Pressure Testing
It is recommended that the general requirements of paragraph HCB-6111 be accepted as written because it is fundamentally identical to paragraph NC-6111, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Note that HCB-6111 has changed “hydrostatically tested” to the generic form of “pressure test.” This change is minor; therefore, it is recommended as acceptable. See Section 4, HCB-6111 for further detail.

HCB-6600

HCB-6630, ALTERNATIVE TESTS OF CLOSURE WELDS AND ACCESS HATCHES
It is recommended that paragraph HCB-6630 be accepted as written because this is analogous to what is stated in HBB-6117(a). HBB-6117(a) is fundamentally identical to subparagraph 6116(a) of Code Case 1595, which has been approved for use through NRC RG 1.87. The language for Class B construction (III-5-HCB) is fundamentally identical to the language for Class A construction (III-5-HBB) which is a more stringent construction code. See Section 4, HCB-6630 for further detail.

HCB-6640, ALTERNATIVE TESTS AT SPECIALLY DESIGNED WELDED SEALS
It is recommended that paragraph HCB-6640 be accepted as written because this is analogous to what is stated in HBB-6118(b). HBB-6118(b) is fundamentally identical to subparagraph 6116(c) of Code Case 1595, which has been approved for use through NRC RG 1.87. The language for Class B construction (III-5-HCB) is fundamentally identical to the language for Class A construction (III-5-HBB), which is a more stringent construction code. See Section 4, HCB-6640 for further detail.

3.3. SUBSECTION HG, CLASS A METALLIC CORE SUPPORT STRUCTURES, SUBPART B, ELEVATED TEMPERATURE SERVICE

3.3.1. ARTICLE HGB-3000, DESIGN

HGB-3100, GENERAL REQUIREMENTS
It is recommended that subarticle HGB-3100 be accepted as written because it stipulates that core support structure material and material welded thereto shall meet the requirements of III-1 NG-3000, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, except as modified in HGB-3000. Note that HGB-3200 completely replaces NG-3200.

HGB-3110

HGB-3112, Design Parameters
It is recommended that paragraph HGB-3112 be accepted as written because it is fundamentally identical to paragraph HBB-3112 and paragraph -3112 of Code Case 1592,

which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3112.1, Specified Pressure Difference
It is recommended that subparagraph HGB-3112.1 be accepted as written because parts are fundamentally identical to subparagraph -3112.1 of Code Case 1592, which has been approved for use through NRC RG 1.87, and NG-3112.1, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. See Section 4, HGB-3112.1 for further detail.

HGB-3112.2, Specified Temperature
It is recommended that subparagraph HGB-3112.2 be accepted as written because it is fundamentally identical to subparagraph HBB-3112.2 and subparagraph -3112.2 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3112.3, Specified Mechanical Load Forces
It is recommended that subparagraph HGB-3112.3 be accepted as written because parts are fundamentally identical to subparagraph -3112.3 of Code Case 1592, which has been approved for use through NRC RG 1.87, and NG-3112.3, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. See Section 4, HGB-3112.3 for further detail.

HGB-3112.4, Design Stress Intensity Values
It is recommended that subparagraph HGB-3112.4 be accepted as written because it is fundamentally identical to NG-3112.4, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

Note:

> The use of Tables HBB-I-14.3A through HBB-I-14.3E is governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

HGB-3113, Loading Categories
It is recommended that paragraph HGB-3113 be accepted as written because it is fundamentally identical to paragraph HBB-3113 and paragraph -3113 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures. Note that III-5-HGB does not have "Testing Loads."

HGB-3113.1, Design Loadings
It is recommended that subparagraph HGB-3113.1 be accepted as written because it is fundamentally identical to subparagraph HBB-3113.1 and subparagraph -3113.1 of Code Case

1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3113.2, Service Loadings

It is recommended that subparagraph HGB-3113.2 be accepted as written because it is fundamentally identical to subparagraph HBB-3113.2 and subparagraph -3113.2 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3113.3, Level A Service Loadings

It is recommended that subparagraph HGB-3113.3 be accepted as written because it is fundamentally identical to subparagraph HBB-3113.3 and subparagraph -3113.3 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures. Note that III-5-HGB does not have “Testing Loads.”

HGB-3113.4, Level B Service Loadings (From Incidents of Moderate Frequency)

It is recommended that subparagraph HGB-3113.4 be accepted as written because it is fundamentally identical to subparagraph HBB-3113.4 and subparagraph -3113.4 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3113.5, Level C Service Loadings (From Infrequent Incidents)

It is recommended that subparagraph HGB-3113.5 be accepted as written because it is fundamentally identical to subparagraph HBB-3113.5 and subparagraph -3113.5 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3113.6, Level D Service Loadings (From Limiting Faults)

It is recommended that subparagraph HGB-3113.6 be accepted as written because it is fundamentally identical to subparagraph HBB-3113.6 and subparagraph -3113.6 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3114, Load Histogram

HGB-3114.1, Level A and B Service Events

It is recommended that subparagraph HGB-3114.1 be accepted as written because it is fundamentally identical to subparagraph HBB-3114.1 and subparagraph -3114.1 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to

use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3114.2, Level C Service Events
It is recommended that subparagraph HGB-3114.2 be accepted as written because it is fundamentally identical to subparagraph HBB-3114.2 and subparagraph -3114.2 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3120

HGB-3122, Cladding
It is recommended that paragraph HGB-3122 be accepted as written. This paragraph explicitly states that the requirements of III-1 NG-3122 shall not be used. Cladding requirements are contained in HGB-3227.8.

HGB-3124, Environmental Effects
It is recommended that paragraph HGB-3124 be accepted as written because it is fundamentally identical to paragraph NG-3124, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. See Section 4, HGB-3124 for further detail.

HGB-3130

HGB-3132, Reinforcement for Openings
It is recommended that paragraph HGB-3132 be accepted as written because it is fundamentally identical to paragraph NG-3132, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. See Section 4, HGB-3132 for further detail.

HGB-3133, External Pressure Difference
It is recommended that paragraph HGB-3133 be accepted as written. This paragraph explicitly states that the requirements of III-1 NG-3133 shall not be used. Therefore, the applicant must explicitly state how any external pressure difference is to be evaluated, if applicable, in the Design Report.

HGB-3138, Elastic Follow-Up
It is recommended that paragraph HGB-3138 be accepted as written because it is fundamentally identical to paragraph HBB-3138 and paragraph -3138 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3139, Welding

HGB-3139.1, Abrupt Changes in Mechanical Properties at Weld and Compression Contact Junctions

It is recommended that subparagraph HGB-3139.1 be accepted as written because it is fundamentally identical to subparagraph HBB-3139.1 and paragraph -3139 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3139.2, Weld Design

It is recommended that the general requirement for design subparagraph HGB-3139.2 be accepted as written. This requirement directs the applicant to comply, at a minimum, with the rules of III-1 NG-3350, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, in addition to the other requirements of article HGB-3000. Additionally, this is analogous to what is stated in HBB-3139.2.

HGB-3200, DESIGN BY ANALYSIS

HGB-3210, DESIGN CRITERIA

HGB-3211, Requirements for Acceptability

It is recommended that paragraph HGB-3211 be accepted as written. This paragraph directs the applicant to meet the requirements of HGB-3211(a) through HGB-3211(d) for acceptability of a design based on analysis. The requirements are recommended as acceptable. See Section 4, HGB-3211 for further detail.

HGB-3212, Basis for Determining Stress, Strain, and Deformation Quantities

It is recommended that paragraph HGB-3212 be accepted as written because it is fundamentally identical to paragraph HBB-3212. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures. See Section 4, HGB-3212 for further detail.

Note:

> Paragraph HGB-3212 states that 9Cr-1Mo-V has several unique characteristics that should be recognized and reflected in multiaxial stress–strain relationships. The use of this material is governed by the requirements and recommendations of ORNL's report on HBB-2000 *Material*.

HGB-3213, Terms Relating to Analysis

It is recommended that paragraph HGB-3213 be accepted as written because it is fundamentally identical to paragraph HBB-3213 and paragraph -3213 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.1, Stress Intensity

It is recommended that subparagraph HGB-3213.1 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.1 and subparagraph -3213.1 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.2, Gross Structural Discontinuity

It is recommended that subparagraph HGB-3213.2 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.2 and subparagraph -3213.2 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.3, Local Structural Discontinuity

It is recommended that subparagraph HGB-3213.3 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.3 and subparagraph -3213.3 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.4, Normal Stress

It is recommended that subparagraph HGB-3213.4 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.4 and subparagraph -3213.4 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.5, Shear Stress

It is recommended that subparagraph HGB-3213.5 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.5 and subparagraph -3213.5 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.6, Membrane Stress

It is recommended that subparagraph HGB-3213.6 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.6 and subparagraph -3213.6 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.7, Bending Stress

It is recommended that subparagraph HGB-3213.7 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.7 and subparagraph -3213.7 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to

use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.8, Primary Stress

It is recommended that subparagraph HGB-3213.8 be accepted as written because it is fundamentally identical, except for the added sentence and table reference, to subparagraph HBB-3213.8 and subparagraph -3213.8 of Code Case 1592, which has been approved for use through NRC RG 1.87. Additionally, the definition is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(y) of the 2017 Code and i III-1 NB-3213.8 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.9, Secondary Stress

It is recommended that subparagraph HGB-3213.9 be accepted as written because it is fundamentally identical, except for the added sentence and table reference, to subparagraph HBB-3213.9. and subparagraph -3213.9of Code Case 1592, which has been approved for use through NRC RG 1.87. Additionally, the definition is fundamentally identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(ab) of the 2017 Code and III-1 NB-3213.9 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.11, Peak Stress

It is recommended that subparagraph HGB-3213.11 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.11 and subparagraph -3213.11 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.13, Thermal Stress

It is recommended that subparagraph HGB-3213.13 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.13 and subparagraph -3213.13 of Code Case 1592, which has been approved for use through NRC RG 1.87. Additionally, the expansion of the thermal stress definition from -3213.13 to HGB-3213.13 is fundamentally identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(aj) of the 2017 Code and NB-3213.13 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

The reference to subparagraph HBB-T-1331(d) is acceptable because NUMARK recommends that paragraph HBB-T-1331 be accepted based on the summary given in Section 3, HBB-T-1331 *General Requirements* and the accompanying arguments in Section 4.

HGB-3213.14, Total Stress

It is recommended that subparagraph HGB-3213.14 be accepted as written because it is fundamentally identical to subparagraph NG-3213.13, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HGB-3213.15, Service Cycle

It is recommended that subparagraph HGB-3213.15 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.15 and subparagraph -3213.15 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.16, Strain Cycle

It is recommended that subparagraph HGB-3213.16 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.16 and subparagraph -3213.16 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

The reference to paragraph HBB-T-1413 is acceptable because NUMARK recommends that paragraph HBB-T-1413 be accepted based on the summary given in Section 3, HBB-T-1413 *Equivalent Strain Range* and the accompanying arguments in Section 4.

HGB-3213.17, Fatigue Strength Reduction Factor

It is recommended that subparagraph HGB-3213.17 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.17 and subparagraph -3213.17 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.18, Free End Displacement

It is recommended that subparagraph HGB-3213.18 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.18 and subparagraph -3213.19 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.20, Deformation

It is recommended that subparagraph HGB-3213.20 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.20. The definition given in this subparagraph defines a common engineering term and is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(d) of the 2017 Code and NB-3213.20 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Additionally, it is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.21, Inelasticity

It is recommended that subparagraph HGB-3213.21 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.21. The definition given in this subparagraph defines a common engineering term and is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(j) of the 2017 Code and NB-3213.21 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Additionally, it is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.22, Creep

It is recommended that subparagraph HGB-3213.22 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.22. The definition given in this subparagraph defines a common engineering term and is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(c) of the 2017 Code and NB-3213.22 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Additionally, it is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.23, Plasticity

It is recommended that subparagraph HGB-3213.23 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.23. The definition given in this subparagraph, excluding the last sentence involving 9Cr-1Mo-V, defines a common engineering term and is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(x) of the 2017 Code and NB-3213.23 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Additionally, it is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

> Paragraph HGB-3213.23 states that for 9Cr-1Mo-V, time-independent plasticity at higher temperature occurs only in limiting cases where strain rates are high relative to creep

rates. The use of this material is governed by the requirements and recommendations of ORNL's report on HBB-2000 *Material*.

HGB-3213.24, Plastic Analysis

It is recommended that subparagraph HGB-3213.24 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.24. The definition given in this subparagraph, excluding the sentence regarding the use of 9Cr-1Mo-V, defines a common engineering analysis method and is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(t) of the 2017 Code and NB-3213.24 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Additionally, it is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

Paragraph HGB-3213.24 states that for 9Cr-1Mo-V, a plastic analysis must generally account for rate dependence and creep effects. The use of this material is governed by the requirements and recommendations of ORNL's report on HBB-2000 *Material*.

HGB-3213.25, Plastic Analysis – Collapse Load

It is recommended that subparagraph HGB-3213.25 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.25. The definition given in this subparagraph defines a common engineering analysis and is fundamentally identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(u) of the 2017 Code and NB-3213.25 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Additionally, it is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.26, Plastic Instability Load

It is recommended that subparagraph HGB-3213.26 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.26. The definition given in this subparagraph defines a common engineering term and is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(w) of the 2017 Code and NB-3213.26 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Additionally, it is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.27, Limit Analysis

It is recommended that subparagraph HGB-3213.27 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.27. The definition given in this subparagraph defines a common engineering analysis and is fundamentally identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(k) of the 2017 Code and NB-3213.27 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and

2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Additionally, it is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.28, Limit Analysis – Collapse Load

It is recommended that subparagraph HGB-3213.28 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.28 and subparagraph -3213.21 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.29, Calculated Collapse Load – Lower Bound

It is recommended that subparagraph HGB-3213.29 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.29 and subparagraph -3213.22 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.30, Plastic Hinge

It is recommended that subparagraph HGB-3213.30 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.30. The definition given in this subparagraph defines a common engineering term and is fundamentally identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(v) of the 2017 Code and NB-3213.30 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Additionally, it is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.31, Strain Limiting Load

It is recommended that subparagraph HGB-3213.31 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.31. The definition given in this subparagraph defines a common engineering term and is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(af) of the 2017 Code and NB-3213.31 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Additionally, it is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.33, Ratcheting

It is recommended that subparagraph HGB-3213.33 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.33 and subparagraph -3213.23 of Code Case 1592 which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.34, Shakedown

It is recommended that subparagraph HGB-3213.34 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.34 and subparagraph -3213.18 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.36, Use-Fraction

It is recommended that subparagraph HGB-3213.36 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.36 and subparagraph -3213.25 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.37, Fatigue Damage

It is recommended that subparagraph HGB-3213.37 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.37 and subparagraph -3213.26 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.38, Creep Damage

It is recommended that subparagraph HGB-3213.38 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.38 and subparagraph -3213.27 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.39, Creep-Fatigue Interaction

It is recommended that subparagraph HGB-3213.39 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.39 and subparagraph -3213.28 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3214, Stress Analysis

It is recommended that paragraph HGB-3214 be accepted as written because it is fundamentally identical to paragraph HBB-3214 and paragraph -3214 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3214.1, Elastic Analysis

It is recommended that subparagraph HGB-3214.1 be accepted as written because it is fundamentally identical to subparagraph HBB-3214.1 and subparagraph -3214.1 of Code Case 1592 which has been approved for use through NRC RG 1.87. It is an acceptable approach to

use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3214.2, Inelastic Analysis

It is recommended that subparagraph HGB-3214.2 be accepted as written because it is fundamentally identical to subparagraph HBB-3214.2. and subparagraph HBB-3214.2 is an expanded version of subparagraph -3214.2 of Code Case 1592, which has been approved for use through NRC RG 1.87. The primary reason for recommendation for acceptance of subparagraph HGB-3214.2 is based on the third written paragraph that states, “The basis for choosing the selected methods and relations used should be included in the Design Report.” Additionally, it is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

> Paragraph HGB-3214.2 states for 9Cr-1Mo-V, decoupling of plastic and creep strains in the classical constitutive framework is generally a poor representation of the true material behavior. Unified constitutive equations, which do not distinguish between rate-dependent plasticity and time-dependent creep, represent the rate dependence and softening that occur, particularly at higher temperatures. The use of this material is governed by the requirements and recommendations of ORNL’s report on HBB-2000 *Material*.
>
> The use of Nonmandatory Appendix HBB-T is acceptable and is governed by the requirements and recommendations of NUMARK’s report on Nonmandatory Appendix HBB-T *Rules for Strain, Deformation, and Fatigue Limits at Elevated Temperatures*.

HGB-3214.3, Mechanical Properties

It is recommended that subparagraph HGB-3214.3 be accepted as written because it is fundamentally identical to subparagraph HBB-3214.3 and subparagraph -3214.3 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

> The reference to the mechanical and physical properties in Mandatory Appendix HBB-I-14 is acceptable. The use of these mechanical and physical properties is governed by the requirements and recommendations of ORNL’s report on Mandatory Appendix HBB-I-14 *Tables and Figures*.
>
> The reference to the mechanical and physical properties in Nonmandatory Appendix HBB-T is acceptable. The use of these mechanical and physical properties is governed by the requirements and recommendations of NUMARK’s report on Nonmandatory Appendix HBB-T *Rules for Strain, Deformation, and Fatigue Limits at Elevated Temperatures*.

HGB-3215, Derivation of Stress Intensities

It is recommended that paragraph HGB-3215 be accepted as written because it is fundamentally identical to paragraph HBB-3215 and paragraph -3215 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3216, Derivation of Stress Differences and Strain Differences

It is recommended that paragraph HGB-3216 be accepted as written because it is fundamentally identical to paragraph HBB-3216 and paragraph -3216 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3217, Classification of Stresses

It is recommended that paragraph HGB-3217 be accepted as written because it is fundamentally identical to paragraph HBB-3217 and paragraph -3217 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

It is recommended that Table HGB-3217-1 be accepted as written because it is fundamentally identical to Table HBB-3217-1.

Note:

> Table HGB-3217-1, cladding type of stress should be peak stress, as described in the 2017 edition of Sec. III Div. 1 Sub. NG Table NG-3217-1.

HGB-3220, DESIGN RULES AND LIMITS FOR LOAD-CONTROLLED STRESSES IN STRUCTURES OTHER THAN THREADED STRUCTURAL FASTENERS

HGB-3221, General Requirements

It is recommended that paragraph HGB-3221 be accepted as written because it is fundamentally identical to paragraph HBB-3221. The detailed explanation and notes associated with the use of HBB-3221 (refer to Section 3, HBB-3221, *General Requirements*) is also applicable to HGB-3221. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3222, Design Limits

It is recommended that paragraph HGB-3222 be accepted as written because it is fundamentally identical to subparagraph HBB-3222.1 and subparagraph -3222.1 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures. The requirement of HGB-3222.1(c), not present in -3222.1 of Code Case 1592, to account for adequate buckling strength is acceptable.

Note:

Justification of the method(s) used to demonstrate there is an acceptable amount of buckling strength must be included by the applicant in the Design Report.

HGB-3223, Level A and B Service Limits

It is recommended that paragraph HGB-3223 be accepted as written because it is fundamentally identical to paragraph HBB-3223 and paragraph -3223 of Code Case 1592, which has been approved for use through NRC RG 1.87. The detailed explanation associated with the use of HBB-3223 (refer to Section 3, HBB-3223, Level A and B Service Limits) is also applicable to HGB-3223. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3224, Level C Service Limits

It is recommended that paragraph HGB-3224 be accepted as written because it is fundamentally identical to paragraph HBB-3224 and paragraph -3224 of Code Case 1592, which has been approved for use through NRC RG 1.87. The detailed explanation and notes associated with the use of HBB-3224 (refer to Section 3, HBB-3224, *Level C Service Limits*) are also applicable to HGB-3224. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

It is recommended that Figure HGB-3224-1 be accepted as written because it is fundamentally identical to Figure HBB-3224-1. The detailed explanation and notes associated with the use of Figure HBB-3224-1 (refer to Section 3, HBB-3224) are also applicable to Figure HGB-3224-1.

It is recommended that Figure HGB-3224-2 be accepted as written because it is fundamentally identical to Figure HBB-3224-2. The detailed explanation and notes associated with the use of Figure HBB-3224-2 (refer to Section 3, HBB-3224) are also applicable to Figure HGB-3224-2.

HGB-3225, Level D Service Limits

It is recommended that paragraph HGB-3225 be accepted as written because it is fundamentally identical to paragraph HBB-3225. The detailed explanation and notes associated with the use of HBB-3225 (refer to Section 3, HBB-3225, *Level D Service Limits*) are also applicable to HGB-3225. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3227, Special Stress Limits

It is recommended that paragraph HGB-3227 be accepted as written because it is fundamentally identical to paragraph HBB-3227 and paragraph -3227 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3227.1, Bearing Loads

It is recommended that subparagraph HGB-3227.1 be accepted as written because it is fundamentally identical to subparagraph HBB-3227.1 and is a slight expansion of subparagraph -3227.1 of Code Case 1592, which has been approved for use through NRC RG 1.87. The

detailed explanation and notes associated with the use of HBB-3227.1 (refer to Section 3, HBB-3227.1, Bearing Loads) are also applicable to HGB-3227.1. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3227.2, Pure Shear

It is recommended that subparagraph HGB-3227.2 be accepted as written because it is fundamentally identical to subparagraph HBB-3227.2 and subparagraph -3227.2 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3227.3, Progressive Distortion of Nonintegral Connections

It is recommended that subparagraph HGB-3227.3 be accepted as written because it is fundamentally identical to subparagraph HBB-3227.3 and subparagraph -3227.3 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3227.4, Triaxial Stresses

It is recommended that subparagraph HGB-3227.4 be accepted as written because it is fundamentally identical to subparagraph HBB-3227.4 and subparagraph -3227.4 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3227.5, Nozzle Piping Transition

It is recommended that subparagraph HGB-3227.5 be accepted as written because it is fundamentally identical to subparagraph HBB-3227.5 and subparagraph -3227.5 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3227.8, Cladding

It is recommended that subparagraph HGB-3227.8 be accepted as written, except for subsubparagraph HGB-3227.8(d), because it is fundamentally identical to subparagraph HBB-3227.8 and subparagraph -3227.8 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

It is recommended that subsubparagraph HGB-3227.8(d) be rejected as written and supplemented with the requirements of NG-3227.1 *Bearing Loads* (2017 edition) because this error has been identified and corrected in the 2017 edition of Sec. III Div. 1 Sub. NG.

HGB-3230, STRESS LIMITS FOR LOAD-CONTROLLED STRESSES IN THREADED STRUCTURAL FASTENERS

HGB-3231, General Requirements

It is recommended that the general requirement paragraph HGB-3231 be accepted as written. See Section 4, HGB-3231 for further detail.

Note:

> The use of Tables HBB-I-14.3A through HBB-I-14.3E for threaded structural fasteners is acceptable and is governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

HGB-3232, Design and Level A Service Limits

It is recommended that paragraph HGB-3232 be accepted as written. This paragraph states that the number and cross-sectional area of threaded structural fasteners must be such that the stress intensity limits of the Design Loadings and Level A Service Limits are satisfied. The applicant will demonstrate this in the Design Report.

HGB-3232.1, Average Stress

It is recommended that subparagraph HGB-3232.1 be accepted as written because it is fundamentally identical to HBB-3233.1 and HBB-3233.2. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures. See Section 4, HGB-3232.1 for further detail.

HGB-3232.2, Maximum Stress

It is recommended that subparagraph HGB-3232.2 be accepted as written because it is fundamentally identical to subparagraph HBB-3233.3 and subparagraph -3233.3 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures. See Section 4, HGB-3232.2 for further detail.

HGB-3232.3, Nonductile Fracture

It is recommended that subparagraph HGB-3232.3 be accepted as written because it is fundamentally identical to subparagraph HBB-3233.4 and subparagraph -3233.4 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3233, Level B Service Limits

It is recommended that paragraph HGB-3233 be accepted as written because it states that Level A Service Limits apply for Level B Service limits.

HGB-3234, Level C Service Limits for Threaded Structural Fasteners

It is recommended that paragraph HBB-3234 be accepted as written. This paragraph states that the number and cross-sectional area of threaded structural fasteners must be such that the requirements of HGB-3224 are satisfied for the Service Loadings for which Level C Service

Limits are designated in the Design Specification. The applicant will demonstrate this in the Design Report.

HGB-3235, Level D Service Limits for Threaded Structural Fasteners
It is recommended that paragraph HBB-3235 be accepted as written. This paragraph states that the number and cross-sectional area of threaded structural fasteners must be such that the requirements of HGB-3225 are satisfied for the Service Loadings for which Level D Service Limits are designated in the Design Specification. The applicant will demonstrate this in the Design Report.

HGB-3240, SPECIAL REQUIREMENTS FOR ELEVATED TEMPERATURE COMPONENTS

HGB-3241, Nonductile Fracture
It is recommended that paragraph HGB-3241 be accepted as written because it is fundamentally identical to paragraph HBB-3241 and paragraph -3241 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3250, LIMITS ON DEFORMATION-CONTROLLED QUANTITIES

HGB-3251, General Requirements
It is recommended that paragraph HGB-3251 be accepted as written because it is fundamentally identical to paragraph HBB-3251 and paragraph -3251 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3252, Criteria
It is recommended that paragraph HGB-3252 be accepted as written because it is fundamentally identical to paragraph HBB-3252 and paragraph -3252 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

> The use of Nonmandatory Appendix HBB-T is acceptable and is governed by the requirements and recommendations of NUMARK's report on Nonmandatory Appendix HBB-T *Rules for Strain, Deformation, and Fatigue Limits at Elevated Temperatures*.

HGB-3300

HGB-3350

HGB-3352, Permissible Types of Welded Joints
It is recommended that paragraph HGB-3352 be accepted as written because it is fundamentally identical to the first written sentence of paragraph NG-3352, which is approved

for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HGB-3352.2, Type II Joints
It is recommended that subparagraph HGB-3352.2 be accepted as written because it is fundamentally identical to subparagraph NG-3352.2, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HGB-3353, Design of Welded Construction at Elevated Temperatures
It is recommended that paragraph HGB-3353 be accepted as written because it is fundamentally identical to paragraph HBB-3353 and paragraph -3353 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

3.3.2. ARTICLE HGB-4000, FABRICATION AND INSTALLATION

HGB-4100, GENERAL REQUIREMENTS
It is recommended that subarticle HGB-4100 be accepted as written because the subarticle stipulates that core support structure material and material welded thereto shall meet the requirements of ASME Code Section III Division 1, Article NG-4000, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, except as modified in HGB-4000.

HGB-4200

HGB-4210

HGB-4212, Forming and Bending Processes
It is recommended that paragraph HGB-4212 be accepted as written because it is fundamentally identical to paragraph HBB-4212. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

The rules of HGB-4212 provides additional requirements to those in NB-4212. HGB-4212 provides more detailed requirements than those listed in Code Case 1593. Subsequent to ASME Code approval of Code Case 1593, a substantial multi-year research effort was sponsored by the Department of Energy regarding the use of cold worked 304 and 316 stainless steels, as well as Nickel-Iron-Chromium Alloy 800H, for use in high-temperature environments. The purpose of this research was to provide a database for subsequent use by individuals or groups within the ASME BPVC committees. The data produced as a result of this research effort was likely used as the basis for the Figure HBB-4212-1 *Permissible Time/Temperature Conditions for Material Which Has Been Cold Worked>5% and <20% and Subjected to Short-Time High Temperature Transients.*

HGB-4230

HGB-4233, Alignment Requirements When Component Inside Surface is Inaccessible
It is recommended that paragraph HGB-4233 be accepted as written because it is fundamentally identical to paragraph NB-4233(a) and NB-4233(b), which are approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. It is an acceptable approach to use the Class 1 pressure-retaining components construction Code for Class A core support structures because this requirement is not temperature dependent.

HGB-4400

HGB-4420

HGB-4424, Surfaces of Welds
It is recommended that paragraph HGB-4424 be accepted as written because it is fundamentally identical to paragraph NG-4424, which is approved for ASME Code Section III, Division 1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, with the added requirement that the surface geometry must be considered in the stress analysis in accordance with the rules for design of core support structures in elevated surface. HGB-4424 states that the as-welded surface geometry is permitted provided the surface geometry is considered in the stress analysis in accordance with the rules for design of Class A elevated temperature components. The requirement to include the surface geometry in the stress analysis will ensure the impact of as-welded surfaces will be appropriately accounted for by using the proper stress indices when performing analysis in accordance with HGB-3000.

3.3.3. ARTICLE HGB-5000, EXAMINATION

HGB-5100, GENERAL REQUIREMENTS FOR EXAMINATION
It is recommended that subarticle HGB-5100 be accepted as written because it stipulates that core support structure material and material welded thereto shall meet the requirements of III-1 NG-5000, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, except as modified in HGB-5000.

HGB-5200

HGB-5220, REQUIREMENTS FOR RADIOGRAPHY OR ULTRASONIC AND LIQUID PENETRANT OR MAGNETIC PARTICLE EXAMINATION
It is recommended that paragraph HGB-5220 be accepted as written because it is fundamentally identical to paragraph NG-5220, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156 and because the NDE methods and examination volumes identified are consistent with those identified in HBB-5000.

HGB-5221, Category A Welded Joints
It is recommended that paragraph HGB-5221 be accepted as written because it is fundamentally identical to paragraph HBB-5210. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support.

HGB-5222, Category B Welded Joints
It is recommended that paragraph HGB-5222 be accepted as written because it is fundamentally identical to paragraph HBB-5220. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support.

HGB-5223, Category C Welded Joints
It is recommended that paragraph HGB-5223 be accepted as written because it is fundamentally identical to paragraph HBB-5230. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support.

It is recommended that Figure HGB-5223-1 be accepted as written because it is fundamentally identical to III-1-NB Figure NB-4243-1, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HGB-5224, Category D Welded Joints
It is recommended that paragraph HGB-5224 be accepted as written because it is fundamentally identical to paragraph HBB-5240. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support.

HGB-5224.1, Butt-Welded Nozzles
It is recommended that subparagraph HGB-5224.1 be accepted as written because it is fundamentally identical to paragraph HBB-5242. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support.

HGB-5224.2, Full Penetration Corner-Welded Nozzles
It is recommended that subparagraph HGB-5224.2 be accepted as written because it is fundamentally identical to paragraph HBB-5243. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support.

It is recommended that Figure HGB-5224.2-1 be accepted as written because it is fundamentally identical to III-1-NB Figure NB-4244(b)-1, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HGB-5224.3, Deposited Weld Metal as Reinforcement for Openings and Attachment of Nozzles
It is recommended that subparagraph HGB-5224.3 be accepted as written because it is fundamentally identical to paragraph HBB-5244. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support.

It is recommended that Figure HGB-5224.3-1 be accepted as written because it is fundamentally identical to III-1-NB Figure NB-4244(c)-1, which is approved for III-1 use by 10

CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HGB-5224.4, Full Penetration Welds at Oblique Connections
It is recommended that subparagraph HGB-5224.4 be accepted as written because it is fundamentally identical to paragraph HBB-5246. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support.

It is recommended that Figure HGB-5224.4-1 be accepted as written because it is fundamentally identical to III-1-NB Figure NB-4244(e)-1, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HGB-5225, Category E Welded Joints
It is recommended that paragraph HGB-5225 be accepted as written. HGB-5225 states that Category E welds are defined in III-1-NG NG-3351.5 and shall be examined in accordance with the requirements of HGB-5221. The requirements of HGB-5221 are detailed and sufficient to examine welds requiring considerably greater ability to handle stresses and loads as Category A components. This results in the Category E welds being examined with considerable rigor over the actual needs.

3.4. MANDATORY APPENDIX HGB-I, RULES FOR STRAIN, DEFORMATION, AND FATIGUE LIMITS AT ELEVATED TEMPERATURES

3.4.1. ARTICLE HGB-I-1000, INTRODUCTION

It is recommended that Mandatory Appendix HGB-1 be accepted as written because it provides rules that may be used by the applicant with respect to evaluation by analysis of strain, deformation, and fatigue limits for components whose load-controlled stresses are evaluated by the rules of III-5-HGB. Article HGB-I-1000 states that load-controlled stresses governed by III-5-HGB are to be evaluated under the rules contained in Nonmandatory Appendix HBB-T.

3.5. MANDATORY APPENDIX HGB-II, RULES FOR CONSTRUCTION OF CORE SUPPORT STRUCTURES, EXTENDED FOR RESTRICTED SERVICE AT ELEVATED TEMPERATURE, WITHOUT EXPLICIT CONSIDERATION OF CREEP AND STRESS-RUPTURE

3.5.1. ARTICLE HGB-II-1000, INTRODUCTION

HGB-II-1100, GENERAL
It is recommended that paragraph HGB-II-1100 be accepted as written because it directs the applicant to use the rules of III-1-NG NG-1000, which is approved for III-1 use by 10 CFR

50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, except as modified by article HGB-II-1000.

HGB-II-1110, ASPECTS OF CONSTRUCTION COVERED BY THESE RULES
It is recommended that paragraph HGB-1110 be accepted as written. The purpose of this paragraph is to dictate the aspects of construction covered by these rules. This paragraph states that the rules of III-1-NG apply to core support structures whose service metal temperature does not exceed the III-1 continuous use temperature and that the rules of III-1-NG as modified in III-5-HGB HGB-II apply to core support structures for elevated temperature service.

3.5.2. ARTICLE HGB-II-2000, MATERIALS

HGB-II-2100
It is recommended that paragraph HGB-II-2100 be accepted as written because it directs the applicant to use the rules of III-1-NG NG-2000, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, except as modified by article HGB-II-2000.

HGB-II-2120

HGB-II-2121, Permitted Material Specifications
It is recommended that paragraph HGB-II-2121 be accepted as written because it is fundamentally identical to paragraph III-1-NG NG-2121, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, except for the minor modification of HGB-II-2121(a) when it is compared to NB-2121(a). See Section 4, HGB-II-2121 for further detail.

It is recommended that Tables HGB-II-2121-1, HGB-II-2121-2, HGB-II-2121-3, and HGB-II-2121-4 be accepted as written. See Section 4, HGB-II-2121 for further detail.

HGB-II-2400

HGB-II-2430

HGB-II-2433

HGB-II-2433.2, Acceptance Standards
It is recommended that subparagraph HGB-II-2433.2 be accepted as written because it is fundamentally identical to paragraph HBB-2433. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

3.5.3. ARTICLE HGB-II-3000, DESIGN

HGB-II-3100
It is recommended that paragraph HGB-II-3100 be accepted as written because it directs the applicant to use the rules of III-1-NG NG-3000, which is approved for III-1 use by 10 CFR

50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, except as modified by article HGB-II-3000.

HGB-II-3110

HGB-II-3112

HGB-II-3112.4, Design Stress Intensity Values
It is recommended that subparagraph HGB-II-3112.4 be accepted as written because it is fundamentally identical, except for the extension of higher temperatures, to subparagraph NG-3112.4, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. The extension of the HGB-II-3112.4 from NB-3112.4 is the allowance of Tables HGB-II-2121-1 through HGB-2121-4 that are extensions of ASME BPVC Section II, Part D Subpart 1 Tables 2A and 2B.

HGB-II-3130

HGB-II-3132, Reinforcement for Openings
It is recommended that paragraph HGB-II-3132 be accepted as written because the first sentence is fundamentally identical to paragraph NG-3132, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. The remaining text specifies acceptable requirements that area replacement rules for Class A components can only be used for internal pressure loadings and that other loadings be accounted for by additional engineering analysis.

HGB-II-3133, External Pressure Difference
It is recommended that paragraph HGB-II-3133 be accepted as written because this directs the applicant to follow the rules of paragraph NG-3133, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156 or to follow HGB II-3133.7 when the rules of NG-3133 are not applicable due to the nature of the load or geometry.

HGB-II-3133.7, Alternate Rules for Buckling Loadings Due to External Pressure
It is recommended that subparagraph HGB-II-3133.7 be accepted as written because this directs the applicant to use the design factors of Appendix HGB-III to demonstrate compliance with the requirements of paragraph NG-3133.

HGB-II-3200

HGB-II-3210

HGB-II-3211, Requirements for Acceptability
It is recommended that paragraph HGB-II-3211 be accepted as written because it is fundamentally identical, except for additional information in HGB-II-3211(a), to paragraph NG-3211, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. The additional

information in HGB-II-3211(a) is recommended as accepted. See Section 4, HGB-II-3211 for further detail.

HGB-II-3220

It is recommended that paragraph HGB-II-3220 be accepted as written. This paragraph directs the applicant to follow the rules of III-1-NG NG-3220 with a modification on Note (7) of Table NG-3221-1 that adds text directing the applicant to refer to Tables HGB-II-3222.4-1 through HGB-II-3222.4-4 in this appendix for elevated temperature applications.

HGB-II-3222

HGB-II-3222.4, Analysis for Cyclic Operation

It is recommended that subparagraph HGB-II-3222.4 be accepted as written because it is fundamentally identical, with slight modifications, to subparagraph NG-3222.4, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. The modifications are recommended as acceptable because they allow the applicant to extend III-A Mandatory Appendix I with Tables HGB-II-3222.4-1 through HGB-II-3222.4-4 for elevated temperature use. See Section 4, HGB-II-3222.4 for further detail.

It is recommended that Tables HGB-II-3222.4-1 through HGB-II-3222.4-4 for elevated temperature use be accepted as written. The values appear to be acceptable and logical, i.e., the values decrease with an increase in the number of cycles and temperature. It is believed that the additional values were developed in studies funded by the Department of Energy in the 1970s and 1980s during the development of these high-temperature alloys. This data was incorporated in databases for use by the ASME Code Committee for use in developing tables for these alloys.

HGB-II-3224

It is recommended that paragraph HGB-II-3224 be accepted as written. This paragraph directs the applicant to follow the rules of III-1-NG NG-3224.1 with a modification on Note (8) of Table NG-3224-1 that adds text directing the applicant to refer to Tables HGB-II-3229-4 through HGB-II-3229-6 in this appendix for elevated-temperature applications.

HGB-II-3224.1, Stress Intensity Limits

It is recommended that subparagraph HGB-II-3224.1 be accepted as written because it is fundamentally identical, with slight modifications, to subparagraph NG-3224.1, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. The modifications are recommended as acceptable because they provide conditions, when all present, that may produce invalid and unconservative results when the Stress Ratio Analysis method is used.

HGB-II-3228

HGB-II-3228.3, Simplified Elastic-Plastic Analysis

It is recommended that subparagraph HGB-II-3228.3 be accepted as written because it is fundamentally identical, except for the permitted materials table and NG-3228.3(e), to

subparagraph NG-3228.3, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. The permitted materials and the exclusion of NG-3228.3(e) are recommended as acceptable because the materials listed are specific materials for III-5-HGB use instead of general materials and because NG-3228.3(e) states the III-1 temperature limits are not to be exceeded.

HGB-II-3229, Design Stress Values
It is recommended that paragraph HGB-II-3229 be accepted as written. The first paragraph of HGB-II-3229 is fundamentally identical to paragraph NG-3229 with the additional information allowing the applicant to extend III-A Mandatory Appendix I with Tables HGB-II-3222.4-1 through HGB-II-3222.4-4 for elevated temperature use. The second paragraph of HGB-II-3229 is recommended as acceptable because it details how the applicant extends the design stress intensity values for HGB-II use.

It is recommended that Tables HGB-II-3229-1 through HGB-II-3229-6 for elevated temperature use be accepted as written. The values appear to be acceptable and logical, i.e., point to II-D with the additional values decreasing as temperature increases. It is believed that the additional values were developed in studies funded by the Department of Energy in the 1970s and 1980s during the development of these high-temperature alloys. This data was incorporated in databases for use by the ASME Code Committee for use in developing tables for these alloys.

HGB-II-3230

HGB-II-3231, Design Conditions
It is recommended that paragraph HGB-II-3231 be accepted as written because it is fundamentally identical, with additional information for elevated temperature use, to paragraph NG-3231. The additional information is recommended as accepted. See Section 4, HGB-II-3231 for further detail.

3.5.4. ARTICLE HGB-II-4000, FABRICATION AND INSTALLATION REQUIREMENTS

HGB-II-4100
It is recommended that paragraph HGB-II-4100 be accepted as written because it directs the applicant to use the rules of ASME Section III, Division 1, Article NG, NG-4000, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, except as modified by article HGB-II-4000.

HGB-II-4200

HGB-II-4230

HGB-II-4233, Alignment Requirements When Component Inside Surface is Inaccessible
It is recommended that paragraph HGB-II-4233 be accepted as written because it is fundamentally identical to paragraph HGB-4233. HGB-4233 is fundamentally identical to NB-4233(a) through NB-4233(b), which are approved for ASME Section III Division 1 use by 10

CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. It is an acceptable approach to use the Class 1 pressure-retaining components construction Code for Class A core support structures because this requirement is not temperature dependent.

3.5.5. ARTICLE HGB-II-5000, EXAMINATION REQUIREMENTS

It is recommended that article HGB-II-5000 be accepted as written because it directs the applicant to use the rules of III-1-NG, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

3.6. MANDATORY APPENDIX HGB-III, BUCKLING AND INSTABILITY

3.6.1. ARTICLE HGB-III-1000, GENERAL REQUIREMENTS

It is recommended that the general requirements of article HGB-III-1000 be accepted as written because it acceptably imposes additional limits to account for buckling or instability due to time-independent behavior and is applicable to all specified Design and Service Loadings. See Section 4, HGB-III-1000 for further detail.

3.6.2. ARTICLE HGB-III-2000, BUCKLING LIMITS: TIME-INDEPENDENT BUCKLING

It is recommended that article HGB-III-2000 be accepted as written because the Load Factor for load-controlled buckling and the Strain Factor for strain-controlled buckling must be equal or exceed the values in Table HGB-III-2000-1 for the specified Design and Service Loading to guard against time-independent buckling. This is conservative because the Load/Strain Factors add factors of safety to the design of the core support structure.

It is recommended that Table HGB-III-2000-1 be accepted as written. This table shows the largest factors of safety for the Design and Service Level A and B limits with a gradual decrease for the Level C and Level D Service Limits. However, the Time-Independent Buckling Limits in this table have not been independently verified because it is unknown where the ASME BPVC committee members acquired the raw data to populate this table.

3.6.3. ARTICLE HGB-III-3000, ALTERNATIVE PROCEDURES

It is recommended that article HGB-III-3000 be accepted as written because it provides an alternate procedure in lieu of HGB-III-2000 that is more conservative. HGB-III-3000 states that an evaluation of stresses, strains, and deformations resulting from buckling may be used to demonstrate the component has remained structurally and functionally integral with the specified loads multiplied by the applicable Load Factor. This Article also stipulates that nonlinear, plastic, and initial imperfection effects shall be included. This is conservative because the load to be compared to the specified Design or Service Limits is amplified by the Load Factor, thus reducing the amount of load the core support structure can experience to sufficiently stay below the specified limit.

3.7. MANDATORY APPENDIX HGB-IV, TIME—TEMPERATURE LIMITS

3.7.1. ARTICLE HGB-IV-1000, TIME-TEMPERATURE LIMITS

It is recommended that article HGB-IV-1000 be accepted as written. The approach given in this article appears to be acceptable for using a use fraction and is a similar approach to what is found in HGB-3000. HGB-IV-1000 gives the applicant the ability to determine the maximum allowable time at temperature where creep and stress rupture do not need to be acknowledged and states this method cannot be used if the specified design lifetime exceeds 300,000 hrs.

It is recommended that Figure HGB-IV-1000-1 be accepted as written. The figure appears to be acceptable and shows an expected trend, i.e., time increases as temperature decreases. It is believed that the additional values were developed in studies funded by the Department of Energy in the 1970s and 1980s during the development of these high-temperature alloys. This data was incorporated in databases for use by the ASME Code Committee for use in developing tables for these alloys.

4. TECHNICAL REVIEW DETAIL

This section details PNNL's review of Section III, Division 5, Subsection HB, Subpart B, Articles HBB-3000 through HBB-6000; Subsection HC, Subpart B, Articles HCB-3000 through HCB-6000; Subsection HG, Subpart B Articles HGB-3000 through HGB-5000; and Mandatory Appendices HGB-I, HGB-II, HGB-III, and HGB-IV.

General Notes:

Normal, Upset, Emergency, and Faulted are now Level A, Level B, Level C, and Level D, respectively.

Class 1 components from Sec. III, Div. 1 are analogous to Class A components from Sec. III, Div. 5.

Class 2 components from Sec. III, Div. 1 are analogous to Class B components from Sec. III, Div. 5.

4.1. SUBSECTION HB, CLASS A METALLIC PRESSURE BOUNDARY COMPONENTS, SUBPART B, ELEVATED TEMPERATURE SERVICE

4.1.1. ARTICLE HBB-3000, DESIGN

HBB-3100, GENERAL REQUIREMENTS FOR DESIGN

HBB-3110, SCOPE, ACCEPTABILITY, AND LOADINGS

HBB-3111, Scope

It is recommended that paragraph HBB-3111 be accepted as written because it is fundamentally identical to paragraph -3111 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3111.1, Acceptability

It is recommended that subparagraph HBB-3111.1 be accepted as written because it is fundamentally identical to subparagraph -3111.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3111.2, Loadings

It is recommended that subparagraph HBB-3111.2 be accepted as written because it is fundamentally identical, except for subsubparagraph HBB-3111.2(g), to subparagraph -3111.2 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is recommended that subsubparagraph HBB-3111.2(g) be accepted as written. This is an acceptable addition, and the applicant will develop the detailed methods to account for the design loads as part of the Design Report.

HBB-3112, Design Parameters
It is recommended that paragraph HBB-3112 be accepted as written because it is fundamentally identical to paragraph -3112 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3112.1, Specified Pressure
It is recommended that subparagraph HBB-3112.1 be accepted as written because it is fundamentally identical to subparagraph -3112.1 of Code Case 1592 which has been approved for use through NRC RG 1.87.

HBB-3112.2, Specified Temperature
It is recommended that subparagraph HBB-3112.2 be accepted as written because it is fundamentally identical to subparagraph -3112.2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3112.3, Specified Mechanical Load Forces
It is recommended that subparagraph HBB-3112.3 be accepted as written because it is fundamentally identical to subparagraph -3112.3 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3113, Loading Categories
It is recommended that paragraph HBB-3113 be accepted as written because it is fundamentally identical to paragraph -3113 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3113.1, Design Loadings
It is recommended that subparagraph HBB-3113.1 be accepted as written because it is fundamentally identical to subparagraph -3113.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3113.2, Service Loadings
It is recommended that subparagraph HBB-3113.2 be accepted as written because it is fundamentally identical to subparagraph -3113.2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3113.3, Level A Service Loadings
It is recommended that subparagraph HBB-3113.3 be accepted as written because it is fundamentally identical to subparagraph -3113.3 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3113.4, Level B Service Loadings (From Incidents of Moderate Frequency)
It is recommended that subparagraph HBB-3113.4 be accepted as written because it is fundamentally identical to subparagraph -3113.4 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3113.5, Level C Service Loadings (From Infrequent Incidents)
It is recommended that subparagraph HBB-3113.5 be accepted as written because it is fundamentally identical to subparagraph -3113.5 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3113.6, Level D Service Loadings (From Limiting Faults)
It is recommended that subparagraph HBB-3113.6 be accepted as written because it is fundamentally identical to subparagraph -3113.6 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3113.7, Test Loadings
It is recommended that subparagraph HBB-3113.7 be accepted as written because it is fundamentally identical to subparagraph -3113.7 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3114, Load Histogram

HBB-3114.1, Level A and B Service Events
It is recommended that subparagraph HBB-3114.1 be accepted as written because it is fundamentally identical to subparagraph -3114.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3114.2, Level C Service Events
It is recommended that subparagraph HBB-3114.2 be accepted as written because it is fundamentally identical to subparagraph -3114.2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3120, SPECIAL CONSIDERATIONS

HBB-3121, Corrosion
It is recommended that paragraph HBB-3121 be accepted as written because HBB-3121 is identical to paragraph NB-3121, which has been approved for III-1 use by 10 CFR 50.55a with the 2017 Edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HBB-3122, Cladding
It is recommended that the general requirements for design paragraph HBB-3122 be accepted as written; the basis for acceptance is that HBB-3122 simply points to HBB-3227.8, which is identical to subparagraph 3227.8 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3123, Welding

HBB-3123.1, Dissimilar Welds
It is recommended that subparagraph HBB-3123.1 be accepted as written because HBB-3123.1 is identical to NB-3123.1, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR

56156. Additionally, it cautions the applicant on the use of dissimilar metals having different coefficients of thermal expansion as part of the general requirements for design in order to avoid difficulties in service. The applicant will develop the detailed methods to account for dissimilar welds as part of the Design Report.

HBB-3123.2, Fillet Welded Attachments

It is recommended that subparagraph HBB-3123.2 be accepted as written because this paragraph states that the fillet welded attachment requirements are contained in subparagraph HBB-3356.2, where it is evaluated, which is fundamentally identical to subparagraph -3356.2, except for the added requirement of HBB-3356.2(c), of Code Case 1592, which has been approved for use through NRC RG 1.87. See subparagraph HBB-3356.2 for information on HBB-3356.2(c).

HBB-3124, Environmental Effects

It is recommended that paragraph HBB-3124 be accepted as written because it is identical to NB-3124, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Additionally, paragraph HBB-3124 directs the applicant to consider changes in material properties as part of the general requirements for design due to neutron radiation that may increase the brittle fracture transition temperature and deterioration in the resistance to fracture at temperatures above the transition range. This paragraph also recommends that structural discontinuities in ferritic vessels should not be placed in regions of high neutron flux. The applicant will develop the detailed methods to account for environmental effects as part of the Design Report.

HBB-3125, Configuration

It is recommended that the general requirements for design paragraph HBB-3125 be accepted as written because it is identical to NB-3125 which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. It directs the applicant to account for accessibility to permit the in-service examinations required by ASME BPVC Section XI for components governed by this construction code. The applicant will demonstrate a suitable configuration to perform the examination requirements as part of the Design Report.

HBB-3130, GENERAL DESIGN RULES

HBB-3131, Scope

It is recommended that paragraph HBB-3131 be accepted as written because it is fundamentally identical to paragraph -3131 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3132, Dimensional Standards for Standard Products

It is recommended that the general requirement for design paragraph HBB-3132 be accepted as written because it is identical to NB-3132 which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Additionally, paragraph HBB-3132 directs the applicant to use the

approved dimensional standard documents and applicable editions from Table NCA-7100-1, which is approved for III-1 use by 10 CFR 50.55a, when the standard or specification is referenced in III-5-HBB. Additionally, it stipulates that these standards do not replace the requirements of stress analysis by any design article for a specific component.

HBB-3133, Size Restrictions in Nozzle, Branch, Piping, and Other Connections

It is recommended that the general requirement for design paragraph HBB-3133 be accepted as written because it warns the applicant that the size of certain design features is restricted on components constructed to III-5-HBB and points to Table HBB-3133-1 for assistance on where these limits are imposed.

It is recommended that Table HBB-3133-1 be accepted as written. This table lists the referenced sections of III-5-HBB for the creep service condition that differ from the approved sections of III-1-NB for the non-creep service condition.

Note:

> For socket welded fittings used in pressure-retaining joints in accordance with 10 CFR 50.55a(b)(1)(ii), applicants and licensees may not apply the Section III provisions for welds with leg size less than 1.09* t_n, where t_n is the nominal pipe thickness.
>
> The non-creep service conditions reference III-1-NB, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC and is expected to be incorporated by reference according to 83 FR 56156. The one reference of HBB-3337.3 for the non-creep service condition associated with pumps is identical to -3337.3 of Code Case 1592, which is approved for use through NRC RG 1.87.
>
> The creep service conditions that reference III-5-HBB, except for HBB-3331(b) and HBB-3660(b), are fundamentally identical to Code Case 1592, which has been approved for use through NRC RG 1.87.
>
> HBB-3331(b) is recommended to be accepted as written. See Section -3331 *General Requirements* for information on HBB-3331(b).
>
> HBB-3660(b) is recommended to be accepted as written. See Section -3360 *Design of Welds* for information on HBB-3660(b).

HBB-3134, Leak Tightness

It is recommended that paragraph HBB-3134 be accepted as written because it is fundamentally identical to paragraph -3134 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3135, Attachments

It is recommended that paragraph HBB-3135 be accepted as written because it is fundamentally identical to paragraph -3135 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3136, Reinforcement for Openings
It is recommended that paragraph HBB-3136 be accepted as written. HBB-3136 has conservatively omitted the language that allowed post-weld heat treatment to not be performed on nozzles and branch connections and directs the applicant to the use the more detailed rules of HBB-3330 and HBB-3646. HBB-3136 is acceptable because it directs the applicant to use vessel design (HBB-3330) and piping design (HBB-3646), which cover the use of nozzles and branch connections.

HBB-3137, Design Considerations Related to Other Articles of the Code

HBB-3137.1, Design Considerations for Static Pressure Testing
It is recommended that subparagraph HBB-3137.1 be accepted as written because it is fundamentally identical to subparagraph -3137.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3137.2, Design Considerations for Overpressure Protection of the System
It is recommended that subparagraph HBB-3137.2 be accepted as written because it is fundamentally identical to subparagraph -3137.2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3138, Elastic Follow-up
It is recommended that all subparagraphs and subsubparagraphs under paragraph HBB-3138 be accepted as written because they are fundamentally identical to paragraph -3138 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3139, Welding

HBB-3139.1, Abrupt Changes in Mechanical Properties at Weld and Compression Contact Junctions
It is recommended that subparagraph HBB-3139.1 be accepted as written because it is fundamentally identical to paragraph -3139 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3139.2, Weld Design
It is recommended that the general requirement for design subparagraph HBB-3139.2 be accepted as written. This requirement directs the applicant to comply with the rules of III-1 NB-3350, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156 for all welds except as modified in HBB-3400, HBB-3500, or HBB-3600.

HBB-3200, DESIGN BY ANALYSIS

HBB-3210, DESIGN CRITERIA

HBB-3211, Requirements for Acceptability
It is recommended that paragraph HBB-3211 be accepted as written because it is fundamentally identical to paragraph -3211 of Code Case 1592, which has been approved for use through

NRC RG 1.87. HBB-3211(c) references the correct 2017 Code location, which is expected to be incorporated by reference according to 83 FR 56156. Additionally, Code Case 1592 subparagraphs -3211(d) and -3211(e) have been summarized and combined as subparagraph HBB-3211(d) of the 2017 Code.

It is recommended that subparagraphs HBB-3211(a) and HBB-3211(b) be accepted as written since they are fundamentally identical to subparagraphs -3211(a) and -3211(b) of Code Case 1592 which has been approved for use through NRC RG 1.87.

It is recommended that subparagraph HBB-3211(c) be accepted as written. Code Case 1592 states that other restrictions of temperature maxima from NB-3228.3(e) shall apply. The 2017 Code underwent a Sec. III Div. 1 overhaul on subarticles NB-3200, NC-3200, and ND-3200 by moving the identical information from these subarticles to Sec. III, Mandatory Appendix XIII. Additionally, the Code has added more subparagraphs to paragraph NB-3228 compared to the 1971 Code that was in effect when Code Case 1592 was introduced. The call out of "Section III Appendices, Mandatory Appendix XIII, XIII-3450(e)" is identical to what is found in NB-3228.5(e) of the 2015 Code and identical to NB-3228.3(e) of the 1971 Code.

It is recommended that Note 10 in HBB-3211(c) be accepted as written because it is in the same location and identical to Note 1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that the deletion of -3211(d) from Code Case 1592 does not detract from the use of this paragraph. Code Case subparagraph -3211(d) states that "the rules of this case shall apply even when the component is not at elevated temperatures" and states that the properties and allowables of Sec. III, Div. 1, Subsection NB may be used in analyses made to demonstrate compliance with subarticle -3200. This statement has been combined with subparagraph -3211(e) and placed in subparagraph HBB-3211(d).

It is recommended that subparagraph HBB-3211(d) be accepted as written because it is fundamentally identical to subparagraphs -3211(d) and -3211(e) of Code Case 1592, which have been approved for use through NRC RG 1.87.

HBB-3212, Basis for Determining Stress, Strain, and Deformation Quantities

It is recommended that paragraph HBB-3212 be accepted as written. Generally, this paragraph is fundamentally identical to paragraph -3212 of Code Case 1592, which has been approved for use through NRC RG 1.87. HBB-3212(a) references the correct 2017 Code location, which is expected to be incorporated by reference according to 83 FR 56156. Subparagraph HBB-3212(c) refers to a Class A (Class 1 for III-1 use) material (9Cr-1Mo-V) allowed per the material requirements of III-5-HBB, Article HBB-2000, and III-1-NB, Article NB-2000.

It is recommended that subparagraph HBB-3212(a) be accepted as written because it is fundamentally identical to subparagraph -3212(a) of Code Case 1592, which has been approved for use through NRC RG 1.87. Code Case 1592 states maximum shear stress theory shall be used to determine stress intensities and sends the applicant to paragraph NB-3212. The 2017 Code underwent a Sec. III Div. 1 overhaul on subarticles NB-3200, NC-3200, and ND-

3200 by moving the identical information from these subarticles to Sec. III, Mandatory Appendix XIII. The call out of "Section III Appendices, Mandatory Appendix XIII, XIII-1220" is correct, and the information in XIII-1220 is identical to what is found in NB-3212 of the 2015 Code and of the 1971 Code that was in effect when Code Case 1592 was introduced.

It is recommended that subparagraph HBB-3212(b) be accepted as written since it is fundamentally identical to subparagraph -3212(b) of Code Case 1592 which has been approved for use through NRC RG 1.87.

Subparagraph HBB-3212(c) refers to a Class 1 material (9Cr-1Mo-V) allowed per the material requirements of Sec. III, Div. 5, Subsection HB, Subpart B, Article HBB-2000, and Sec. III, Div. 1 Subsection NB, Article NB-2000. Additionally, 9Cr-1Mo-V is one of the original five permissible base materials for structures other than bolts in ASME BPVC Sec. III, Div. 1 Subsection NH. Therefore, it is recommended that subparagraph HBB-3212(c) be accepted as written.

Note:

> Subparagraph HBB-3212(c) gives several unique characteristics that an applicant must consider when 9Cr-1Mo-V is used in high-temperature applications. The use of this material is governed by the requirements and recommendations of ORNL's report on HBB-2000 *Material*.

HBB-3213, Terms Relating to Analysis

It is recommended that paragraph HBB-3213 be accepted as written because it is fundamentally identical to paragraph -3213 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that Note 11 in HBB-3213 be accepted as written because it is in the same location and identical to Note 2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3213.1, Stress Intensity

It is recommended that subparagraph HBB-3213.1 be accepted as written because it is fundamentally identical to subparagraph -3213.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that Note 12 in HBB-3213.1 be accepted as written because it is in the same location and identical to Note 3 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3213.2, Gross Structural Discontinuity

It is recommended that subparagraph HBB-3213.2 be accepted as written because it is fundamentally identical to subparagraph -3213.2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3213.3, Local Structural Discontinuity
It is recommended that subparagraph HBB-3213.3 be accepted as written because it is fundamentally identical to subparagraph -3213.3 of Code Case 1592 which has been approved for use through NRC RG 1.87.

HBB-3213.4, Normal Stress
It is recommended that subparagraph HBB-3213.4 be accepted as written because it is fundamentally identical to subparagraph -3213.4 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3213.5, Shear Stress
It is recommended that subparagraph HBB-3213.5 be accepted as written because it is fundamentally identical to subparagraph -3213.5 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3213.6, Membrane Stress
It is recommended that subparagraph HBB-3213.6 be accepted as written because it is fundamentally identical to subparagraph -3213.6 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3213.7, Bending Stress
It is recommended that subparagraph HBB-3213.7 be accepted as written because it is fundamentally identical to subparagraph -3213.7 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3213.8, Primary Stress
It is recommended that subparagraph HBB-3213.8 be accepted as written. The 2017 Code underwent a Sec. III Div. 1 overhaul on subarticles NB-3200, NC-3200, and ND-3200 by moving the identical information from these subarticles to Sec. III, Mandatory Appendix XIII. The additional sentence in HBB-3213.8 states, "Primary stresses that considerably exceed the yield strength will result in failure or, at least in gross distortion," and is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(y) of the 2017 Code and is identical to what is found in NB-3213.8 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Furthermore, this expanded primary stress definition is not temperature dependent and would still be applicable for high-temperature use.

It is recommended that subsubparagraphs HBB-3213.8(a) through HBB-3213.8(c) be accepted as written because they are fundamentally identical to subsubparagraphs -3213.8(a) through -3213.8(c) of Code Case 1592, which have been approved for use through NRC RG 1.87.

It is recommended that the reference at the bottom of subparagraph HBB-3213.8 be accepted as written because it directs the applicant to examples of primary stress. Table HBB-3217-1 of the 2017 Code is fundamentally identical to Table NB-3217-1 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 edition of the ASME BPVC expected to

be incorporated by reference according to 83 FR 56156, and Table -3217-1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3213.9, Secondary Stress

It is recommended that subparagraph HBB-3213.9 be accepted as written because it is fundamentally identical to subparagraph -3213.9 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3213.9(a) correctly directs the applicant to subparagraph HBB-3213.13 for the definition of thermal stresses in relation to secondary stresses. Additionally, the removed subsubparagraphs of -3213.9(e) and -3213.9(f) of Code Case 1592 have been moved to subsubparagraphs HBB-3213.13(a)(1) and HBB-3213.13(a)(2), respectively.

It is recommended that the deletion of -3213.9(b) through -3213.9(d) of Code Case 1592 be accepted. The examples given in -3213.9(b) through -3213.9(d) do not detract from the meaning of secondary stress and were only given as an aid in defining secondary stress.

It is recommended that the reference at the bottom of subparagraph HBB-3213.9 be accepted as written because it directs the applicant to examples of secondary stress. Table HBB-3217-1 of the 2017 Code is fundamentally identical to Table NB-3217-1 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, and Table -3217-1 of Code Case 1592 which has been approved for use through NRC RG 1.87.

HBB-3213.10, Local Primary Membrane Stress

It is recommended that subparagraph HBB-3213.10 be accepted as written. The 2017 Code underwent a Sec. III Div. 1 overhaul on subarticles NB-3200, NC-3200, and ND-3200 by moving the identical information from these subarticles to Sec. III, Mandatory Appendix XIII. The expansion of the local primary membrane stress definition from -3213.10 of Code Case 1592 to III-5 HBB-3213.10 is fundamentally identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(n) of the 2017 Code and NB-3213.10 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Furthermore, this expanded local primary membrane stress definition is not temperature dependent and would still be applicable for high-temperature use.

HBB-3213.11, Peak Stress

It is recommended that subparagraph HBB-3213.11 be accepted as written because it is fundamentally identical to subparagraph -3213.11 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3213.13, Thermal Stress

It is recommended that subparagraph HBB-3213.13 be accepted as written because it is fundamentally identical to subparagraph -3213.13 of Code Case 1592, which has been approved for use through NRC RG 1.87. The 2017 Code underwent a Sec. III Div. 1 overhaul on subarticles NB-3200, NC-3200, and ND-3200 by moving the identical information from these

subarticles to Sec. III, Mandatory Appendix XIII. The expansion of the thermal stress definition from -3213.13 to HBB-3213.13 is fundamentally identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(aj) of the 2017 Code and NB-3213.13 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

It is recommended that subsubparagraph HBB-3213.13(a) be accepted as written. The first sentence is fundamentally identical to subsubparagraph -3213.13(a) of Code Case 1592, which has been approved for use through NRC RG 1.87. The second sentence clarifies that peak stresses do not belong in this category and sends the applicant to HBB-T-1331(d) for classification guidance. This is true based on the description of thermal stress in HBB-3213.13. Subsubparagraphs HBB-3213.13(1) and HBB-3213.13(2) are fundamentally identical to -3213.9(e) and -3213.9(f), respectively. HBB-3213.13(3) is an additional example of general thermal stress and is valid for high-temperature use.

Note:

> The reference to subparagraph HBB-T-1331(d) is acceptable because NUMARK recommends that paragraph HBB-T-1331 be accepted based on the summary given in Section 3, HBB-T-1331 *General Requirements* and the accompanying arguments in Section 4.

It is recommended that subsubparagraph HBB-3213.13(b) be accepted as written because it is fundamentally identical to subsubparagraph -3213.13(b) of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3213.15, Service Cycle

It is recommended that subparagraph HBB-3213.15 be accepted as written because it is fundamentally identical to subparagraph -3213.15 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3213.16, Strain Cycle

It is recommended that subparagraph HBB-3213.16 be accepted as written because it is fundamentally identical to subparagraph -3213.16 of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

> The reference to paragraph HBB-T-1413 is acceptable because NUMARK recommends that paragraph HBB-T-1413 be accepted based on the summary given in Section 3, HBB-T-1413 *Equivalent Strain Range* and the accompanying arguments in Section 4.

HBB-3213.17, Fatigue Strength Reduction Factor

It is recommended that subparagraph HBB-3213.17 be accepted as written because it is fundamentally identical to subparagraph -3213.17 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3213.18, Free End Displacement

It is recommended that subparagraph HBB-3213.18 be accepted as written because it is fundamentally identical to subparagraph -3213.19 of Code Case 1592, which has been approved for use through NRC RG 1.87. Because paragraph HBB-3213 is solely a listing of definitions, the exact order and placement within this paragraph are irrelevant and do not detract from the actual definition provided by the Code.

HBB-3213.20, Deformation

It is recommended that subparagraph HBB-3213.20 be accepted as written. The 2017 Code underwent a Sec. III Div. 1 overhaul on subarticles NB-3200, NC-3200, and ND-3200 by moving the identical information from these subarticles to Sec. III, Mandatory Appendix XIII. The definition given in this subparagraph defines a common engineering term and is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(d) of the 2017 Code and NB-3213.20 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. This definition allows the applicant to know exactly what is meant by "deformation" in this section of the Code.

HBB-3213.21, Inelasticity

It is recommended that subparagraph HBB-3213.21 be accepted as written. The 2017 Code underwent a Sec. III Div. 1 overhaul on subarticles NB-3200, NC-3200, and ND-3200 by moving the identical information from these subarticles to Sec. III, Mandatory Appendix XIII. The definition given in this subparagraph defines a common engineering term and is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(j) of the 2017 Code and NB-3213.21 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. This definition allows the applicant to know exactly what is meant by "inelasticity" in this section of the Code.

HBB-3213.22, Creep

It is recommended that subparagraph HBB-3213.22 be accepted as written. The 2017 Code underwent a Sec. III Div. 1 overhaul on subarticles NB-3200, NC-3200, and ND-3200 by moving the identical information from these subarticles to Sec. III, Mandatory Appendix XIII. The definition given in this subparagraph defines a common engineering term and is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(c) of the 2017 Code and NB-3213.22 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. This definition allows the applicant to know exactly what is meant by "creep" in this section of the Code.

HBB-3213.23, Plasticity

It is recommended that subparagraph HBB-3213.23 be accepted as written. The 2017 Code underwent a Sec. III Div. 1 overhaul on subarticles NB-3200, NC-3200, and ND-3200 by moving the identical information from these subarticles to Sec. III, Mandatory Appendix XIII. The definition given in this subparagraph, excluding the last sentence involving 9Cr-1Mo-V, defines

a common engineering term and is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(x) of the 2017 Code and NB-3213.23 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. This definition allows the applicant to know exactly what is meant by “plasticity” in this section of the Code.

It is recommended that the last sentence of subparagraph HBB-3213.23 be accepted as written. This sentence states for 9Cr-1Mo-V, time-independent plasticity at higher temperatures occurs only in limiting cases where strain rates are high relative to creep rates. Note that the use of this material is governed by the requirements and recommendations of ORNL’s report on HBB-2000 *Material*.

HBB-3213.24, Plastic Analysis

It is recommended that subparagraph HBB-3213.24 be accepted as written. The 2017 Code underwent a Sec. III Div. 1 overhaul on subarticles NB-3200, NC-3200, and ND-3200 by moving the identical information from these subarticles to Sec. III, Mandatory Appendix XIII. The definition given in this subparagraph, excluding the sentence regarding the use of 9Cr-1Mo-V, defines a common engineering analysis method and is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(t) of the 2017 Code and NB-3213.24 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. This allows the applicant to know exactly what is meant when “plastic analysis” is stated in the Code.

It is recommended that the sentence pertaining to 9Cr-1Mo-V of subparagraph HBB-3213.24 be accepted as written. This sentence states for 9Cr-1Mo-V, plastic analysis must generally account for rate dependence and creep effects. Note that the use of this material is governed by the requirements and recommendations of ORNL’s report on HBB-2000 *Material*.

HBB-3213.25, Plastic Analysis – Collapse Load

It is recommended that subparagraph HBB-3213.25 be accepted as written. The 2017 Code underwent a Sec. III Div. 1 overhaul on subarticles NB-3200, NC-3200, and ND-3200 by moving the identical information from these subarticles to Sec. III, Mandatory Appendix XIII. The definition given in this subparagraph defines a common engineering analysis and is fundamentally identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(u) of the 2017 Code and NB-3213.25 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. This definition allows the applicant to know exactly what is meant by using a “plastic analysis” to determine the “collapse load” in this section of the Code.

HBB-3213.26, Plastic Instability Load

It is recommended that subparagraph HBB-3213.26 be accepted as written. The 2017 Code underwent a Sec. III Div. 1 overhaul on subarticles NB-3200, NC-3200, and ND-3200 by moving the identical information from these subarticles to Sec. III, Mandatory Appendix XIII. The definition given in this subparagraph defines a common engineering term and is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(w) of the 2017 Code

and NB-3213.26 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. This definition allows the applicant to know exactly what is meant by “plastic instability load” in this section of the Code.

HBB-3213.27, Limit Analysis

It is recommended that subparagraph HBB-3213.27 be accepted as written. The 2017 Code underwent a Sec. III Div. 1 overhaul on subarticles NB-3200, NC-3200, and ND-3200 by moving the identical information from these subarticles to Sec. III, Mandatory Appendix XIII. The definition given in this subparagraph defines a common engineering analysis and is fundamentally identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(k) of the 2017 Code and NB-3213.27 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. This definition allows the applicant to know exactly what is meant by using a “limit analysis” in this section of the Code.

HBB-3213.28, Limit Analysis – Collapse Load

It is recommended that subparagraph HBB-3213.28 be accepted as written because it is fundamentally identical to the first and last sentence of paragraph -3213.21 of Code Case 1592, which has been approved for use through NRC RG 1.87. Because paragraph HBB-3213 is solely a listing of definitions, the exact order and placement within this paragraph are irrelevant and have no bearing on the actual definition provided by the Code. Additionally, the remaining text from -3213.21 that is not in HBB-3213.28 does not detract from the definition of how a "limit analysis” is used to compute the maximum carrying load or “collapse load”.

HBB-3213.29, Calculated Collapse Load – Lower Bound

It is recommended that subparagraph HBB-3213.29 be accepted as written because it is fundamentally identical to subparagraph -3213.22 of Code Case 1592, which has been approved for use through NRC RG 1.87. Because paragraph HBB-3213 is solely a listing of definitions, the exact order and placement within this paragraph are irrelevant and do not detract from the actual definition provided by the Code.

HBB-3213.30, Plastic Hinge

It is recommended that subparagraph HBB-3213.30 be accepted as written. The 2017 Code underwent a Sec. III Div. 1 overhaul on subarticles NB-3200, NC-3200, and ND-3200 by moving the identical information from these subarticles to Sec. III, Mandatory Appendix XIII. The definition given in this subparagraph defines a common engineering term and is fundamentally identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(v) of the 2017 Code and is fundamentally identical to what is found in NB-3213.30 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. This definition allows the applicant to know exactly what is meant by “plastic hinge” in this section of the Code.

HBB-3213.31, Strain Limiting Load

It is recommended that subparagraph HBB-3213.31 be accepted as written. The 2017 Code underwent a Sec. III Div. 1 overhaul on subarticles NB-3200, NC-3200, and ND-3200 by moving

the identical information from these subarticles to Sec. III, Mandatory Appendix XIII. The definition given in this subparagraph defines a common engineering term and is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(af) of the 2017 Code and NB-3213.31 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. This definition allows the applicant to know exactly what is meant by “strain limiting load” in this section of the Code.

HBB-3213.32, Test Collapse Load

It is recommended that subparagraph HBB-3213.32 be accepted as written. The 2017 Code underwent a Sec. III Div. 1 overhaul on subarticles NB-3200, NC-3200, and ND-3200 by moving the identical information from these subarticles to Sec. III, Mandatory Appendix XIII. The definition given in this subparagraph defines a common engineering term and is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(ai) of the 2017 Code and NB-3213.32 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. This definition allows the applicant to know exactly what is meant by “test collapse load” in this section of the Code.

HBB-3213.33, Ratcheting

It is recommended that subparagraph HBB-3213.33 be accepted as written because it is fundamentally identical to subparagraph -3213.23 of Code Case 1592, which has been approved for use through NRC RG 1.87. Because paragraph HBB-3213 is solely a listing of definitions, the exact order and placement within this paragraph are irrelevant and do not detract from the actual definition provided by the Code.

HBB-3213.34, Shakedown

It is recommended that subparagraph HBB-3213.34 be accepted as written because it is fundamentally identical to subparagraph -3213.18 of Code Case 1592, which has been approved for use through NRC RG 1.87. Because paragraph HBB-3213 is solely a listing of definitions, the exact order and placement within this paragraph are irrelevant and do not detract from the actual definition provided by the Code.

HBB-3213.35, Design Information on the Nameplate

It is recommended that subparagraph HBB-3213.35 be accepted as written because it is fundamentally identical to subparagraph -3213.24 of Code Case 1592, which has been approved for use through NRC RG 1.87. Because paragraph HBB-3213 is solely a listing of definitions, the exact order and placement within this paragraph are irrelevant and do not detract from the actual definition provided by the Code.

HBB-3213.36, Use-Fraction

It is recommended that subparagraph HBB-3213.36 be accepted as written because it is fundamentally identical to subparagraph -3213.25 of Code Case 1592, which has been approved for use through NRC RG 1.87. Because paragraph HBB-3213 is solely a listing of definitions, the exact order and placement within this paragraph are irrelevant and do not detract from the actual definition provided by the Code.

HBB-3213.37, Fatigue Damage

It is recommended that subparagraph HBB-3213.37 be accepted as written because it is fundamentally identical to subparagraph -3213.26 of Code Case 1592, which has been approved for use through NRC RG 1.87. Because paragraph HBB-3213 is solely a listing of definitions, the exact order and placement within this paragraph are irrelevant and do not detract from the actual definition provided by the Code.

HBB-3213.38, Creep Damage

It is recommended that subparagraph HBB-3213.38 be accepted as written because it is fundamentally identical to subparagraph -3213.27 of Code Case 1592, which has been approved for use through NRC RG 1.87. Because paragraph HBB-3213 is solely a listing of definitions, the exact order and placement within this paragraph are irrelevant and do not detract from the actual definition provided by the Code.

HBB-3213.39, Creep-Fatigue Interaction

It is recommended that subparagraph HBB-3213.39 be accepted as written because it is fundamentally identical to subparagraph -3213.28 of Code Case 1592, which has been approved for use through NRC RG 1.87. Because paragraph HBB-3213 is solely a listing of definitions, the exact order and placement within this paragraph are irrelevant and do not detract from the actual definition provided by the Code.

HBB-3214, Stress Analysis

It is recommended that paragraph HBB-3214 be accepted as written because it is fundamentally identical to paragraph -3214 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3214.1, Elastic Analysis

It is recommended that subparagraph HBB-3214.1 be accepted as written because it is fundamentally identical to subparagraph -3214.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3214.2, Inelastic Analysis

It is recommended that subparagraph HBB-3214.2 be accepted as written. Subparagraph -3214.2 explicitly states that inelastic analysis may be necessary, does not contain any methods or instructions on how to perform an inelastic analysis, and requires justification for any method used be included in the Design Report. The recommendation for acceptance of subparagraph HBB-3214.2 is based on the third written paragraph that states, “The basis for choosing the selected methods and relations used should be included in the Design Report.”

Note:

> The stress analysis in subparagraph HBB-3214.2 states for 9Cr-1Mo-V, decoupling of plastic and creep strains in the classical constitutive framework is generally a poor representation of the true material behavior. Unified constitutive equations, which do not distinguish between rate-dependent plasticity and time-dependent creep, represent the rate dependence and softening that occur, particularly at higher temperatures. The use

of this material is governed by the requirements and recommendations of ORNL's report on HBB-2000 *Material*.

The reference to "rules and limits" in Nonmandatory Appendix HBB-T and subparagraph HBB-T-1510(g) is acceptable because NUMARK states in the introduction of Section 3.1 *Nonmandatory Appendix HBB-T Rules for Strain, Deformation, and Fatigue Limits at Elevated Temperatures*, "Our technical recommendation finds the limits of HBB-T are an acceptable approach for demonstrating compliance with the design requirements for Division 5 Class A components although the owner may use other methods as justified in the design report (NCA-3550)."

HBB-3214.3, Mechanical and Physical Properties

It is recommended that subparagraph HBB-3214.3 be accepted as written because it is fundamentally identical to subparagraph -3214.3 of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

The reference to the mechanical and physical properties in Mandatory Appendix HBB-I-14 is acceptable. The use of these mechanical and physical properties is governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

The reference to the mechanical and physical properties in Nonmandatory Appendix HBB-T is acceptable. The use of these mechanical and physical properties is governed by the requirements and recommendations of NUMARK's report on Nonmandatory Appendix HBB-T *Rules for Strain, Deformation, and Fatigue Limits at Elevated Temperatures*.

HBB-3215, Derivation of Stress Intensities

It is recommended that paragraph HBB-3215 be accepted as written because it is fundamentally identical to paragraph -3215 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that deletion of Note 1 from -3215(b) be accepted. Note 1 of -3215(b) is identical to Note 11 of III-5-HBB and is accounted for through reference to the design requirements of HBB-3210.

HBB-3216, Derivation of Stress Differences and Strain Differences

It is recommended that paragraph HBB-3216 be accepted as written because it is fundamentally identical to paragraph -3216 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3217, Classification of Stresses

It is recommended that paragraph HBB-3217 be accepted as written because it is fundamentally identical to paragraph -3217 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that Table HBB-3217-1 be accepted as written. Table HBB-3217-1 is fundamentally identical to Table -3217-1 of Code Case 1592, except for the added note and the expansion on the vessel component – Nozzles, which has been approved for use through NRC RG 1.87. It is recommended that these additions to Table HBB-3217-1 be accepted as written because the addition of Vessel Component – Nozzles (HBB-3227.5) is similar to Table NB-3217-1 Vessel Part – Nozzles (NB-3227.5) and Table XIII-2600-1 Vessel Part – Nozzles, which are approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

Note:

> The 2017 Code underwent a Sec. III Div. 1 overhaul on subarticles NB-3200, NC-3200, and ND-3200 by moving the identical information from these subarticles to Sec. III, Mandatory Appendix XIII. Therefore, the information from Table NB-3217-1 is now found in Table XIII-2600-1.
>
> Table HBB-3217-1, cladding type of stress should be peak stress, as described in the 2017 edition of Sec. III Appendices Appendix XIII Table XIII-2600-1.
>
> The addition of Note (2) is acceptable because it draws further distinction on how to classify the bending at the juncture of a head to shell. This distinction reclassifies the bending stress at this location from a secondary stress (Q) to a primary stress (P_b) if bending is required to maintain bending stress at a location away from a discontinuity, i.e., the center region of a flat head, to acceptable limits. This is identical to the language used in footnote (1) of Sec. III Div. 1 Table NB-3217-1 (2015 edition) and footnote (3) of Sec. III Appendices Table XIII-2600-1 (2017 edition). For III-1-NB, this conservatism is shown by a reduction of the allowable stress intensity limits from $3S_m$ (Q) to $1.5S_m$ (P_b).

It is recommended that Table HBB-3217-2 be accepted as written because it is fundamentally identical to Table -3217-2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3220, DESIGN RULES AND LIMITS FOR LOAD-CONTROLLED STRESSES IN STRUCTURES OTHER THAN BOLTS

HBB-3221, General Requirements

It is recommended that paragraph HBB-3221 be accepted as written because it is fundamentally identical, with additional information discussed below, to -3221 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that subparagraph HBB-3221(a) be accepted as written. Excluding the additional information on where to locate the allowable stress intensity values, HBB-3221(a) is fundamentally identical to -3221(a) of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

For HBB-3221(a), the allowable stress intensity values found in the 2017 edition of ASME BPVC Section II, Part D (II-D), Subpart 1, Tables 2A and 2B at or below the continuous operating temperature defined for III-1 use are acceptable. These tables from II-D are approved for use by reference in III-1-NB, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Additionally, the allowable stress intensity values found in Tables HBB-I-14.1(a) through HBB-I-14.13C are acceptable. The use of these tables is governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

It is recommended that subparagraph HBB-3221(b) be accepted as written because it is fundamentally identical to subparagraph -3221(b) of Code Case 1592, which has been approved for use through NRC RG 1.87. The only difference is this subparagraph makes a distinction between base metal and weldments.

It is recommended that subsubparagraph HBB-3221(b)(1) – S_m be accepted as written. Excluding the language on the use of HBB-2160(d), HBB-3221(b)(1) – S_m is fundamentally identical to -3221(b) – S_m of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

For HBB-3221(b)(1) S_m, any value for the time-independent allowable design stress intensity, S_m, found using the criteria from the 2017 edition of II-D at or below the continuous operating temperature defined for III-1 is acceptable for use, because the 2017 edition of the ASME BPVC is expected to be incorporated by reference according to 83 FR 56156. The use of S_m values extended beyond the III-1 continuous use temperature and the adjustment to account for long-time service at elevated temperature as discussed in HBB-2160(d) is acceptable and is governed by the requirements and recommendations of ORNL's report on HBB-2000 *Material*.

It is recommended that subsubparagraph HBB-3221(b)(1) – S_{mt} be accepted as. Excluding the language on the use of HBB-2160(d), HBB-3221(b)(1) – S_{mt} is fundamentally identical to -3221(b) – S_{mt} of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

For HBB-3221(b)(1) S_{mt}, the value for the stress intensity, S_{mt}, found from Figures HBB-I-14.3A through HBB-I-14.3E and in Tables HBB-I-14.3A through HBB-I-14.3E and the adjustment to account for long-time service at elevated temperature as discussed in HBB-2160(d) is acceptable. The acceptance of HBB-2160(d) and HBB-I-14 tables and figures are governed by the requirements and recommendations of ORNL's report on HBB-2000 *Material* and Mandatory Appendix HBB-I-14 *Tables and Figures*.

It is recommended that subsubparagraph HBB-3221(b)(1) – S_o be accepted as written. Excluding the additional language in the last two sentences, HBB-3221(b)(1) – S_o is fundamentally identical to -3221(b) – S_o of Code Case 1592, which has been approved for use through NRC RG 1.87. Note that the maximum allowable stress values, S, for ASME BPVC Section VIII, Division 1 are found in ASME BPVC Section II, Part D, Subpart 1, Table 1A.

Note:

> For HBB-3221(b)(1) S_o, the value for the maximum allowable stress, S_o, given in Table HBB-I-14.2 is acceptable for use and governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

It is recommended that subsubparagraph HBB-3221(b)(1) – S_t be accepted as written. Excluding the additional limit reduction imposed on the testing parameters used to determine the temperature and time-dependent stress intensity limit, HBB-3221(b)(1) – S_t is fundamentally identical to -3221(b) – S_t of Code Case 1592, which has been approved for use through NRC RG 1.87. The additional sentence that states the lesser value from (a), (b), and (c) should be used is conservative when compared to the language in Code Case 1592, which only stipulates that (a), (b), and (c) must be considered.

Note:

> For HBB-3221(b)(1) S_t, creep rupture test at various temperature and stress levels must be performed to obtain the full creep curve data for the material in question. This is required to determine the limits established in (a) through (c) to determine the time-dependent allowable stress value for Service Loadings, S_t. Literature values should not be used.
>
> For HBB-3221(b)(1) S_t(a), the updated language of "100% of the average stress required to obtain a total (elastic, plastic, primary, and secondary creep) strain of 1%" is fundamentally identical to -3221(b) S_t(a) of Code Case 1592, which states that "the stress required to obtain a total (elastic, plastic, primary, and secondary creep) strain of 1%." Therefore, this requirement is acceptable because these are fundamentally identical, and no further investigation is required.
>
> For HBB-3221(b)(1) S_t(b), the updated language of "80% of the minimum stress to cause initiation of tertiary creep" is more conservative than -3221(b) S_t(b) of Code Case 1592, which states "the stress to cause initiation of tertiary creep." ASME BPVC HBB-3221 requires the use of the "minimum stress" instead of simply stating "stress" and imposes an additional factor of safety by lowering the stress value from 100% to 80%. Therefore, this requirement is acceptable because it is more conservative the requirement of Code Case 1592.
>
> For HBB-3221(b)(1) S_t(c), the updated language of "67% of the minimum stress to cause rupture" is more conservative than -3221(b) S_t(c) of Code Case 1592, which states "the stress to cause rupture." ASME BPVC HBB-3221 requires the use of the "minimum

stress" instead of simply stating "stress" and imposes an additional factor of safety by lowering the stress value from 100% to 67%. Therefore, this requirement is acceptable because it is more conservative the requirement of Code Case 1592.

It is recommended that subsubparagraph HBB-3221(b)(1) – S_y be accepted as written because it is fundamentally identical to -3221(b) – S_y of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

For HBB-3221(b)(1) S_y, the value for the yield strength, S_y, above the continuous use temperature for III-1 use given in II-D and in Table HBB-I-14.5 is acceptable for use and governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

It is recommended that subsubparagraph HBB-3221(b)(2) be accepted as written. HBB-3221(b)(2) draws a distinction between the base metal and weldments of components constructed in Sec. III Div. 5. The limits established in HBB-3221(b)(2) are an acceptable approach because it lowers the allowable limits for the weldments instead of using the allowable limits of the base material that is implied through the use of -3221 of Code Case 1592.

Specifically, the value for allowable limits of S_{mt} and S_t on the weldments are the minimum of the base material allowable limits from Tables HBB-I-14.3A through HBB-I-14.3E and Tables HBB-I-14.4A through HBB-I-14.4E, respectively, or 80% of the minimum stress to rupture, S_r, from Tables HBB-I-14.6A through HBB-I-14.6F scaled by the weld metal to base metal creep rupture strength ratio from Tables HBB-I-14.10A-1 through HBB-I-14.0E-1. This requirement places lower allowable limits on the weldment when compared to Code Case 1592, which used the base material allowable limits for the weldments. Therefore, this is acceptable with the HBB-I-14 tables governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*. Additionally, the adjustment to account for long-time service at elevated temperature as discussed in HBB-2160(d) is acceptable and is governed by the requirements and recommendations of ORNL's report on HBB-2000 *Material*.

Note:

The description of S_{mt} erroneously states that "it may be necessary to adjust the values of S_m", when it should say "it may be necessary to adjust the values of S_{mt}."

Figure HBB-3221-1, Flow Diagram for Elevated Temperature Analysis

It is recommended that Figure HBB-3221-1 be accepted. The summary of Figure HBB-3221-1 is given below.

Load-Controlled Stress Limits:

It is recommended that the Design Limits entry be accepted as written because it is fundamentally identical to this entry in Figure 3220-1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that the Levels A and B Limits entry be accepted as written because it is fundamentally identical to this entry in Figure 3220-1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

> The combined primary membrane and bending limits shown in Figure 3220-1 of Code Case 1592 have been split out into separate limit entries for readability and usability in Figure HBB-3221-1.
>
> The combined primary membrane and bending limit in Figure HBB-3221-1 uses a variable K called the section factor. The applicant may use a section factor for the cross section being investigated in the calculation of the Levels A and B Service Limits. The section factor of 1.5 is the section factor for a rectangular cross-section and what was used in Figure 3220-1 of Code Case 1592.
>
> The combined primary membrane and bending limit that uses the variable K_t is correct as shown and discussed in detail in Section 4, HBB-3223. This variable requires the use of the section factor, K, discussed in the previous note. The variable K_t given in Table HBB-3221-1 is not the same K_t variable given in Table 3220-1 of Code Case 1592.

It is recommended that the Level C Limits entry be accepted as written because it is fundamentally identical to this entry in Figure 3220-1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

> The combined primary membrane and bending limits shown in Figure 3220-1 of Code Case 1592 have been split out into separate limit entries for readability and usability in Figure HBB-3221-1.
>
> The combined primary membrane and bending limit in Figure HBB-3221-1 uses the section factor discussed for Level A and B Service limits but is limited to the range of $1.0 < K \leq 1.5$ (HBB-3224(c)). The section factor of 1.5 is the section factor for a rectangular cross-section and what was used in Figure 3220-1 of Code Case 1592, i.e., 1.5 times 1.2 equals 1.8.
>
> The combined primary membrane and bending limit that uses the variable K_t is correct as shown and discussed in detail in Section 4, HBB-3223. This variable requires the use of the section factor previously discussed. The variable K_t given in Table HBB-3221-1 is not the same K_t variable given in Table 3220-1 of Code Case 1592.
>
> The summation entries are correct as written in Table HBB-3221-1. The updated entries are now written in the correct form by including the summation indices.

It is recommended that the Level D Limits entry be accepted as written because it is fundamentally identical to this entry in Figure 3220-1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

The combined primary membrane and bending limits shown in Figure 3220-1 of Code Case 1592 have been split out into separate limit entries for readability and usability in Figure HBB-3221-1.

The combined primary membrane and bending limit that uses the variable K_t is correct as shown and discussed in greater detail in Section 4, HBB-3223. This variable requires the use of the section factor, K, limited to the range of $1.0 \leq K \leq 1.5$ (HBB-3225(d)). The variable K_t given in Table HBB-3221-1 is not the same K_t variable given in Table 3220-1 of Code Case 1592.

Figure HBB-3221-1 has replaced the two occurrences of $1.2S_t$ with the definition of S_t in terms of rupture for the base metal, $S_t = 0.67S_r$ from HBB-3221(b)(1) and for the weldments, $S_t = 0.8*R*S_r$ from HBB-3221(b)(2). In doing so, the scale factor of 1.2 has been eliminated, thus lowering the allowables used for the general primary membrane stress intensity. Therefore, the elimination of the factor 1.2 and the use of the reduced minimum stress-to-rupture (see discussion on HBB-3221(b)) is an acceptable approach for determining the allowable stress intensity values.

The two entries that have been changed to App. F in Table HBB-3221-1 are correct as written. ASME BPVC Section III, Appendices, Nonmandatory Appendix F is where the applicant would locate the Level D Service Limits for inelastic analysis for Collapse Load, C_L, and the Plastic Instability Load. This is acceptable because III-1 Sub. NB NB-3225 (2015 edition) directs the user to Nonmandatory Appendix F for Level D service Limits. Additionally, the 2017 Code underwent a Sec. III Div. 1 overhaul on subarticles NB-3200, NC-3200, and ND-3200 by moving the identical information from these subarticles to Sec. III, Mandatory Appendix XIII and creating Mandatory Appendix XXVII as a replacement for Nonmandatory Appendix F. The use of III-1 NB-3225 is acceptable for use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Although Nonmandatory Appendix F is present in the 2017 edition of the Code, it is recommended that the Figure HBB-3221-1 be changed to reflect Mandatory Appendix XXVII to be in line with HBB-3225 and the NB-3200 of the 2017 edition of the ASME BPVC.

The summation entries are correct as written Table HBB-3221-1. The updated entries now include the summation indices and different subscript notations to differentiate the Level C and Level D use-fractions.

Strain and Deformation Limits:

It is recommended that the Design Limits entry be accepted as written. Figure 3220-1 of Code Case 1592 does not impose strain and deformation limits for the Design, while Figure HBB-3221-1 requires that time-independent buckling be checked. Adding the requirement to investigate buckling is conservative and will bolster the safety of the design. The use of III-1 NB-3133 is acceptable for use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC

expected to be incorporated by reference according to 83 FR 56156. Additionally, the use of HBB-T-1500 is acceptable for use and is governed by the requirements and recommendations of NUMARK's report on subarticle HBB-T-1500 *Buckling and Instability*.

It is recommended that the Levels A, B, and C Limits entry be accepted as written. This entry is fundamentally identical to Figure 3220-1 of Code Case 1592. Additionally, Nonmandatory Appendix HBB-T is acceptable for use and is governed by the requirements and recommendations of NUMARK's report on Nonmandatory Appendix HBB-T *Rules for Strain, Deformation, and Fatigue Limits at Elevated Temperatures*.

Note:

The "computed quantity" of "Elastic Analysis and Test" in HBB-3221-1 replaces the equation shown in Figure 3220-1 of Code Case 1592. The equation is listed as guideline (b) in paragraphs HBB-T-1321 from Sec. III, Div. 5 and T-1321 from Code Case 1592 for satisfying the strain limits using an elastic analysis. The simplification in Figure HBB-3221-1 is acceptable because this encompasses the entire subsubarticle HBB-T-1320, which gives greater detail on how to determine this limit.

The removal of S_q from Figure HBB-3221-1 is acceptable as written. The variable does not appear to be defined in Code Case 1592 and is presumed to be a "generic" all-encompassing variable for the material strain limits. Because the material strain limits are still listed in the updated Figure HBB-3221-1, this is considered acceptable.

The "controlled quantity for inelastic analysis" variable "D" in HBB-3221-1 replaces the quantity of "1.0" shown in Figure 3220-1 of Code Case 1592. Variable "D" is defined as the total creep-fatigue damage in HBB-T-1411 and T-1411 of Sec. III, Div. 5 and Code Case 1592, respectively. From Figures HBB-T-1420-2 of Sec. III, Div. 5 and T-1420-2 of Code Case 1592, the maximum possible value of "D" in the creep-fatigue damage envelope is 1.0. Therefore, it is conservative to replace the maximum possible value of "1.0" with the more general form "D" that allows for a lower creep-fatigue damage limit.

The "computed quantity" associated with the "controlled quantity for inelastic analysis," D, appears to be correct as written based off paragraph HBB-T-1411 Equation (10) and Figure HBB-T-1420-2 of Sec. III, Div. 5 and paragraph T-1411 Equation (5) and Figure T-1420-2 Code Case 1592. The variable "β" omitted in Figure HBB-3221-1 appears to be a typo because it is not defined and/or used in equation (5) of Appendix T in Code Case 1592.

It is recommended that the Level D Limits entry be accepted as written because it is fundamentally identical to this entry in Figure 3220-1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3222, Design and Service Limits

HBB-3222.1, Design Limits

It is recommended that subparagraph HBB-3222.1 be accepted as written because it is fundamentally identical to subparagraph -3222.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that subsubparagraph HBB-3222.1(a) be accepted as written because it is fundamentally identical to subsubparagraph -3222.1(a) of Code Case 1592, which has been approved for use through NRC RG 1.87. Additionally, footnote 14 of Sec. III Div. 5 is identical to footnote * of Code Case 1592.

It is recommended that subsubparagraph HBB-3222.1(b) be accepted as written because it is fundamentally identical to subsubparagraph -3222.1(b) of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

> The left side of Equation (2) in its current form is correct as written because the use of P_l describes the total membrane stress that results from pressure and mechanical loads, including gross structural discontinuity effects. P_l always includes the P_m contribution. To avoid any potential confusion, the left side of Equation (2) could be written in the general form of (P_m or P_l) + P_b which is the definition in Sec. III Appendices subsubarticle XIII-3130 of the 2017 edition of the ASME BPVC. This would better define the use of combined membrane plus bending because the section of the component being investigated may not be at a discontinuity, which means the membrane component is classified as general primary membrane stress.
>
> The multiplication factor 1.5 on the right side of the equation is the maximum α factor permitted in Sec. III Div. 1 use and is associated with solid rectangular sections. For other than rectangular sections, a value of α times the P_m limit, i.e., αS_o, where the factor α is defined as the ratio of the load set producing a fully plastic section to the load set producing initial yielding in the extreme fibers of the section, may potentially be used, effectively lowering the allowable stress intensity limit for combined primary and bending. In no case shall the value of α exceed 1.5. See Sec. III Appendices subsubarticle XIII-3130 of the 2017 edition of the ASME BPVC for more information.

The additional requirement to account for adequate buckling strength is conservative and uses the approved rules of III-1 NB-3133, which is acceptable for use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Therefore, it is recommended that subsubparagraph HBB-3222.1(c) be accepted as written.

Note:

HBB-3222.1(c) is permitted for use under HBB-3252. HBB-3252 is fundamentally identical to paragraph -3252 of Code Case 1592, which has been approved for use through NRC RG 1.87.

The ASME Code Reconciliation document provided by the NRC indicates that the “or equal to” sign was added to the equations in this subparagraph. Upon review of Code Case 1592, it has been determined that this statement is incorrect and that the “less than or equal to” sign is present in the equations of -3221.1.

HBB-3222.2, Level A Service Limits

It is recommended that subparagraph HBB-3222.2 be accepted as written because it is fundamentally identical to subparagraph -3222.2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

The terms Normal Conditions and Upset Conditions are now called Level A and Level B, respectively.

HBB-3223, Level A and B Service Limits

It is recommended that paragraph HBB-3223 be accepted as written because it is fundamentally identical to paragraph -3223 of Code Case 1592 which has been approved for use through NRC RG 1.87.

It is recommended that subparagraph HBB-3223(a) be accepted as written because it is fundamentally identical to subparagraph -3223(a) of Code Case 1592, which has been approved for use through NRC RG 1.87. The revised wording of this paragraph does not change the meaning of the statement and is essentially identical to Code Case 1592.

Note:

The ASME Code Reconciliation document provided by the NRC indicates that the “or equal to” sign was added to the equation in this subparagraph. Upon review of Code Case 1592, it has been determined that this statement is incorrect and that the “less than or equal to” sign is present in the equation of -3223(a).

It is recommended that subparagraph HBB-3223(b) be accepted as written because it is fundamentally identical to subparagraph -3223(b) of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that subparagraph HBB-3223(c) be accepted as written because it is fundamentally identical to subparagraph -3223(c) of Code Case 1592, except for the additional information present in HBB-3223(c), which has been approved for use through NRC RG 1.87.

Note:

The first written paragraph of HBB-3223(c) is fundamentally identical to what is written in subparagraph -3223(c) of Code Case 1592, which has been approved for use through NRC RG 1.87. The last written sentence in HBB-3223(c) prior to equations (4) and (5) states that the combined stress intensity “shall satisfy the following limits” while -3223(c) states “shall not exceed the smaller of.” The wording change is acceptable. If the limits are satisfied as mentioned in HBB-3223(c), then the combined stress intensity value must be less than the lesser of the two.

Equations (4) and (5) of paragraph HBB-3223(c) are fundamentally identical to Equation (4) of paragraph -3223(c) of Code Case 1592, which has been approved for use through NRC RG 1.87. Equation (4) of -3223 has been split into two separate equations in HBB-3223.

Equation (4) is accepted as written. Paragraph -3223(c) uses $1.5S_m$ as the limit for this equation while HBB-3223(c) used $K*S_m$, where K is the section factor for the cross section being considered. The use of K = 1.5 is appropriate for shell-type structures as discussed in HBB-3223(d) and -3223(d), which is the likely reason Code Case 1592 used this value explicitly. The applicant should use a section factor that is applicable to the cross section being analysed.

Equation (5) is accepted as written. This equation is fundamentally similar to what is given in Equation (6) of -3223(c). When Equation (8) of -3223(c) is plugged into Equation (6) of -3223(c), the same equation is produced as seen when Equation (6) of HBB-3223(c) is plugged into Equation (5) of HBB-3223(c). Using a section factor of 1.5 as is done in Code Case 1592, it can be shown that Equation (5) of HBB-3223(c) is identical to Equation (6) of -3223(c).

Paragraph -3233(c):

Equation (8) $$k_s = \alpha \cdot (K - 1)$$

Equation (6) $$P_L + \frac{P_b}{1 + k_s} \leq S_t$$

Equation (8) into (6): $$P_L + \frac{P_b}{1 + \alpha \cdot (K - 1)} \leq S_t \qquad \text{where,} \qquad \alpha = 0.5$$

$$P_L + \frac{P_b}{1 + \alpha \cdot (K - 1)} = P_L + \frac{P_b}{1 + 0.5 \cdot (K - 1)} = P_L + \frac{P_b}{1 + 0.5K - 0.5} = P_L + \frac{P_b}{0.5K + 0.5}$$

Therefore: $$P_L + \frac{P_b}{0.5 \cdot (K + 1)} \leq S_t$$

Paragraph HBB-3223(c):

Equation (6) $$K_t = 0.5 \cdot (K + 1)$$

Equation (5) $$P_L + \frac{P_b}{K_t} \leq S_t$$

Equation (6) into (5): $$P_L + \frac{P_b}{0.5 \cdot (K + 1)} \leq S_t$$

Therefore, the variable $(1+k_s)$ of -3223(c) is identical to the variable K_t of HBB-3223(c). Note that the variable K_t of HBB-3223(c) is not the same variable K_t of -3223(c), which is not needed to determine the limit as written in HBB-3223(c). Additionally, the second written paragraph of HBB-3223(c) describes the new, updated variable of K_t from HBB-3223(c) and Equation (6). This is correct for how the limit is written in Equation (5) of HBB-3223(c). Therefore, it is recommended that this written paragraph be accepted as written.

The third written paragraph of HBB-3223(c) is accepted as written. The first sentence is identical to the first sentence of the last written paragraph of -3223(c). The last sentence of paragraph HBB-3223(c) is fundamentally identical to the second/last sentence of the last paragraph of -3223(c). -3223(c) refers to Table 9221(a)-1 and HBB-3223(c) refers to Table 9521(b)-1. Table 9221(a)-1 of the 1971 Code edition (Winter 1972 Addenda), which was in effect when Code Case 1592 was introduced, is identical to Table 9521(b)-1 of the 2017 Code edition. Therefore, the reference change is acceptable. The additional information between the first and last sentences of this written paragraph in

HBB-3223(c) details what a section factor is and why is it is used. This is for informational purposes and does not detract from the acceptance of the third written paragraph of HBB-3223(c).

It is recommended that subparagraph HBB-3223(d) be accepted as written because it is fundamentally identical to subparagraph -3223(d) of Code Case 1592, which has been approved for use through NRC RG 1.87. The differences between the two paragraphs involve the calculated value of k_s and K_t from Equation (8) of -3223 and Equation (6) of HBB-3223, respectively. As previously discussed, either one of these variables is acceptable and gives the correct allowable limit.

It is recommended that subparagraph HBB-3223(e) be accepted as written because it is fundamentally identical to subparagraph -3223(e) of Code Case 1592, which has been approved for use through NRC RG 1.87. The only difference between the two paragraphs is the variable change between Code years. As previously discussed, either one of these variables is acceptable and gives the correct allowable limit.

It is recommended that subparagraph HBB-3223(f) be accepted as written because it is fundamentally identical to subparagraph -3223(f) of Code Case 1592, which has been approved for use through NRC RG 1.87. The only difference between the two paragraphs is the variable change between Code years. As previously discussed, either one of these variables is acceptable and gives the correct allowable limit.

The additional requirement of subparagraph HBB-3223(g) to account for buckling under the requirements of HBB-3250 is conservative. Therefore, it is recommended that subparagraph HBB-3223(g) be accepted as written.

HBB-3224, Level C Service Limits

It is recommended that paragraph HBB-3224 be accepted as written because it is fundamentally identical to paragraph -3224 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that subparagraph HBB-3224(a) be accepted as written because it is fundamentally identical to subparagraph -3224(a) of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

The ASME Code Reconciliation document provided by the NRC indicates that the “or equal to” sign was added to the equation in this subparagraph. Upon review of Code Case 1592, it has been determined that this statement is incorrect and that the “less than or equal to” sign is present in the equation of -3224(a).

It is recommended that subparagraph HBB-3224(b) be accepted as written because it is fundamentally identical to subparagraph -3224(b) of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

The ASME Code Reconciliation document provided by the NRC indicates that the “or equal to” sign was added to the equation in this subparagraph. Upon review of Code Case 1592, it has been determined that this statement is incorrect and that the “less than or equal to” sign is present in the equation of -3224(b).

The definition of t_{im}, and the next written paragraph state that the value for t_{im} must be taken from graphs of S_t-vs-time and points to Figures HBB-I-14.4A through HBB-I-14.4E. The use of Figures HBB-I-14.4A through HBB-I-14.4E is acceptable and is governed by the requirements and recommendations of ORNL’s report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

It is recommended that subparagraph HBB-3224(c) be accepted as written because it is fundamentally identical to subparagraph -3224(c) of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

The written part of HBB-3224(c), prior to Equation (9) that states that the combined stress intensity “shall satisfy the following limits”, is fundamentally identical to -3224(c), which states “shall not exceed the smaller of.” This wording change is acceptable. If the limits are satisfied as mentioned in HBB-3224(c), then the combined stress intensity value must be less than the lesser of the two.

Equation (9) is accepted as written. -3224(c) uses $1.8S_m$ as the limit for this equation, while HBB-3224(c) used $1.2*K*S_m$, where K is the section factor for the cross section being considered and is limited to the range of $1.0 < K \leq 1.5$. If the upper limit of 1.5 is used, then the limit becomes $1.8S_m$. The use of K = 1.5 is appropriate for shell type structures as discussed in HBB-3223(d) and -3223(d), which is the likely reason Code Case 1592 used this value explicitly.

Equation (10) is accepted as written. This equation is identical to in Equation (5) of HBB-3223(c). Therefore, the same argument for the acceptance of Equation (5) of HBB-3223(c) also applies to Equation (10) of HBB-3224(c).

Figure HBB-3224-1 is accepted as shown. The figure has truncated the two lines shown in Figure -3224-1 to one generic line to illustrate the Level C use-fraction for membrane stresses. The additional information provided on this figure is the Level D (HBB-3225) use-fraction for membrane stresses that involve rupture.

Note:

The applicable temperature curves from Figure HBB-I-14.4 for Level C and Figure HBB-I-14.6 for Level D use-fractions are acceptable for use and are governed by the requirements and recommendations of ORNL’s report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

Figure HBB-3224-2 is accepted as shown. The figure shows one generic line to illustrate the Level C use-fraction for membrane plus bending stresses. The additional information provided in this figure is the Level D (HBB-3225) use-fraction for membrane plus bending stresses that involve rupture.

Note:

> The applicable temperature curves from Figure HBB-I-14.4 for Level C and Figure HBB-I-14.6 for Level D use-fractions are acceptable for use and are governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

HBB-3225, Level D Service Limits

It is recommended that paragraph HBB-3225 be accepted as written. The first written paragraph is new and simply states what is in the paragraph, and it does not have any technical merit associated with it.

It is recommended that subparagraph HBB-3225(a) be accepted as written because it is fundamentally identical to subparagraph -3225(a) of Code Case 1592, which has been approved for use through NRC RG 1.87. Note that the 2017 Code underwent a Sec. III Div. 1 overhaul on subarticles NB-3200, NC-3200, and ND-3200 by moving the identical information from these subarticles to Sec. III, Mandatory Appendix XIII and creating Mandatory Appendix XXVII as a replacement for Nonmandatory Appendix F. Therefore, the reference to Mandatory Appendix XXVII is correct as written.

It is recommended that subparagraph HBB-3225(b) be accepted as written because unmodified portions are fundamentally identical to subparagraph -3225(b) of Code Case 1592, which has been approved for use through NRC RG 1.87. The Level D Service Limits have been moved from Nonmandatory Appendix F to Mandatory Appendix XXVII. Therefore, the reference of Mandatory Appendix XXVII for Level D Service Limits is correct.

Note:

> HBB-3225(b) has replaced the Level D Service Limit of $1.2S_t$ found in -3225(b) with the definition of S_t for the base metal, $S_t = 0.67S_r$, from HBB-3221(b)(1) and for the weldments, $S_t = 0.8*R*S_r$, from HBB-3221(b)(2). In doing so, the scale factor of 1.2 has been eliminated, thus lowering the allowables used for the general primary membrane stress intensity. Therefore, the elimination of the factor 1.2 and the use of the reduced minimum stress-to-rupture (see discussion on HBB-3221(b)) is an acceptable approach for determining the allowable stress intensity values. Note that Level D Service Limits are intended to ensure that violation of the pressure-retaining boundary will not occur but are not intended to ensure component operability and functionality either during or following the specified event.
>
> The values for R and S_r taken from Tables HBB-I-14.10A-1 through HBB-I-14.10E-1 and Tables HBB-I-14.6A through HBB-I-14.6F, respectively, are acceptable for use and are

governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

It is recommended that subparagraph HBB-3225(c) be accepted as written. The intent and usage of subparagraph -3225(c) is captured in the updated subparagraph of HBB-3225(c).

Note:

Subparagraph -3225(c) directs the user to satisfy rules for the use-fraction for membrane stress as described in -3224(b). It has been recommended that subparagraph HBB-3224(b) be accepted as written because it is fundamentally identical to subparagraph -3224(b) of Code Case 1592, which has been approved for use through NRC RG 1.87.

The expanded subparagraph HBB-3225(c) shows a virtually identical equation when compared to Equation (8) located in subparagraph HBB-3224(b) with the definitions of the variables also fundamentally identical. The subtle difference between the variables in these sections is the change in subscripts designed solely to help the applicant differentiate between Level C and Level D use-fractions.

The factors for P_{mi} (1.5 and 1.25/R) used in the definition of t_{ir} are acceptable as written because they are the Level D Service Limits of HBB-3225(b) rearranged for S_r.

The definition of t_{ir}, and the next written paragraph state the value for t_{ir} must be taken from a graph of minimum stress-to-rupture versus time and points to Figures HBB-I-14.6A through HBB-I-14.6F. Figures HBB-I-14.6A through HBB-I-14.6F are acceptable for use and are governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

The information in the last paragraph is acceptable as written because it details how the applicant would use Figure HBB-3224-1 and is identical to what is written in HBB-3224(b).

It is recommended that subparagraph HBB-3225(d) be accepted as written because unmodified portions are fundamentally identical to subparagraph -3225(d) of Code Case 1592, which has been approved for use through NRC RG 1.87.

The Level D Service Limits have been moved from Nonmandatory Appendix F to Mandatory Appendix XXVII. Therefore, the reference of Mandatory Appendix XXVII for Level D Service Limits is correct.

Subparagraph HBB-3225(d) has factored the variable K_t into the primary membrane plus bending stress intensities similarly to what was done for Equations (5) and (10) of HBB-3223(c) and HBB-3224(c), respectively. Therefore, the same argument for the acceptance of Equation (5) and Equation (10) is also valid for the left side of Equation (13).

When the factor K_t is removed from the right side of Equation (14) from -3225(d) as shown in Equation (13) of HBB-3225(d), the same argument for acceptance in HBB-

3225(b) for the replacement of the general primary membrane Level D Service Limit can be made for the combined primary membrane plus bending Level D Service Limit change shown in HBB-3225(d). Therefore, the elimination of the factor 1.2 and the use of the reduced minimum stress-to-rupture (see discussion on HBB-3221(b)) is an acceptable approach for determining the allowable stress intensity values.

It is recommended that subparagraph HBB-3225(e) be accepted as written. The intent and usage of subparagraph -3225(e) are captured in the updated subparagraph of HBB-3225(e).

Subparagraph -3225(e) directs the user to satisfy the rules for the use-fraction for combined membrane plus bending stress as described in -3224(d). Note that there is a typo in the Code Case that erroneously points to -3224(b). It has been recommended that subparagraph HBB-3224(d) be accepted as written because it is fundamentally identical to paragraph -3224(d) of Code Case 1592, which has been approved for use through NRC RG 1.87.

The expanded subparagraph HBB-3225(e) shows a virtually identical equation when compared to Equation (11) located in subparagraph HBB-3224(d) with definitions of the variables also fundamentally identical. The subtle difference between the variables in these sections is the change in subscripts designed solely to help the applicant differentiate between Level C and Level D use-fractions.

The factors for combined primary membrane and bending (1.5 and 1.25/R) used in the definition of t_{ibr} is acceptable as written because this is the Level D Service Limits of HBB-3225(d) rearranged for S_r.

The definition of t_{ir}, and the next written paragraph state that the value for t_{ir} must be taken from a graph of minimum stress-to-rupture versus time and points to Figures HBB-I-14.6A through HBB-I-14.6F. Figures HBB-I-14.6A through HBB-I-14.6F are acceptable for use and are governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

It is recommended that subparagraph HBB-3225(f) be accepted as written. This new information directs the applicant to determine the Sec. III Div. 5 yield strength value to use in the Appendix XXVII calculations (Level D Service Limits) as the product of the value from Table HBB-I-14.5 (yield strength) and the strength reduction factor shown in Tables HBB-3225-2, HBB-3225-3A, and HBB-3225-3B. Likewise, for tensile strength, the product of the value from Table HBB-3225-1 (tensile strength) and the strength reduction factor shown in Tables HBB-3225-2, HBB-3225-3A, HBB-3225-3B, and HBB-3225-4.

Note:

The yield strength, tensile strength and strength reduction factors from Tables HBB-I-14.5, HBB-3225-1, HBB-3225-2, HBB-3225-3A, HBB-3225-3B, and HBB-3225-4 are acceptable for use and are governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures* and HBB-2000 *Material*.

HBB-3226, Pressure Testing Limitations

It is recommended that paragraph HBB-3226 be accepted as written because it is fundamentally identical to paragraph -3226 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3227, Special Stress Limits

It is recommended that paragraph HBB-3227 be accepted as written because it is fundamentally identical to paragraph -3227 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3227.1, Bearing Loads

It is recommended that subsubparagraph HBB-3227.1(a) be accepted as written because it is fundamentally identical, excluding the additional information, to the first part of subsubparagraph -3227.1(a) of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

> Code Case 1592 subsubparagraph -3227.1(a) and subsubparagraph HBB-3227.1(a) both explicitly state that the average bearing stress for resistance to crushing under the maximum load, other than Level D Service Loads, shall be considered. The additional information provided in subsubparagraph HBB-3227.1(a) gives the applicant a method for evaluating bearing loads that do not exist in Code Case 1592. HBB-3227.1(a) states that the lesser of the two options below should be used.

The HBB-3227.1(a)(1) limit is similar to the limit used for Service Levels A, B, and C found in in Sec. III, Mandatory Appendix XIII, XIII-3710, which is associated with Sec. III, Div. 1 use. Note that the 2017 Code underwent a Sec. III Div. 1 overhaul on subarticles NB-3200, NC-3200, and ND-3200 by moving the identical information from these subarticles to Sec. III, Mandatory Appendix XIII. The limit in HBB-3227.1(a)(1) is more conservative than XIII-3710 because it does not allow the limit to increase by a factor 1.5 due to the distance to a free edge being larger than the distance over which the bearing load is applied. Because no explicit limit is given in Code Case 1592, it is acceptable to rely on the temperature dependent S_y as the limit because this is an acceptable choice when compared to Sec. III Div. 1 use.

Note:

> The use of S_y at temperatures above the III-1 maximum temperature limits found in Mandatory Appendix HBB-1-14 is acceptable and is governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

HBB-3227.1(a)(2) directs the applicant to produce a stress at 0.2% offset strain from the isochronous stress-strain curve for a temperature and time equal to the expected lifetime the component is expected to spend at a temperature greater than the Sec. III, Div. 1 maximum temperature limits. Typically, the 0.2% offset strain is used to determine the S_y of a material from a stress-strain curve. Because this option requires the applicant to take time and temperature into account, it appears to be a more conservative option to develop the bearing

load limit. Therefore, this is acceptable because the requirement of HBB-3227.1(a) is to take the lesser of HBB-3227.1(a)(1) and HBB-3227(a)(2).

It is recommended that subsubparagraph HBB-3227.1(b) be accepted as written because it is fundamentally identical to the second part of subsubparagraph -3227.1(a) of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that subsubparagraph HBB-3227.1(c) be accepted as written because it is fundamentally identical to subsubparagraph -3227.1(b) of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3227.2, Pure Shear
It is recommended that subparagraph HBB-3227.2 be accepted as written because it is fundamentally identical to subparagraph -3227.2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3227.3, Progressive Distortion of Nonintegral Connections
It is recommended that subparagraph HBB-3227.3 be accepted as written because it is fundamentally identical to subparagraph -3227.3 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3227.4, Triaxial Stresses
It is recommended that subparagraph HBB-3227.4 be accepted as written because it is fundamentally identical to subparagraph -3227.4 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3227.5, Nozzle Piping Transition
It is recommended that subparagraph HBB-3227.5 be accepted as written because it is fundamentally identical to subparagraph -3227.5 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3227.7, Requirements for Specially Designed Welded Seals
It is recommended that subparagraph HBB-3227.7 be accepted as written because it is fundamentally identical to subparagraph -3227.7 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3227.8, Cladding
It is recommended that subparagraph HBB-3227.8 be accepted, except for subsubparagraph HBB-3227.8(d), as written because it is fundamentally identical to subparagraph -3227.8 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that subsubparagraph HBB-3227.8(d) be rejected as written and supplemented with the requirements of XIII-3710 *Bearing Loads* (2017 edition) because this error has been identified and corrected in the 2017 edition of Sec. III Appendices, Mandatory Appendix XIII.

HBB-3230, STRESS LIMITS FOR LOAD-CONTROLLED STRESSES ON BOLTS

HBB-3231, General Requirements

It is recommended that paragraph HBB-3231 be accepted as written because it is fundamentally identical to paragraph -3231 of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

HBB-3231(a) references the correct 2017 Code location, which is expected to be incorporated by reference according to 83 FR 56156.

HBB-3232, Design Limits for Bolts at Elevated Temperatures

It is recommended that paragraph HBB-3232 be accepted as written because it is fundamentally identical to paragraph -3232 of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

The use of Table HBB-I-14.12 is acceptable and is governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

HBB-3233, Level A and B Service Limits for Bolts at Elevated Temperatures

HBB-3233.1, Average Stress

It is recommended that subparagraph HBB-3233.1 be accepted as written because it is fundamentally identical to subparagraph -3233.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

The use of Figures HBB-I-14.3A through HBB-I-14.13C is acceptable and is governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

HBB-3233.2, Maximum Stress in the Cross Section

It is recommended that subparagraph HBB-3233.2 be accepted as written because it is fundamentally identical to subparagraph -3233.2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

The use of Figures HBB-I-14.3A through HBB-I-14.13C is acceptable and is governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

HBB-3233.3, Maximum Stress in the Bolt Periphery
It is recommended that subparagraph HBB-3233.3 be accepted as written because it is fundamentally identical to subparagraph -3233.3 of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

> The use of Figures HBB-I-14.3A through HBB-I-14.13C is acceptable and is governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

HBB-3233.4, Nonductile Fracture
It is recommended that subparagraph HBB-3233.4 be accepted as written because it is fundamentally identical to subparagraph -3233.4 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3234, Level C Service Limits
It is recommended that paragraph HBB-3234 be accepted as written because it is fundamentally identical to paragraph -3234 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3235, Level D Service Limits
It is recommended that paragraph HBB-3235 be accepted as written because it is fundamentally identical to paragraph -3235 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3240, SPECIAL REQUIREMENTS FOR ELEVATED TEMPERATURE COMPONENTS

HBB-3241, Nonductile Fracture
It is recommended that paragraph HBB-3241 be accepted as written because it is fundamentally identical to paragraph -3241 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3250, LIMITS ON DEFORMATION-CONTROLLED QUANTITIES

HBB-3251, General Requirements
It is recommended that paragraph HBB-3251 be accepted as written because it is fundamentally identical to paragraph -3251 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3252, Criteria
It is recommended that paragraph HBB-3252 be accepted as written because it is fundamentally identical to paragraph -3252 of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

> The use of Nonmandatory Appendix HBB-T is acceptable and is governed by the requirements and recommendations of NUMARK's report on Nonmandatory Appendix HBB-T *Rules for Strain, Deformation, and Fatigue Limits at Elevated Temperatures*.

HBB-3300, VESSEL DESIGNS

HBB-3310, GENERAL REQUIREMENTS

HBB-3311, Acceptability
It is recommended that paragraph HBB-3311 be accepted as written because it is fundamentally identical to paragraph -3311 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3330, OPENINGS AND REINFORCEMENT

HBB-3331, General Requirements for Openings
It is recommended that subparagraphs HBB-3331(a) and HBB-3331(c) be accepted as written because they are fundamentally identical to subparagraphs -3331(a) and -3331(b), respectively, of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

> The ASME Code Reconciliation document provided by the NRC indicates that the HBB-3331(c) is new, unreviewed text. Upon review of Code Case 1592, it has been determined that HBB-3331(c) is fundamentally identical to -3331(b) and that HBB-3331(b) is new, unreviewed information.

It is recommended that HBB-3331(b) be accepted as written because it conservatively places an upper limit of ≤ 4 in. on the outer diameter on "deposited weld metal as reinforcement for openings and branch connections," while III-1-NB has no upper limit.

HBB-3332, Reinforcement Requirements for Openings in Shells and Formed Heads
It is recommended that paragraph HBB-3332 be accepted as written because it is fundamentally identical to paragraph -3332 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3333, Reinforcement Requirements for Openings in Flat Heads
It is recommended that paragraph HBB-3333 be accepted as written because it is fundamentally identical to paragraph -3333 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3334, Limits of Reinforcement
It is recommended that paragraph HBB-3334 be accepted as written because it is fundamentally identical to paragraph -3334 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3335, Metal Available for Reinforcement
It is recommended that paragraph HBB-3335 be accepted as written because it is fundamentally identical to paragraph -3335 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3336, Strength of Reinforcing Material
It is recommended that paragraph HBB-3336 be accepted as written because it is fundamentally identical to paragraph -3336 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3337, Attachment of Nozzles and Other Connections

HBB-3337.1, General Requirements
It is recommended that subparagraph HBB-3337.1 be accepted as written because it is fundamentally identical to subparagraph -3337.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3337.2, Full Penetration Welded Nozzles
It is recommended that subparagraph HBB-3337.2 be accepted as written because it is fundamentally identical to subparagraph -3337.2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3337.3, Partial Penetration Welded Nozzles
It is recommended that subparagraph HBB-3337.3 be accepted as written because it is fundamentally identical to subparagraph -3337.3 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3338, Evaluation of Strain and Creep-Fatigue Limits in Openings

HBB-3338.1, General
It is recommended that subparagraph HBB-3338.1 be accepted as written. Paragraph -3338 of Code Case 1592 states that the rules of NB-3338 apply when creep phenomena are insignificant and subsubarticle -3250 applies when creep effects are significant. Subsubarticle -3250 is identical to HBB-3250 and only directs the applicant to account for creep effects with no specific indication of how to complete this task. HBB-3338.1 details two applicable methods for determining deformation-controlled stresses, and these methods are fundamentally identical to information found in NB-3338.1, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Therefore, the information contained in paragraph -3338 of Code Case 1592 is accounted for in subparagraph HBB-3338.1.

HBB-3338.2, Stress Index Method
It is recommended that subparagraph HBB-3338.2 be accepted as written. Subparagraph HBB-3338.2 points to NB-3338, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, as an acceptable Code location for the stress indices and rules to satisfy strain and creep-fatigue limits.

Note:

> The use of strain and creep-fatigue limits from HBB-T-1320, HBB-T-1330, and HBB-T-1430 is acceptable and is governed by the requirements and recommendations of NUMARK's report on Nonmandatory Appendix HBB-T *Rules for Strain, Deformation, and Fatigue Limits at Elevated Temperatures*.

HBB-3339, Alternative Rules for Nozzle Design

It is recommended that paragraph HBB-3339 be accepted as written. HBB-3339 expands the requirements of paragraph -3339 of Code Case 1592 by requiring the wall thickness t_r be defined by III-5-HBB instead of allowing it to be defined by III-1-NB. Additionally, HBB-3339 aligns itself with NB-3339 as an acceptable alternative to the rules of HBB-3332 through HBB-3336 and HBB-3338, which is analogous to what is stated in NB-3339, i.e., alternative to the rules of NB-3332 through NB-3336 and NB-3338, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HBB-3339.1, Stress Indices

It is recommended that subparagraph HBB-3339.1 be accepted as written. HBB-3339.1 indicates that the stress indices and rules of NB-3339.7, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, may be used with an elastic or simplified inelastic analysis to satisfy the strain and creep-fatigue limits. This is an acceptable approach and is in line with the what is stated in paragraph -3339 of Code Case 1592.

Note:

> The use of strain and creep-fatigue limits from HBB-T-1320, HBB-T-1330, and HBB-T-1430 is acceptable and is governed by the requirements and recommendations of NUMARK's report on Nonmandatory Appendix HBB-T *Rules for Strain, Deformation, and Fatigue Limits at Elevated Temperatures*.

HBB-3350, DESIGN OF WELDED CONSTRUCTION

HBB-3351, Welded Joint Category

It is recommended that paragraph HBB-3351 be accepted as written because it is fundamentally identical to paragraph -3351 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that Figure HBB-3351-1 be accepted as shown because it is fundamentally identical to Figure -3351-1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3351.1, Category A

It is recommended that subparagraph HBB-3351.1 be accepted as written because it is fundamentally identical to subparagraph -3351.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that Notes 16 and 17 in HBB-3351.1 be accepted as written because they are in the same location and identical to Notes 1 and 2 of Code Case 1592 subparagraph -3351.1, which have been approved for use through NRC RG 1.87.

HBB-3351.2, Category B

It is recommended that subparagraph HBB-3351.2 be accepted as written because it is fundamentally identical to subparagraph -3351.2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that Note 16 in HBB-3351.2 be accepted as written because it is in the same location and identical to Note 1 of Code Case 1592 subparagraph -3351.2, which has been approved for use through NRC RG 1.87.

HBB-3351.3, Category C

It is recommended that subparagraph HBB-3351.3 be accepted as written because it is fundamentally identical to subparagraph -3351.3 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that the Notes 16 and 17 in HBB-3351.3 be accepted as written since they are in the same location and identical to Notes 1 and 2 of Code Case 1592 subparagraph -3351.3 which have been approved for use through NRC RG 1.87.

HBB-3351.4, Category D

It is recommended that subparagraph HBB-3351.4 be accepted as written because it is fundamentally identical to subparagraph -3351.4 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that Note 16 in HBB-3351.4 be accepted as written because it is in the same location and identical to Note 1 of Code Case 1592 subparagraph -3351.4, which has been approved for use through NRC RG 1.87.

HBB-3352, Permissible Types of Welded Joints

It is recommended that subparagraphs HBB-3352(a) through HBB-3352(g) be accepted as written because they are fundamentally identical to subparagraphs -3352(a) through -3352(g), respectively, of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that subparagraph HBB-3352(h) be accepted as written because it conservatively places an upper limit of ≤ 4 inch on the nominal diameter of full penetration corner welds (III-1-NB does not have an upper limit), which are defined as Category C and D vessel welds, or as similar welds for piping, pumps, and valves as shown in Figures NB-4243-1 and NB-4244(b)-1, which are approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

It is recommended that Figure HBB-3352-1 be accepted as shown because it is fundamentally identical to Figure -3352-1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3353, Design of Welded Construction at Elevated Temperatures
It is recommended that paragraph HBB-3353 be accepted as written because it is fundamentally identical to paragraph -3353 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3354, Structural Attachment Welds
It is recommended that subparagraph HBB-3354(a) be accepted as written because it is fundamentally identical to paragraph -3354 of Code Case 1592, which has been approved for use through NRC RG 1.87. The additional weld requirement of NB-4240 is acceptable and dictates the types of acceptable welds per Category instead of leaving the weld type solely to the discretion of the applicant.

It is recommended that subparagraph HBB-3354(b) be accepted as written. HBB-3354(b) is an acceptable approach that requires the structural attachment welds to be on a rib outside the limits of reinforcement to comply with the rules of Class A pressure boundary welds and requires the loads imposed by permanent attachments be considered in the Design Report.

Note:

> The use of HBB-2121(h) is acceptable and is governed by the requirements and recommendations of ORNL's report on HBB-2000 *Material*.

It is recommended that Figure HBB-3354-1 be accepted as shown because it visually depicts what is stated in HBB-3354(b).

HBB-3355, Welding Grooves
It is recommended that paragraph HBB-3355 be accepted as written because it is fundamentally identical to paragraph -3355 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3356, Fillet Welds

HBB-3356.1, At Pressure Loaded Joints
It is recommended that subparagraph HBB-3356.1 be accepted as written because it is fundamentally identical to the first part of paragraph -3356 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3356.2, At Structural Attachment Joints
It is recommended that subsubparagraphs HBB-3356.2(a) and HBB-3356.2(b) be accepted as written because they are fundamentally identical to the remaining part of paragraph -3356 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that subsubparagraph HBB-3356.2(c) be accepted as written. The approach given in this subsubparagraph is consistent with evaluating fatigue strength. The application of a fatigue strength reduction factor and the requirements to consider the temperature differences between the component and the attachment, and expansion due to pressure is the correct approach for a fatigue evaluation. While a fatigue reduction factor of four is consistent with III-1-NB, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC

expected to be incorporated by reference according to 83 FR 56156, this factor has not been independently verified.

Note:

> For socket welded fittings used in accordance with 10 CFR 50.55a(b)(1)(ii), applicants and licensees may not apply the Section III provisions for welds with leg size less than 1.09* t_n, where t_n is the nominal pipe thickness.

HBB-3357, Thermal Treatment
It is recommended that paragraph HBB-3357 be accepted as written because it is fundamentally identical to paragraph -3357 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3360, SPECIAL VESSEL REQUIREMENTS

HBB-3361, Category A or B Joints Between Sections of Unequal Thickness
It is recommended that paragraph HBB-3361 be accepted as written because it is fundamentally identical to paragraph -3361 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that Figure HBB-3361-1 be accepted as shown because it is fundamentally identical to Figure -3361-1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3362, Bolted Flange Connections
It is recommended that paragraph HBB-3362 be accepted as written because it is fundamentally identical to paragraph -3362 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3363, Access Openings
It is recommended that paragraph HBB-3363 be accepted as written because it is fundamentally identical to paragraph -3363 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3364, Supports
It is recommended that paragraph HBB-3364 be accepted as written because it is fundamentally identical to paragraph -3364 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3400, DESIGN OF CLASS A PUMPS

HBB-3410, GENERAL REQUIREMENTS

HBB-3410.1, Scope
It is recommended that subparagraph HBB-3410.1 be accepted as written because it is fundamentally identical to subparagraph -3410.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3410.2, Definitions

It is recommended that subparagraph HBB-3410.2 be accepted as written because it is fundamentally identical to subparagraph -3410.2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that Figure HBB-3410.2-1 be accepted as shown because it is fundamentally identical to Figure -3410.2-1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that Figure HBB-3410.2-2 be accepted as shown because it is fundamentally identical to Figure -3410.2-2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3411, Acceptability of Large Pumps

It is recommended that paragraph HBB-3411 be accepted as written because it is fundamentally identical to paragraph -3411 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3412, Acceptability of Small Pumps

It is recommended that paragraph HBB-3412 be accepted as written because it is fundamentally identical to paragraph -3412 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3413, Alternative Design Rules

It is recommended that paragraph HBB-3413 be accepted as written because it is fundamentally identical to paragraph -3413 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3420, DESIGN CONSIDERATIONS

HBB-3421, Design Requirements

HBB-3421.1, Loadings

It is recommended that subparagraph HBB-3421.1 be accepted as written because it is fundamentally identical to subparagraph -3421.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3421.2, Piping Under External Pressure

It is recommended that subparagraph HBB-3421.2 be accepted as written because it is fundamentally identical to subparagraph -3421.2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3421.3, Piping Under Internal Pressure

It is recommended that subparagraph HBB-3421.3 be accepted as written because it is fundamentally identical to subparagraph -3421.3 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3421.4, Piping Connections Using Partial Penetration Welds
It is recommended that subparagraph HBB-3421.4 be accepted as written because it is fundamentally identical to subparagraph -3421.4 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3421.5, Bolting – Radially Split Configurations
It is recommended that subparagraph HBB-3421.5 be accepted as written because it is fundamentally identical to subparagraph -3421.5 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3421.6, Bolting – Axially Split Configurations
HBB-3421.6 does not exist in the 2017 Code. However, Code Case 1592 has a subparagraph -3421.6 that states "bolting in axially split configurations may be designed in accordance with the procedure given in -3430 for Type G pumps when creep effects are not present and elastic analysis models are applicable." Subsubarticle -3430 directs the applicant to NB-3430. From the 1971 Code (Winter 1972 Addenda), which was in effect when Code Case 1592 was introduced, NB-3437, a paragraph under subsubarticle NB-3430, discusses the design of a Type G pump. However, upon review of subsubarticle NB-3440 of the 2017 Code, which is the current location for the information of NB-3430 from the 1971 Code, there is no Type G pump. Therefore, the omission of this subparagraph from III-5-HBB is acceptable.

HBB-3421.7, Supports
It is recommended that subparagraph HBB-3421.7 be accepted as written because it is fundamentally identical to subparagraph -3421.7 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3421.8, Axially Oriented Inlets and Outlets
It is recommended that subsubparagraph HBB-3421.8(a) be accepted as written because it is fundamentally identical to subsubparagraph -3421.8(a) of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that subsubparagraph HBB-3421.8(b) be accepted as written. Figure NB-3433-1 from the 1971 Code (Winter 1972 Addenda), which was in effect when Code Case 1592 was introduced, is identical to the Figure NB-3441.3-2 of the 2017 Code.

HBB-3421.9, Radially Oriented Inlets and Outlets
It is recommended that subparagraph HBB-3421.9 be accepted as written because it is fundamentally identical to subparagraph -3421.9 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3421.10, Tangential Inlets and Outlets
It is recommended that subparagraph HBB-3421.10 be accepted as written because it is fundamentally identical to subparagraph -3421.10 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3421.11, Stress Analysis, Nozzle Loads, and Reinforcement
It is recommended that subparagraph HBB-3421.11 be accepted as written because it is fundamentally identical to subparagraph -3421.11 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that Figure HBB-3421.11-1 be accepted as shown because it is fundamentally identical to Figure -3421.11-1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3421.12, Earthquake Design Analysis
It is recommended that subparagraph HBB-3421.12 be accepted as written because it is fundamentally identical to subparagraph -3421.12 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3421.13, Attachments
It is recommended that subparagraph HBB-3421.13 be accepted as written because it is fundamentally identical to subparagraph -3421.13 of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

> The use of Nonmandatory Appendix HBB-T is acceptable and is governed by the requirements and recommendations of NUMARK's report on Nonmandatory Appendix HBB-T *Rules for Strain, Deformation, and Fatigue Limits at Elevated Temperatures*.

HBB-3421.14, Appurtenances
It is recommended that subparagraph HBB-3421.14 be accepted as written because it is fundamentally identical to subparagraph -3421.14 of Code Case 1592, which has been approved for use through NRC RG 1.87. Additionally, the -3421.14 reference of NA-1240 from the 1971 Code, which was in effect when Code Case 1592 was introduced, is identical to the HBB-3421.14 reference of NCA-1260 of the 2017 Code. The Code Case 1592 subparagraph -3421.14 reference appears to be incorrect as written and should have said NA-1240 because there are no requirements for documentation for appurtenances in NA-1231 of the 1971 Code.

HBB-3421.15, Pump Covers
It is recommended that subparagraph HBB-3421.15 be accepted as written because it is fundamentally identical to subparagraph -3421.15 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3421.17, Cladding
It is recommended that subparagraph HBB-3421.17 be accepted as written because it is fundamentally identical to subparagraph -3421.17 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3421.19, Cutwater Tip Stresses
It is recommended that subparagraph HBB-3421.19 be accepted as written because it is fundamentally identical to subparagraph -3421.19 of Code Case 1592, which has been

approved for use through NRC RG 1.87. Additionally, Figure NB-3433-1 from the 1971 Code (Winter 1972 Addenda), which was in effect when Code Case 1592 was introduced, is identical to the Figure NB-3441.3-2 of the 2017 Code. The Code Case 1592 reference to Figure NB-3422-1 is a typo and should read as Figure NB-3433-1.

It is recommended that subsubparagraph HBB-3421.19(a) be accepted as written. HBB-3421.19(a) explicitly states that sufficient area at the cutwater tip of volute casings must be present to meet the stress limits of HBB-3220 through the evaluation of load-controlled stresses. The addition of this subsubparagraph is conservative because it mandates that the applicant evaluate the design of the cutwater tip against the Design and Service Limits. Additionally, it does not limit the evaluation to an experimental analysis by making this a broader statement to include any analytical analysis.

It is recommended that subsubparagraph HBB-3421.19(b) be accepted as written because it is fundamentally identical to subsubparagraphs -3421.19(a), -3421.19(c), and -3421.19(d) of Code Case 1592, which has been approved for use through NRC RG 1.87. HBB-3421.19(b)(1) through HBB-3421.19(b)(3) is to be used to evaluate the localized stress at the cutwater tip.

HBB-3421.19(b)(1) is fundamentally identical to -3421.19(a).

HBB-3421.19(b)(2) is fundamentally identical to -3421.19(c). Code Case 1592 states that a detailed finite element analysis can be used to evaluate the stresses, while HBB-3421.19(b)(2) states a detailed stress analysis which would encompass a finite element analysis. This is a more general statement and is acceptable because the applicant will detail the stress analysis used to evaluate the localized stress at the cutwater tip in the Design Report.

HBB-3421.19(b)(3) is fundamentally identical to -3421.19(d).

It is recommended that subsubparagraph HBB-3421.19(c) be accepted as written because it is fundamentally identical to the last written paragraph of -3421.19. HBB-3421.19(c) is more conservative because it stipulates that if experimental and/or detailed stress analysis is used, then it must also meet the limits on deformation-controlled quantities, i.e., HBB-3250.

HBB-3430, PUMP TYPES

It is recommended that paragraph HBB-3430 be accepted as written because it is fundamentally identical to subparagraph -3430(b) of Code Case 1592. It is recommended that the deletion of the special requirements of subparagraph -3430(a) be accepted. Subparagraph -3430(a) limits the use of III-1 NB-3430 to regions where creep behavior is negligible. The deletion of this statement is considered acceptable because the design requirements for centrifugal pumps would still be applicable for III-5-HBB use because the applicant would be required to follow the general requirements of subarticle HBB-3400 for the design of Class A pumps.

HBB-3500, DESIGN OF CLASS A VALVES

HBB-3510, DESIGN REQUIREMENTS

HBB-3511, Acceptability
It is recommended that paragraph HBB-3511 be accepted as written because it is fundamentally identical to paragraph -3511 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3512, Stress Analysis
It is recommended that paragraph HBB-3512 be accepted as written because it is fundamentally identical to paragraph -3512 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3513, Wall Thickness Requirements for Design Conditions Analysis
HBB-3513 does not exist in the 2017 Code. However, Code Case 1592 has a paragraph -3513 that gives an equation for the minimum wall thickness requirement for pressure retaining parts for the Design Limits analysis. The omission of this paragraph from III-5-HBB and accompanying Table -3513-1 is recommended as acceptable because this general requirement is inherently part of HBB-3512, which sends the applicant to III-1 NB-3500. NB-3500, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, has criteria for minimum thicknesses for pressure retaining parts.

HBB-3520

HBB-3524, Earthquake Design Analysis
It is recommended that paragraph HBB-3524 be accepted as written because it is fundamentally identical to paragraph -3524 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3526, Level C Service Limits
It is recommended that paragraph HBB-3526 be accepted as written because it is fundamentally identical to paragraph -3526 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3540

HBB-3544, Body Shape Rules
It is recommended that paragraph HBB-3544 be accepted as written because it is fundamentally identical to paragraph -3544 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3546, Other Valve Parts
It is recommended that paragraph HBB-3546 be accepted as written because it is fundamentally identical to paragraph -3546 of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

The use of Tables HBB-I-14.1(a), HBB-I-14.1(b), and HBB-I-14.2 for the stress intensity limit of S_o is acceptable and is governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

HBB-3550, CYCLIC LOADING REQUIREMENTS
It is recommended that subsubarticle HBB-3550 be accepted as written because it is fundamentally identical to subsubarticle -3550 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3600, PIPING DESIGN

HBB-3610, GENERAL REQUIREMENTS

HBB-3611, Acceptability
It is recommended that paragraph HBB-3611 be accepted as written because it is fundamentally identical to paragraph -3611 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3612, Pressure-Temperature Ratings for Piping Components
It is recommended that paragraph HBB-3612 be accepted as written because it is fundamentally identical to paragraph -3612 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3620, DESIGN CONSIDERATIONS

HBB-3622, Dynamic Effects

HBB-3622.1, Impact
It is recommended that subparagraph HBB-3622.1 be accepted as written because it is fundamentally identical to subparagraph -3622.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3622.2, Earthquake
It is recommended that subparagraph HBB-3622.2 be accepted as written because it is fundamentally identical to subparagraph -3622.2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3622.3, Vibration
It is recommended that subparagraph HBB-3622.3 be accepted as written because it is fundamentally identical to subparagraph -3622.3 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3623, Weight Effects
It is recommended that paragraph HBB-3623 be accepted as written because it is fundamentally identical to paragraph -3623 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3624, Loadings, Displacements, and Restraints
It is recommended that paragraph HBB-3624 be accepted as written because it is fundamentally identical to paragraph -3624 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3626, Special Drainage Problems
It is recommended that paragraph HBB-3626 be accepted as written because it is fundamentally identical to paragraph -3626 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3627, Considerations for Liquid Metal Piping

HBB-3627.1, Location
It is recommended that subparagraph HBB-3627.1 be accepted as written because it is fundamentally identical to subparagraph -3627.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3627.2, Heat Tracing
It is recommended that subparagraph HBB-3627.2 be accepted as written because it is fundamentally identical to subparagraph -3627.2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3627.3, Filling and Draining
It is recommended that subparagraph HBB-3627.3 be accepted as written because it is fundamentally identical to subparagraph -3627.3 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3640, PRESSURE DESIGN OF COMPONENTS

HBB-3641

HBB-3641.1, Straight Pipe
It is recommended that subparagraph HBB-3641.1 be accepted as written because it is fundamentally identical to subparagraph -3641.1 of Code Case 1592 which has been approved for use through NRC RG 1.87.

HBB-3642, Curved Segments of Pipe

HBB-3642.1, Pipe Bends
It is recommended that subparagraph HBB-3642.1 be accepted as written because it is fundamentally identical to subparagraph -3642.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that Table HBB-3642.1-1 be accepted as shown because it is fundamentally identical to Table -3642.1-1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3643, Intersections
It is recommended that paragraph HBB-3643 be accepted as written because it is fundamentally identical to paragraph -3643 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3643.1, General Requirements
It is recommended that subsubparagraphs HBB-3643.1(a) through HBB-3643.1(c) be accepted as written because they are fundamentally identical to subsubparagraphs -3643.1(a) through -3643.2(c), respectively, of Code Case 1592, which have been approved for use through NRC RG 1.87.

It is recommended that subsubparagraph HBB-3643.1(d) be accepted as written because it is fundamentally identical to subsubparagraph -3643.1(d) of Code Case 1592, which has been approved for use through NRC RG 1.87. HBB-3643.1(d) has corrected the mistake -3643.1 Code Case 1592 had when it referenced the wrong subsubparagraphs in the Code Case. The correct Code Case subsubparagraphs should have been -3643.2(a) through -3643.2(c), and this corresponds to what is now referenced in subsubparagraph HBB-3643.1(d), i.e., HBB-3643.2(b), HBB-3643.2(c), and HBB-3643.2(d).

HBB-3643.2, Branch Connections
It is recommended that subparagraph HBB-3643.2 be accepted as written because it is fundamentally identical to subparagraph -3643.2 of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

> For socket welded fittings used in pressure-retaining joints in accordance with 10 CFR 50.55a(b)(1)(ii), applicants and licensees may not apply the Section III provisions for welds with leg size less than 1.09* t_n, where t_n is the nominal pipe thickness.

HBB-3644, Miters
It is recommended that paragraph HBB-3644 be accepted as written because it is fundamentally identical to paragraph -3644 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3645, Attachments
It is recommended that paragraph HBB-3645 be accepted as written because it is fundamentally identical to paragraph -3645 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3646, Closures
It is recommended that paragraph HBB-3646 be accepted as written because it is fundamentally identical to paragraph -3646 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3647, Flanged Joints

It is recommended that paragraph HBB-3647 be accepted as written because it is fundamentally identical to paragraph -3647 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3648, Reducers

It is recommended that paragraph HBB-3648 be accepted as written because it is fundamentally identical to paragraph -3648 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3649, Pressure Design of Other Pressure-Retaining Components

It is recommended that paragraph HBB-3649 be accepted as written because it is fundamentally identical to paragraph -3649 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3649.1, Experimental Analysis

It is recommended that subparagraph HBB-3649.1 be accepted as written because it is fundamentally identical to subparagraph -3649.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3650, ANALYSIS OF PIPING COMPONENTS

HBB-3651, General Requirements

It is recommended that paragraph HBB-3651 be accepted as written because it is fundamentally identical to paragraph -3651 of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that subparagraph HBB-3651(a) be accepted as written because it is fundamentally identical to subparagraph -3651(a) of Code Case 1592, which has been approved for use through NRC RG 1.87.

Note:

> HBB-3651(a) states that the experimental analysis shall demonstrate that the component fully complies with the requirements of HBB-3200 *Design by Analysis*.

It is recommended that subparagraph HBB-3651(b) be accepted as written.

Note:

> The first written sentence of HBB-3651(b) is fundamentally identical to what is found in the first written sentence of -3651(b), except for “strain limits using elastic analysis (HBB-T-1320)”. Per the definition of *Load-Controlled Quantities* in HBB-3213(a), load-controlled stresses are considered general primary membrane (P_m), local primary membrane (P_l), primary bending (P_b) and secondary (Q). HBB-3651(b) adds more detail to the limits on load-controlled stresses by stating primary and secondary stress indices (B and C) instead of just stress indices as written in -3651(b). Therefore, this is acceptable based on the definition of load-controlled stresses.

The remaining portion of the first written sentence of HBB-3651(b) “strain limits using elastic analysis (HBB-T-1320)” is acceptable as written. This sentence points to HBB-T-1320, which uses primary and secondary stress in the elastic analysis to satisfy the strain limits of HBB-T-1310.

Sec. III Div. 1 Sub. NB NB-3680 *Stress Indices and Flexibility Factors* states a similar requirement to HBB-3651(a) in the last sentence of subparagraph NB-3681(a). The 2015 and 2017 editions state that the applicable indices to be used with the detailed analysis of NB-3200 *Design by Analysis* and Sec. III Appendices, Mandatory Appendix XIII *Design Based on Stress Analysis*, respectively, are given in NB-3685 and NB-3338. From subparagraph NB-3685.4 *Classification of Stresses*, the piping analyses governed by paragraph NB-3685 use load-controlled stresses of local primary membrane (P_l), primary bending (P_b) and secondary (Q). Per the definition of Load-Controlled Quantities in HBB-3213(a), load-controlled stresses are primary and secondary stress only. Therefore, it is considered acceptable to use the stress indices given in Sec. III Div. 1 NB-3684, NB-3685, and NB-3338 as stated in the second written sentence of HBB-3651(b).

The second written sentence of HBB-3651(b) is fundamentally identical to what is found in the remainder of -3651(b). The second sentence states the location in NB-3600 to determine the stress indices, as previously discussed, and stipulates these may be used to satisfy the “strain and creep-fatigue limits using elastic and simplified inelastic analyses.” This is what is described in Code Case 1592 -3651(b) when it states, “creep effects are insignificant” and “whenever linearly-elastic material models are appropriate.” Therefore, HBB-3651(b) is accepted as written.

The use of strain and creep-fatigue limits from HBB-T-1320, HBB-T-1330, and HBB-T-1430 are acceptable and are governed by the requirements and recommendations of NUMARK’s report on Nonmandatory Appendix HBB-T *Rules for Strain, Deformation, and Fatigue Limits at Elevated Temperatures*.

It is recommended that subparagraph HBB-3651(c) be accepted as written. The advancement of finite element analysis has allowed for realistic detailed stress distributions. The applicant will develop the detailed finite element analysis methods used as part of the Design Report.

HBB-3660, DESIGN OF WELDS

It is recommended that subparagraph HBB-3660(a) be accepted as written because it is fundamentally identical to subparagraph -3660(a) of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that subparagraph HBB-3660(b), except for the last sentence, “Joints allowed under the rules of this paragraph shall be limited to nominal diameters of 1 in. (25 mm) and smaller,” be accepted as written because it is fundamentally identical to subparagraph -3660(b) of Code Case 1592, which has been approved for use through NRC RG 1.87.

It is recommended that the last sentence of HB- 3660(b), “Joints allowed under the rules of this paragraph shall be limited to nominal diameters of 1 in. (25 mm) and smaller,” be accepted as written because it acceptably places an upper limit of ≤ 1 in. on the nominal diameter.

Note:

> For socket welded fittings used in pressure-retaining joints in accordance with 10 CFR 50.55a(b)(1)(ii), applicants and licensees may not apply the Section III provisions for welds with leg size less than 1.09* t_n, where t_n is the nominal pipe thickness.
>
> III-1-NB has an upper limit of ≤ 2 in. on socket welds, while III-5-HBB has conservatively reduced this upper limit by a factor of 2.
>
> III-1-NB has no upper limit on seal-welded threaded joints, while III-5-HBB has conservatively placed an upper limit.

It is recommended that subparagraph HBB-3660(c) be accepted as written because it is fundamentally identical to subparagraph -3660(c) of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3670, SPECIAL PIPING REQUIREMENTS

HBB-3671, Nonwelded Piping Joints

HBB-3671.1, Excluded Designs
It is recommended that subparagraph HBB-3671.1 be accepted as written because it is fundamentally identical to subparagraph -3671.1 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3671.6, Brazed Joints
It is recommended that subparagraph HBB-3671.6 be accepted as written since it is fundamentally identical to subparagraph -3671.6 of Code Case 1592 which has been approved for use through NRC RG 1.87.

HBB-3671.7, Patented Joints
It is recommended that subparagraph HBB-3671.7 be accepted as written because it is fundamentally identical to subparagraph -3671.7 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3672, Expansion and Flexibility
It is recommended that paragraph HBB-3672 be accepted as written because it is fundamentally identical to paragraph -3672 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3674, Design of Piping Supports
It is recommended that paragraph HBB-3674 be accepted as written because it is fundamentally identical to paragraph -3674 of Code Case 1592, which has been approved for use through NRC RG 1.87.

HBB-3676, Instrument Piping
HBB-3676 does not exist in the 2017 Code; however, Code Case 1592 has paragraph -3676 that is dedicated to “Instrument Piping.” Paragraph -3676 refers to NB-3676, which does not exist in the 2017 Code. NB-3676 does exist in the 1971 Code, which was in effect when Code Case 1592was introduced. Therefore, the omission of paragraph -3676 is recommended as acceptable because instrument piping is no longer part of III-1 use.

4.1.2. ARTICLE HBB-4000, FABRICATION AND INSTALLATION

HBB-4100, GENERAL REQUIREMENTS

HBB-4110, INTRODUCTION
It is recommended that paragraph HBB-4110 be accepted as written because it is fundamentally identical to the reply section of Code Case 1593, which has been approved for use through NRC RG 1.87.

Note:

> Code Case 1593 erroneously references Section III “NB-400” instead of “NB-4000.” This has been corrected in HBB-4110.

Subparagraph HBB-4110(a) states that components that do not experience high-temperature service as defined by HBB-3000 may use III-1-NB NB-4000 rules, which are approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

Subparagraph HBB-4110(b) states that if HBB-4110(a) is not met, then the rules of III-1-NB NB-4000, which are approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, are to be followed except as modified in HBB-4000.

Subparagraph HBB-4110(c) states that the options of HBB-4110(a) and HBB-4110(b) must be identified in all phases of manufacturing and installation. Additionally, this will be explicitly shown in the Design Report.

HBB-4200

HBB-4210

HBB-4212, Effects of Forming and Bending Processes
It is recommended that paragraph HBB-4212 be accepted as written. HBB-4212 incorporates Code Case 1593, which has been approved for use through NRC RG 1.87 and adds language that HBB-4212 supplements the rules of paragraphs NB-4212 and NB-4213, which are approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HBB-4212 provides additional requirements to those in NB-4212 and NB-4213 and that are more detailed than those listed in Code Case 1593. Subsequent to ASME Code approval of

Code Case 1593, a substantial multi-year research effort was sponsored by the Department of Energy regarding the use of cold worked 304 and 316 stainless steels, as well as Nickel-Iron Chromium Alloy 800H, in high-temperature environments. The purpose of this research was to provide a database for subsequent use by individuals or groups within the ASME BPVC committees. The data produced as a result of this research effort was likely used as the basis for Figure HBB-4212-1, *Permissible Time/Temperature Conditions for Material Which Has Been Cold Worked >5% and <20% and Subjected to Short-Time High Temperature Transients.*

HBB-4240, SPECIAL JOINTS AND FITTINGS – ADDED RULES FOR DIVISION 1, NB-4240
It is recommended that paragraph HBB-4240 be accepted as written. HBB-4240 requires the evaluation of socket welds to determine if an axial gap is needed at the bottom of the socket to prevent the pipe from bottoming out during service due to thermal expansion. If a gap is determined necessary, it must be verified by radiographic examination or by following special written procedures. While radiography is the most conservative method to measure the bottom clearance in a socket weld, verifying bottoming clearance by following special written procedures during fabrication is the most commonly used method to verify an axial gap at the pipe end/socket bottom interface.

HBB-4400

HBB-4420

HBB-4424, Surfaces of Welds
It is recommended that paragraph HBB-4424 be accepted as written. HBB-4424 states that as-welded surface geometry is permitted provided that the surface geometry is considered in the stress analysis in accordance with the rules for design of Class A elevated temperature components. The requirement to include the surface geometry in the stress analysis will ensure that the impact of as-welded surfaces will be appropriately accounted for by using the proper stress indices when performing analysis in accordance with HBB-3600.

4.1.3. ARTICLE HBB-5000, EXAMINATION

HBB-5100, GENERAL REQUIREMENTS FOR EXAMINATION

HBB-5110, GENERAL REQUIREMENTS
It is recommended that paragraph HBB-5110 be accepted as written because it is fundamentally identical to the reply section of Code Case 1594, which has been approved for use through NRC RG 1.87.

Subparagraph HBB-5110(a) states that components that do not experience high-temperature service as defined by HBB-3000 may use III-1-NB NB-5000 rules, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

Subparagraph HBB-5110(b) states that if HBB-5110(a) is not met, then the rules of III-1-NB NB-5000, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME

BPVC expected to be incorporated by reference according to 83 FR 56156, are to be followed except as modified in HBB-5000.

Subparagraph HBB-5110(c) states that the options of HBB-5110(a) and HBB-5110(b) must be identified in all steps of examination. Additionally, this will be explicitly shown in the Design Report.

HBB-5130, EXAMINATION OF WELD EDGE PREPARATION SURFACES

It is recommended that paragraph HBB-5130 be accepted as written. HBB-5130 conservatively requires an additional level of component examination with acceptable NDE methods for weld thickness greater than 1 in.

HBB-5200, REQUIRED EXAMINATION OF WELDS

HBB-5210, CATEGORY A VESSEL WELDED JOINTS AND LONGITUDINAL WELDED JOINTS IN OTHER COMPONENTS

It is recommended that paragraph HBB-5210 be accepted as written. HBB-5210 incorporates section 1.0 of Code Case 1594 Revision 0, and Revision 1. Revision 0 of the Code Case was approved for use through NRC RG 1.87. Revision 1 of the Code Case, which was not included in a revision to NRC RG 1.87 after initial issue, provides for the use of additional inspection methodologies, while eliminating a statement that was not relevant but included in Revision 0. The requirement in Section 1.0(b)(2) to conduct radiography at orientations at least 30 degrees but not more than 150 degrees apart is not relevant. Radiography views through the object. Radiographic examinations taken 180 degrees apart show the same material just from the opposite side. Thus, angles greater than 150 degrees would be at less than the original 30 degrees from the vertical initially required. HBB-5210 provides examination requirements that are better defined and more specific than Code Case 1594 in accordance with accepted NDE methods and examination volumes.

HBB-5220, CATEGORY B VESSEL WELDED JOINTS AND CIRCUMFERENTIAL WELDED JOINTS IN OTHER COMPONENTS

It is recommended that paragraph HBB-5220 be accepted as written. HBB-5220 incorporates section 2.0 of Code Case 1594 Revision 0, which has been approved for use through NRC RG 1.87. Paragraph HBB-5220 also includes clarifications included in Code Case 1594 Revision 1, which was prepared by ASME in 1975. NRC Reg Guide 1.87 issued in 1975 was not revised to incorporate the clarified inspection information. As such, subsubarticle HBB-5220 provides examination requirements that are better defined and more specific than Code Case 1594 in accordance with accepted NDE methods and examination volumes.

HBB-5230, CATEGORY C VESSEL WELDED JOINTS AND SIMILAR WELDED JOINTS IN OTHER COMPONENTS

It is recommended that paragraph HBB-5230 be accepted as written because the NDE methods and examination volumes identified are proven based on applicability to similar type welds. HBB-3351.3 describes category C welds as comprising welds connecting flanges, tube sheets, or flat heads to main shells and formed heads to transitions in diameter, nozzles, or communicating chambers. Effectively, any weld joint connecting one side plate to another side

plate of a flat sided vessel. HBB-5230 provides expanded information on the requirements for proper NDE inspection of welds made under this paragraph over the information provided in NB-5230 (NB-5231) detailing methods required for configurations that would be difficult to properly inspect by some methods.

HBB-5240, CATEGORY D VESSEL WELDED JOINTS AND BRANCH AND PIPING CONNECTIONS IN OTHER COMPONENTS

It is recommended that HBB-5240 be accepted as written because it directs the applicant to substitute the rules of NB-5240 with HBB-5240.

HBB-5242, Butt-Welded Nozzles and Branch and Piping Connections

It is recommended that paragraph HBB-5242 be accepted as written because the NDE methods and examination volumes identified are proven based on applicability to similar type welds. These types of welds involve full penetration joining of metal in the installation or fabrication of flanges, nozzles, and piping connections. This paragraph provides expanded direction on inspection over the requirements of Code Case 1594 Section 3.0 for better guidance on the evaluation depending on sizes and configurations of the welds.

HBB-5243, Full Penetration Corner-Welded Nozzles and Branch and Piping Connections

It is recommended that paragraph HBB-5243 be accepted as written because the NDE methods and examination volumes identified are proven based on applicability to similar types of welds. These types of welds involve full penetration joining of metal in the installation or fabrication of flanges, nozzles, and piping connections. This paragraph provides expanded direction on the inspection over the requirements of Code Case 1594 Section 3.0 for better guidance on the evaluation depending on sizes and configurations of the welds.

HBB-5244, Deposited Weld Metal as Reinforcement for Openings and Attachment of Nozzles, Branch, and Piping Connections

It is recommended that paragraph HBB-5244 be accepted as written because the NDE methods and examination volumes identified are proven based on applicability to similar types of welds. These types of welds involve full penetration joining of metal in the installation or fabrication of flanges, nozzles, and piping connections. This paragraph provides expanded direction on the inspection over the requirements of Code Case 1594 Section 3.0 for better guidance on the evaluation depending on sizes and configurations of the welds.

HBB-5245, Partial Penetration Welds

It is recommended that paragraph HBB-5245 be accepted as written because the NDE methods and examination volumes identified are proven based on applicability to similar type welds. These types of welds involve partial penetration joining of metal in the installation or fabrication of flanges, nozzles, and piping connections. These types of welds include fillet welds on small diameter applications. This paragraph provides expanded direction on the inspection over the requirements of Code Case 1594 Section 3.0 for better guidance on the evaluation depending on sizes and configurations of the welds.

HBB-5246, Full Penetration Category D Welds at Oblique Connections
Based on the NDE methods and examination volume identified, it is recommended that this section be accepted as written. While the 1973 Code Case 1594 did not permit the examinations defined in these paragraphs, the NDE methods identified provide surface and volumetric coverage. These types of welds involve full penetration joining of metal in the installation or fabrication of flanges, nozzles, and piping connections. This paragraph provides expanded direction on the inspection over the requirements of Code Case 1594 Section 3.0 for better guidance on the evaluation depending on sizes and configurations of the welds.

HBB-5260, FILLET, SOCKET, AND ATTACHMENT WELDS

HBB-5261, Fillet and Socket Welds
It is recommended that paragraph HBB-5261 be accepted as written because the NDE methods and examination volumes identified are proven based on applicability to similar types of welds. HBB-5261 restricts the use of fillet and socket welds to small diameter joints. It further includes requirements for enhanced inspection over the requirements of NB-5261 to ensure that planned clearances exist after welding, which is not required by NB-5261. As a fillet or socket weld is a partial penetration weld, similar welds would include other small-diameter partial-penetration welds.

HBB-5262, Permanent Structural Attachment Welds
It is recommended that paragraph HBB-5262 be accepted as written. HBB-5262 incorporates section 4.0 of Code Case 1594, which has been approved for use through NRC RG 1.87, and it provides examination requirements that are better defined and more specific than Code Case 1594 with accepted NDE methods and examination volumes.

HBB-5263, Nonstructural and Temporary Attachments
It is recommended that paragraph HBB-5263 be accepted as written because it is fundamentally identical to Section 4.2 of Code Case 1594, which has been approved for use through NRC RG 1.87.

4.1.4. ARTICLE HBB-6000, TESTING

HBB-6100, GENERAL REQUIREMENTS
It is recommended that the general requirement of subarticle HBB-6100 be accepted as written. It explicitly states that HBB-6000 is to be used for testing of III-5 Class A components when metal temperatures exceed allowable stress values given in II-D Subpart 1. As Section III, Division 5 does not cover the use of all of the materials in Section II, the additional temperatures and stress values would not be relevant to this Code.

HBB-6110, SCOPE OF TESTING

HBB-6111, General Hydrostatic and Pneumatic Test Media
It is recommended that paragraph HBB-6111 be accepted as written because it is fundamentally identical to paragraph 6111 of Code Case 1595, which has been approved for use through NRC RG 1.87.

It is recommended that subparagraph HBB-6111(a) be accepted as written. HBB-6111(a) has omitted the first two sentences of 6111(a) of Code Case 1595, which state that “hydrostatic” and “pneumatic” refer to liquid and gaseous test media, respectively, and “hydrostatic testing rules are in 6000; pneumatic testing rules are in 6300.” The omission of these sentences is recommended as acceptable and has no effect on these general requirements for testing as described in HBB-6111(a). Additionally, Code Case 1595 should state that hydrostatic testing rules were located in 6200 instead of 6000 for consistency.

It is recommended that subparagraph HBB-6111(b) be accepted as written. HBB-6111(b) has reworded the first sentence of 6111(b) of Code Case 1595 for readability with no change to the meaning of this sentence.

It is recommended that subparagraphs HBB-6111(c) through HBB-6111(d) be accepted as written because these are fundamentally identical to subparagraphs 6111(c) through 6111(d) of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6112, Pressure Testing of Components and Appurtenances

It is recommended that subparagraph HBB-6112(a) be accepted as written because it is fundamentally identical to subparagraph 6112(a) of Code Case 1595, which has been approved for use through NRC RG 1.87. HBB-6112(a) has changed “this paragraph” to “(b) and (c) below.” This change is consistent with the intent of 6112(a) of Code Case 1595 and directs the applicant to the appropriate subparagraphs of this paragraph.

It is recommended that subparagraphs HBB-6112(b) through HBB-6112(c) be accepted as written because they are fundamentally identical to subparagraphs 6112(b) through 6112(c) of Code Case 1595, which have been approved for use through NRC RG 1.87.

It is recommended that subparagraph HBB-6112(d) be accepted as written because it is fundamentally identical to subparagraph 6112(d) of Code Case 1595, which has been approved for use through NRC RG 1.87. HBB-6112(d) has included the correct paragraphs of HBB-6000, which detail the special conditions as discussed in HBB-6112(d).

It is recommended that subparagraph HBB-6112(e) be accepted as written because it is fundamentally identical to subparagraph 6112(e) of Code Case 1595, which has been approved for use through NRC RG 1.87.

It is recommended that subparagraph HBB-6112(f) be accepted as written. HBB-6112(f) has added a general requirement that allows the components or appurtenance pressure testing requirements from HBB-6221 (Hydrostatic) and HBB-6321 (Pneumatic) to be applicable as a pressure test of part and piping subassemblies. Additionally, this is fundamentally identical to Code Case 1595 subparagraph 6114(a), except for the use of the pneumatic pressure test, which has been approved for use through NRC RG 1.87. The addition of the use of HBB-6321 does not alter the meaning of paragraph HBB-6112 and adds general requirements that an applicant must account for in the Design Report.

It is recommended that subparagraph HBB-6112(g) be accepted as written. HBB-6112(g) states that components and appurtenances subjected to external pressure loads in service may be

pressure tested following the requirements of HBB-6112(a) on the basis of an internal pressure test and that additional tests may be needed to demonstrate structural integrity under external pressure loads. This approach is acceptable because it does not explicitly state that the components and appurtenances should only be pressure tested on the basis of an internal pressure test for external loads in service and stipulates additional tests may be required. This addition does not alter the meaning of paragraph HBB-6112 and gives an additional method for analysing the external pressure loads in service that an applicant must fully describe in the Design Report.

HBB-6113, Pressure Testing of Systems

It is recommended that subparagraph HBB-6113(a) be accepted as written because it is fundamentally identical to subparagraph 6113(a) of Code Case 1595, which has been approved for use through NRC RG 1.87. HBB-6113(a) has changed “nuclear energy system” to “Class A system.” This is consistent with the terminology used throughout the Code.

It is recommended that subparagraph HBB-6113(b) be accepted as written because it is fundamentally identical to subparagraph 6113(b) of Code Case 1595, which has been approved for use through NRC RG 1.87. HBB-6113(b) has included the correct paragraphs of HBB-6000 that detail the special conditions as discussed in HBB-6113(b).

HBB-6114, Time of Static Pressure Tests of Parts, Piping Subassemblies and Materials

HBB-6114 does not exist in the 2017 Code. However, Code Case 1595 has paragraph 6114 that is dedicated to “Time of Static Pressure Tests of Parts, Piping Subassemblies and Materials.” It is recommended that the omission of paragraph 6114 from the 2017 Code be accepted.

Subparagraph 6114(a) of Code Case 1595 is now subparagraph HBB-6112(f); therefore, the omission of this subparagraph is recommended to be accepted. Subparagraph 6114(b) of Code Case 1595 allows for a hydrostatic pressure test to be used in lieu of additional tests required by the material specification for a component or appurtenance provided that 6114(b)(1) through 6114(b)(3) are met. This omission is recommended to be accepted because it adds additional conservatism by disallowing the applicant to solely rely on the pressure test instead of completing the required material tests and pressure tests.

HBB-6115, Time of Pressure Test and Stamping of Components and Appurtenances

It is recommended that the general requirement of subparagraph HBB-6115(a) be accepted as written because it is fundamentally identical to the first written sentence of paragraph 6115 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6115(a) has fixed what appears to be an error in Code Case 1595 that references 6111 by referencing HBB-6112(a). Code Case 1595 paragraph 6111 does not have the requirement for pressure tests of components and appurtenances and should have read 6112 instead.

HBB-6115(a) points to the hydrostatic and pneumatic pressure testing sections (HBB-6221(a) and HBB-6321(a)) that state the requirements for pressure testing of components and

appurtenances. Code Case 1595 appears to erroneously point to paragraph 6113, which does not specify the requirements of the pressure test.

It is recommended that the general requirement of subparagraph HBB-6115(b) be accepted as written. This general requirement reiterates what is stated in HBB-6221(c) and HBB-6321(c), which are identical to 6221(c) and 6321(c) of Code Case 1595, which has been approved for used through NRC RG 1.87.

It is recommended that the general requirement of subparagraph HBB-6115(c) be accepted as written because it is fundamentally identical to the second written sentence of paragraph 6115 of Code Case 1595, which has been approved for use through NRC RG 1.87.

It is recommended that the general requirement of subparagraph HBB-6115(d) be accepted as written. It is recommended that prior to stamping any component following the rules of HBB-6118, the component must be examined per the requirements of HBB-6118.

It is recommended that the general requirement of subparagraph HBB-6115(e) be accepted as written. HBB-6115(e) is fundamentally identical to the last written sentence of paragraph 6115 of Code Case 1595, except for the added portion highlighted in the NRC Code Reconciliation document, which has been approved for use through NRC RG 1.87. This subparagraph requires pressure testing of pumps, if not designed by detailed analysis, prior to installation in the piping system. This does not eliminate the requirement to pressure test the system as required in paragraph 6121 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6116, Machining of Local Areas After Static Pressure Testing
It is recommended that HBB-6116 be accepted as written.

Subparagraphs HBB-6116(a) through HBB-6116(b) are fundamentally identical to the approach given in III-1 NB-6115 for Class 1 (Class A for III-5 use) components, which are approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

Subparagraph HBB-6116(c) is recommended to be accepted as written. This paragraph mandates that the final wall thickness shall comply with the minimum wall thickness requirements defined in the rules for design of Class A components for elevated temperature service.

HBB-6117, Alternative Tests of Closure Welds and Access Hatches
It is recommended that paragraph HBB-6117 be accepted as written because it is fundamentally identical to subparagraphs 6116(a) and 6116(b) of Code Case 1595, which have been approved for use through NRC RG 1.87.

It is recommended that subparagraph HBB-6117(a) be accepted as written.

Note:

HBB-6117(a) has changed “provided all of the following are true” from Code Case 1595 6116(a) to “the conditions of (1) through (4) below are met.” This change is acceptable and does not deter from the meaning of this paragraph.

HBB-6117(a) has deleted the requirement of Code Case 1595 6116(a)(1), which states that “pneumatic test pressures are too high for safety.” Use of a helium leak test as recommended by ASME is advisable due to the risks involved in a high-pressure pneumatic test. A Mass Spectrometer Leak Detector examination using helium can provide confidence that the boundary is fully secured with no leakage over the specified rate selected by the designer and included in the design documentation.

HBB-6117(a)(1) is fundamentally identical to Code Case 1595 6116(a)(2). HBB-6117(a)(1) has reworded this condition but has maintained the fundamental idea.

HBB-6117(a)(2) is fundamentally identical to Code Case 1595 6116(a)(3).

HBB-6117(a)(3) is fundamentally identical to Code Case 1595 6116(a)(4). HBB-6117(a)(3) has reworded this condition but has maintained the fundamental idea.

HBB-6117(a)(4) is fundamentally identical to Code Case 1595 6116(a)(5).

It is recommended that subparagraph HBB-6117(b) be accepted as written because it is fundamentally identical to subparagraph 6116(b) of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6117(b) has omitted the requirement that, following the mass spectrometer helium leak test, both volumetric and surface non-destructive examination of the weld region is to be performed. This omission is recommended as accepted because the requirements of HBB-5000 will ensure that the welds are properly examined, and leak testing will locate any imperfections in the welds.

HBB-6118, Alternative Tests at Specially Designed Welded Seals

It is recommended that paragraph HBB-6118 be accepted as written because it is fundamentally identical to paragraph 6127 and subparagraph 6116(c) of Code Case 1595, which has been approved for use through NRC RG 1.87.

It is recommended that subparagraph HBB-6118(a) be accepted as written. HBB-6118(a) has reworded paragraph 6127 of Code Case 1595 but maintained the fundamental idea.

The reference of NB-3227.7 in Code Case 1595 has been changed to examples of specially design welded seals, i.e., omega and canopy seals. This is deemed acceptable because the intent of referencing NB-3227.7 in Code Case 1595 was to give these examples.

Hydrostatic testing or pneumatic testing in Code Case 1595 has been changed to the general testing requirements of HBB-6112 and HBB-6113. This is deemed acceptable because the

general requirements of HBB-6112 and HBB-6113 are the general requirements of hydrostatic and pneumatic testing.

HBB-6118(a)(1) is fundamentally identical to 6127(a) of Code Case 1595. HBB-6118(a)(1) has reworded this condition but has maintained the fundamental idea.

HBB-6118(a)(2) is fundamentally identical to 6127(b) of Code Case 1595. HBB-6118(a)(2) has reworded this condition but has maintained the fundamental idea.

It is recommended that subparagraph HBB-6118(b) be accepted as written. HBB-6118(b) has reworded subparagraph 6116(c) of Code Case 1595 but maintained the fundamental idea.

HBB-6118(b)(1) is fundamentally identical to 6116(c)(1) of Code Case 1595. HBB-6118(b)(1) has reworded this condition but has maintained the fundamental idea.

HBB-6118(b)(2) is fundamentally identical to 6116(c)(2) of Code Case 1595. HBB-6118(b)(2) has reworded this condition but has maintained the fundamental idea.

HBB-6120, PREPARATION FOR TESTING

HBB-6121, Exposure of Joints
It is recommended that paragraph HBB-6121 be accepted as written because it is fundamentally identical to paragraph 6121 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6122, Addition of Temporary Supports
It is recommended that paragraph HBB-6122 be accepted as written because it is fundamentally identical to paragraph 6122 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6123, Restraint or Isolation of Expansion Joints
It is recommended that paragraph HBB-6123 be accepted as written because it is fundamentally identical to paragraph 6123 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6124, Isolation of Equipment Not Subjected to Pressure Test
It is recommended that paragraph HBB-6124 be accepted as written because it is fundamentally identical to paragraph 6124 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6125, Treatment of Flanged Joints Containing Blinds
It is recommended that paragraph HBB-6125 be accepted as written because it is fundamentally identical to paragraph 6125 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6126, Precautions Against Test Medium Expansion
It is recommended that paragraph HBB-6126 be accepted as written because it is fundamentally identical to paragraph 6126 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6127, Requirements for Specially Designed Welded Seals
HBB-6127 does not exist in the 2017 Code; however, Code Case 1595 has paragraph 6127 that is dedicated to "Requirements for Specially Designed Welded Seals." Paragraph 6127 has been moved to HBB-6118. Therefore, the omission of this paragraph from the 2017 Code is recommended as acceptable.

HBB-6200, HYDROSTATIC TESTS

HBB-6210, HYDROSTATIC TESTING PROCEDURE

HBB-6211, Provision of Air Vents at High Points
It is recommended that paragraph HBB-6211 be accepted as written because it is fundamentally identical to paragraph 6211 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6212, Test Medium and Test Temperature
It is recommended that subparagraph HBB-6212(a) be accepted as written because it is fundamentally identical to subparagraph 6212(a) of Code Case 1595, which has been approved for use through NRC RG 1.87. The reduction of the temperature from 110 °F to 100 °F is conservative and is recommend being accepted as is.

It is recommended that subparagraph HBB-6212(b) be accepted as written because it is fundamentally identical to subparagraph 6212(b) of Code Case 1595, which has been approved for use through NRC RG 1.87. HBB-6212(b) has changed "Tables I-1.1, I-1.2, and I-1.3" to the appropriate location in II-D. This change is recommended as accepted.

It is recommended that subparagraphs HBB-6212(c) through HBB-6212(d) be accepted as written because it is fundamentally identical to subparagraphs 6212(c) through 6212(d), respectively, of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6213, Check of Test Equipment Before Applying Pressure
It is recommended that paragraph HBB-6213 be accepted as written because it is fundamentally identical to paragraph 6213 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6215, Examination for Leakage After Application of Pressure
It is recommended that paragraph HBB-6215 be accepted as written because it is fundamentally identical to paragraph 6215 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6220, HYDROSTATIC TEST PRESSURE REQUIREMENTS

HBB-6221, Minimum Required System Hydrostatic Test Pressure
It is recommended that subparagraph HBB-6221(a) be accepted as written.

Paragraph 6221 of Code Case 1595 has a different subparagraph 6221(a) and refers to a subparagraph 6221(b) that is not present in this Code Case.

The purpose of subparagraph 6221(a) is to guide the applicant in determining the system design pressure based off the nameplates of any component included in the system. Because the applicant will know the design pressure prior to construction and detail this in the Design Report, it is recommended that the omission of 6221(a) be accepted.

It appears that the information presented in HBB-6221(a) should be what is found in 6221(b) as referenced in 6221(c) of Code Case 1595. However, Code Case 1595 has erroneously not included subparagraph 6221(b). Therefore, the approach and information given in HBB-6221(a) appears to be acceptable and is recommended to be approved.

It is recommended that subparagraph HBB-6221(b) be accepted as written because it is fundamentally identical to subparagraph 6221(c) of Code Case 1595, which has been approved for use through NRC RG 1.87.

Paragraph 6116 of Code Case 1595 has been moved between HBB-6117 and HBB-6118; therefore, these updates of the 2017 Code references are correct as written in HBB-6221(b).

It is recommended that subparagraph HBB-6221(c) be accepted as written because it is fundamentally identical to subparagraph 6221(d) of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6221(c)(2) has added subarticle of NB-5400, which is for final examination of vessels as a potential location of applicable rules for examination after component repair. This is recommended as acceptable to add the rules of an additional Code section.

HBB-6222, Maximum Permissible Hydrostatic Test Pressure
It is recommended that paragraph HBB-6222 be accepted as written because it is fundamentally identical to paragraph 6222 of Code Case 1595, which has been approved for use through NRC RG 1.87.

Note:

HBB-6222(a) has replaced “NB-3226” with the more general form of “NB-3000.”

HBB-6223, Hydrostatic Test Pressure for Valves, Pumps, and for Components and Appurtenances Containing Brazed Joints
It is recommended that subparagraph HBB-6223(a) be accepted as written. HBB-6223(a) is fundamentally identical to paragraph 6223 of Code Case 1595, except for the added portion highlighted in the NRC Code Reconciliation document, which has been approved for use through NRC RG 1.87.

It is recommended that subparagraph HBB-6223(b) be accepted as written. This subparagraph stipulates that the inlet or outlet portions of the valve shall be hydrostatically tested at a pressure at least 1.5 times the set pressure marked on the valve. Valves are used as part of a system that is tested to 1.25 times the system design pressure. As valves are not to be used over their stamped rated pressure, this results in the valve inlet and outlet portions being tested to a higher pressure than the system. This is an acceptable approach as it will require valve testing pressures that are higher than the system design pressure.

HBB-6224, Hydrostatic Test Pressure Holding Time

It is recommended that paragraph HBB-6224 be accepted as written because it is fundamentally identical to paragraph 6224 of Code Case 1595, which has been approved for use through NRC RG 1.87. HBB-6224 has added “other components covered by HBB-6223,” which is acceptable because HBB-6223 adds the requirement on the inlet and outlet portions of valves.

HBB-6300, PNEUMATIC TESTS

HBB-6310, PNEUMATIC TESTING PROCEDURES

HBB-6311, General Requirements

It is recommended that paragraph HBB-6311 be accepted as written because it is fundamentally identical to paragraph 6311 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6312, Test Medium and Test Temperature

It is recommended that paragraph HBB-6312 be accepted as written because it is fundamentally identical to paragraph 6312 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6313, Check of Test Equipment Before Applying Pressure

It is recommended that paragraph HBB-6313 be accepted as written because it is fundamentally identical to paragraph 6313 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6314, Procedure for Applying Pressure

It is recommended that paragraph HBB-6314 be accepted as written because it is fundamentally identical to paragraph 6314 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6315, Examination for Leakage After Application of Pressure

It is recommended that paragraph HBB-6315 be accepted as written because it is fundamentally identical to paragraph 6315 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6320, PNEUMATIC TEST PRESSURE REQUIREMENTS

HBB-6321, Minimum Required System Pneumatic Test Pressure

Note that 6321 of Code Case 1595 stipulates that the requirements are the same as 6221 with a few terms replaced, specifically replacing “hydrostatic” with “pneumatic”. Therefore, HBB-6321 is recommended as acceptable for the same reasons as HBB-6221.

It is recommended that subparagraph HBB-6321(a) be accepted as written.

Paragraph -6221 of Code Case 1595 has a different subparagraph 6221(a) and refers to a subparagraph 6221(b) that is not present in this Code Case.

The purpose of subparagraph 6221(a) is to guide the applicant in determining the system design pressure based on the nameplates of any component included in the system. Because the applicant will know the design pressure prior to construction and detail this in the Design Report, it is recommended that the omission of 6221(a) be accepted.

It appears the information presented in HBB-6321(a) should be what is found in 6221(b) as referenced in 6221(c) of Code Case 1595. However, Code Case 1595 has erroneously not included subparagraph 6221(b). Therefore, the approach and information given in HBB-6321(a) appears to be acceptable and is recommended to be approved.

It is recommended that subparagraph HBB-6321(b) be accepted as written because it is fundamentally identical to subparagraph 6221(c) of Code Case 1595, which has been approved for use through NRC RG 1.87.

Paragraph 6116 of Code Case 1595 has been moved between HBB-6117 and HBB-6118; therefore, these updates of the 2017 Code references are correct as written in HBB-6321(b).

It is recommended that subparagraph HBB-6321(c) be accepted as written because it is fundamentally identical to subparagraph 6221(d) of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6321(c)(2) has added references to NB-4400, NB-5100, and NB-5400 as applicable for final examination of vessels as a potential location of applicable rules after component repair. This is recommended as acceptable to add the rules of additional Code sections.

HBB-6322, Maximum Permissible Pneumatic Test Pressure

It is recommended that paragraph HBB-6322 be accepted as written because it is fundamentally identical to paragraph 6322 of Code Case 1595, which has been approved for use through NRC RG 1.87. Note that HBB-6322(a) has replaced “NB-3226” with the more general form of “NB-3000.”

HBB-6323, Pneumatic Test Pressure for Valves, Pumps, and for Components and Appurtenances Containing Brazed Joints

It is recommended that subparagraph HBB-6323(a) be accepted as written. HBB-6323(a) is fundamentally identical to the paragraph 6323 of Code Case 1595, except for the added portion

highlighted in the NRC Code Reconciliation document, which has been approved for use through NRC RG 1.87.

Note:

> It is recommended that the added statement “not designed by detailed stress analysis” be accepted. This statement allows for the computational analysis of the design of a pump to be used to evaluate the pressure handling capacity.

It is recommended that subparagraph HBB-6323(b) be accepted as written. This subparagraph stipulates that the inlet or outlet portions of the valve shall be hydrostatically tested at a pressure at least 1.5 times the set pressure marked on the valve. This is an acceptable approach and will produce testing pressures that are typically higher than the system design pressure.

HBB-6324, Pneumatic Test Pressure Holding Time
It is recommended that paragraph HBB-6324 be accepted as written because it is fundamentally identical to paragraph 6324 of Code Case 1595, which has been approved for use through NRC RG 1.87.

HBB-6400, PRESSURE TEST GAGES
It is recommended that subarticle HBB-6400 be accepted as written because it is fundamentally identical to subarticle 6400 of Code Case 1595, which has been approved for use through NRC RG 1.87.

4.2. SUBSECTION HC, CLASS B METALLIC PRESSURE BOUNDARY COMPONENTS, SUBPART B, ELEVATED TEMPERATURE SERVICE

4.2.1. ARTICLE HCB-3000, DESIGN

HCB-3100, GENERAL DESIGN
It is recommended that subarticle HCB-3100 be accepted as written because it stipulates that pressure-retaining material and material welded thereto shall meet the requirements of III-1 NC-3000, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, except as modified in HCB-3000.

HCB-3110

HCB-3114, Acceptability
It is recommended that the general design requirement of paragraph HCB-3114 be accepted as written. This paragraph states that an acceptable component design will meet the applicable requirements of NC-3100, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156; the appropriate component rules from III-5-HCB (i.e., HCB-3300 (vessels), HCB-3400 (pumps), HCB-3500 (valves), or HCB-3600 (piping)); and/or any optional approved alternative methods

that demonstrate compliance related to buckling, ratcheting, and creep-fatigue. Additionally, this will be demonstrated in the applicant's Design Report.

HCB-3115, Design Report and Certification

It is recommended that the general design requirement of paragraph HCB-3115 be accepted as written. HCB-3115 stipulates the requirement of the Design Report, such as components at elevated temperature, and states the Design Report must be certified by a Certifying Engineer.

HCB-3140, BUCKLING INSTABILITY LOADINGS

HCB-3141, General Requirements

It is recommended that the general design requirement of paragraph HCB-3141 be accepted as written. HCB-3141(a) stipulates that for Class B (Class 2 for III-1-NC) components at elevated temperatures the rules of NC-3133, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, shall apply for external pressure loadings if the conditions of Mandatory Appendix HCB-III are satisfied. Otherwise, HCB-3141(b) directs the applicant to use the rules of HCB-3141, HCB-3142, and HCB-3143 for the limits on buckling loads. Additionally, the approach used will be detailed in the applicant's Design Report.

Note:

> The use of Mandatory Appendix HCB-III is acceptable and is governed by the requirements and recommendations of NUMARK's report on Mandatory Appendix HCB-III *Time-Temperature Limits for Creep and Stress-Rupture Effects*.

HCB-3141.1, Scope of Rules

It is recommended that the general design requirement of subparagraph HCB-3141.1 be accepted as written. HCB-3141.1 states that NC-3133, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, only pertains to specific geometrical configurations under specific loading conditions and does not consider the effects of creep due to long-term loadings at elevated temperatures or the effects of the other loads or geometries. This subparagraph directs the applicant to use the rules of HCB-3141, HCB-3142, and HCB-3143 for limits applicable to general configurations and loading conditions that may lead to buckling or instability due to time-dependent creep behavior of the material. Therefore, this is recommended as accepted and will be detailed in the applicant's Design Report.

HCB-3141.2, Load-Controlled and Strain-Controlled Buckling

It is recommended that the general design requirement of subparagraph HCB-3141.2 be accepted as written. This subparagraph simply states that for the limits of HCB-3140, a distinction is made between load-controlled buckling and strain-controlled buckling with an example and definition given.

HCB-3141.3, Interaction of Load-Controlled and Strain-Controlled Buckling

It is recommended that the general design requirement of subparagraph HCB-3141.3 be accepted as written because it conservatively states that when a combination of these loadings is present, the larger Load Factor associated with load-controlled buckling shall be used.

HCB-3141.4, Effects of Initial Geometry Imperfections

It is recommended that the general design requirement of subparagraph HCB-3141.4 be accepted as written. HCB-3141.4(a) requires the effects of initial geometrical imperfections and tolerances be considered for time-independent and time-dependent calculations for load-controlled buckling according to the requirements of HCB-3142 and HCB-3143, respectively. HCB-3141.4(b) states that if significant geometrical imperfections are initially present, then effects of excessive deformation or strain caused by instability strain under pure strain-controlled buckling must be accounted for.

Note:

> The applicant should also demonstrate in the Design Report that the instability strain under pure strain-controlled buckling due to the effects of geometrical imperfections and tolerances, whether initially present or induced by service, is acceptable when compared to the deformation and strain limits. This is in contrast to what is stated in HCB-3141.4(b).

HCB-3141.5, Stress-Strain Data

It is recommended that the general design requirement of subparagraph HCB-3141.5 be accepted as written because it stipulates that the expected minimum stress-strain curve for the material be used.

HCB-3142, Time-Independent Buckling Limits

It is recommended that the general design requirement of paragraph HCB-3142 be accepted as written. This paragraph states that the Load Factor for load-controlled buckling and the Strain Factor for strain-controlled buckling shall equal or exceed the value in Table HBB-T-1521-1 for the specified Design and Service Loadings to protect against instantaneous buckling.

Note:

> The applicant must justify the Load Factor and Strain Factor used in the Design Report. The values from Table HBB-T-1521-1 are acceptable and are governed by the requirements and recommendations of NUMARK's report on Nonmandatory Appendix HBB-T *Rules for Strain, Deformation, and Fatigue Limits at Elevated Temperatures*.

HCB-3143, Time-Dependent Buckling Limits

It is recommended that the general design requirement of paragraph HCB-3143 be accepted as written. This paragraph states that in order to protect against load-controlled time-dependent buckling, it must be demonstrated that instability will not occur during the specified lifetime for a load history obtained by multiplying the specified service loads by the factor in Table HBB-T-1522-1.

Note:

The values from Table HBB-T-1522-1 are acceptable and are governed by the requirements and recommendations of NUMARK's report on Nonmandatory Appendix HBB-T *Rules for Strain, Deformation, and Fatigue Limits at Elevated Temperatures*.

HCB-3150, LIMITATIONS ON USE

It is recommended that the general design requirement of paragraph HCB-3150 be accepted as written. HCB-3150 stipulates various components cannot be used unless the requirements of Mandatory Appendix HCB-III are satisfied.

Note:

For socket welded fittings used in pressure-retaining joints in accordance with 10 CFR 50.55a(b)(1)(ii), applicants and licensees may not apply the Section III provisions for welds with leg size less than 1.09* t_n, where t_n is the nominal pipe thickness.

The use of Mandatory Appendix HCB-III is acceptable and is governed by the requirements and recommendations of NUMARK's report on Mandatory Appendix HCB-III *Time-Temperature Limits for Creep and Stress-Rupture Effects*.

HCB-3160, COMPONENTS CONTAINING LETHAL OR HAZARDOUS SUBSTANCES

It is recommended that the general design requirement of paragraph HCB-3160 be accepted as written. Paragraph HCB-3160 gives the acceptable weld types for Category A, B, C, and D type welds. The definition for the type of welds is stated to come from NC-4262, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

Note:

Category A weld joints of HCB-3160(a) are identical to Category A weld joints for vessels designed to NC-3200 (NC-4263).

Category B and C weld joints of HCB-3160(b) are identical to Category B weld joints for vessels designed to NC-3200 (NC-4264).

Category D welded joints of HCB-3160(c) are identical to Category D welded joint for vessels designed to NC-3200 (NC-4266).

The approach given in HCB-3160 appears to be acceptable and analogous to the welds of vessels designed to NC-3200. Additionally, the weld used for components containing lethal or hazardous substances will be detailed in the applicant's Design Report.

HCB-3300, VESSEL DESIGN

HCB-3310, GENERAL REQUIREMENTS

It is recommended that the general design requirement of paragraph HCB-3310 be accepted as written. HCB-3310 states that the requirements of III-1 NC-3300, which is approved for III-1 use

by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, are to be satisfied except as modified per HCB-3100. HCB-3310 also states that the rules of NC-3300 as modified by HCB-3100 do not explicitly address fatigue damage resulting from cyclic service and that the allowable stress values used in the design calculations at elevated temperatures shall be obtained from Mandatory Appendix HCB-II.

Note:

> It is recommended that the applicant follow the guidelines of Section III, Mandatory Appendix XIII, XIII-3500 to determine if a fatigue analysis due to cyclic operation at elevated temperatures is required and/or follow the procedures outlined for a fatigue analysis.
>
> The use of Mandatory Appendix HCB-II is acceptable and is governed by the requirements and recommendations of NUMARK's report on Mandatory Appendix HCB-II *Allowable Stress Values for Class B Components*.

HCB-3400, PUMP DESIGN

It is recommended that the general design requirement of subarticle HCB-3400 be accepted as written. HCB-3400 states that the requirements of III-1 NC-3400, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, are to be satisfied except as modified per HCB-3100. HCB-3310 also states that the rules of NC-3400 as modified by HCB-3100 do not explicitly address fatigue damage resulting from cyclic service and that the allowable stress values used in the design calculations at elevated temperatures shall be obtained from Mandatory Appendix HCB-II.

Note:

> It is recommended that the applicant follow the guidelines of Section III, Mandatory Appendix XIII, XIII-3500 to determine if a fatigue analysis due to cyclic operation at elevated temperatures is required and/or follow the procedures outlined for a fatigue analysis.
>
> The use of Mandatory Appendix HCB-II is acceptable and is governed by the requirements and recommendations of NUMARK's report on Mandatory Appendix HCB-II *Allowable Stress Values for Class B Components*.

HCB-3500, VALVE DESIGN

HCB-3510, GENERAL REQUIREMENTS

It is recommended that the general design requirement of paragraph HCB-3510 be accepted as written. HCB-3510 states that the requirements of III-1 NC-3500, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, are to be satisfied except as modified per HCB-3100. HCB-3510 also states that the rules of NC-3500 as modified by HCB-3100 do not explicitly address fatigue damage resulting from cyclic service and that the allowable stress values used

in the design calculations at elevated temperatures shall be obtained from Mandatory Appendix HCB-II.

Note:

> It is recommended that the applicant follow the guidelines of Section III, Mandatory Appendix XIII, XIII-3500 to determine if a fatigue analysis due to cyclic operation at elevated temperatures is required and/or follow the procedures outlined for a fatigue analysis.
>
> The use of Mandatory Appendix HCB-II is acceptable and is governed by the requirements and recommendations of NUMARK's report on Mandatory Appendix HCB-II *Allowable Stress Values for Class B Components*.

HCB-3600, PIPING DESIGN

HCB-3630, GENERAL REQUIREMENTS

It is recommended that the general design requirement of paragraph HCB-3630 be accepted as written. This paragraph simply states that for elevated temperature Class B (Class 2 for III-1 use) piping designs, the rules for piping with negligible creep effects and for piping with creep effects must conform to the rules of HCB-3632 and HCB-3634, respectively.

HCB-3632, Piping with Negligible Creep Effects

It is recommended that the requirements of paragraph HCB-3632 be accepted as written. This paragraph replaces specific sections in III-1-NC, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, with general design requirements in III-5-HCB.

Note:

> The use of Mandatory Appendix HCB-II and Mandatory Appendix HCB-III is acceptable and are governed by the requirements and recommendations of NUMARK's report on Mandatory Appendix HCB-II *Allowable Stress Values for Class B Components* and Mandatory Appendix HCB-III *Time-Temperature Limits for Creep and Stress-Rupture Effects*.

HCB-3634, Piping with Creep Effects

It is recommended that the requirements of subparagraph HCB-3634(a) be accepted as written. This subparagraph states that the requirements of subarticle NC-3600, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, as modified by HCB-3600 be satisfied.

Note:

> The use of Mandatory Appendix HCB-II is acceptable and is governed by the requirements and recommendations of NUMARK's report on Mandatory Appendix HCB-II *Allowable Stress Values for Class B Components*.

It is recommended that the requirements of subparagraph HCB-3634(b) be accepted as written. The allowable stress value in Equation (10a) of NC-3653.2(a) is stated to be determined using Equation (10b) of HCB-3634. Equation (10b) of HCB-3634 is identical to Equation (1) of NC-3611.1(e). The modification between Subsection HCB and Subsection NC is the determination of the stress range reduction factor, f. HCB-3634(b) stipulates this value must be determined using Mandatory Appendix HCB-I. Equation (10c) is an additional equation not shown in the thermal expansion section of NC-3653.2. HCB-3634(b) stipulates that all thermal cycles shall satisfy the stress criteria in Equation (10c). This appears to be an acceptable approach.

Note:

> The modification of the allowable stress value in Equation (10a) of NC-3653.2 is recommended acceptable for determining the stress range reduction factor, f, using Mandatory Appendix HCB-I. The use of Mandatory Appendix HCB-I is acceptable and is governed by the requirements and recommendations of NUMARK's report on Mandatory Appendix HCB-I *Stress Range Reduction Factor for Piping*.

It is recommended that the requirements of subparagraph HCB-3634(c) be accepted as written. The modification of NC-3653.2(c) Equation (11) has the allowable stress values as the lesser of the existing Equation (11) (NC-3653.2(c)) allowable stress values and the allowable stress values of the new Equation (10b) (HBB-3634(b)). This change is acceptable because the allowable stress values for III-5-HCB use may potentially be lower than III-1-NC use by accounting for the effects of all thermal cycles.

It is recommended that the requirements of subparagraph HCB-3634(d) be accepted as written. This subparagraph states that the definitions for the undefined terms in HCB-3634(b) and HCB-3634(c) are found in NC-3611.2(c).

It is recommended that the requirements of subparagraph HCB-3634(e) be accepted as written. This subparagraph makes additional modifications to NC-3600 which stipulate that portions of NC are either satisfied by Subsection HBB, excluded by Subsection HBB, not acceptable for use in Subsection HBB, or that all elevated temperature service durations shall also be duplicated in test.

4.2.2. ARTICLE HCB-4000, FABRICATION AND INSTALLATION

HCB-4100, GENERAL REQUIREMENTS

It is recommended that paragraph HCB-4100 be accepted as written.

Subparagraph HCB-4100(a) states that components that do not experience high-temperature service may use the rules of this Article or Division 1 Article -NC NC-4000 rules, which is approved for ASME Code Section III, Division 1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, or the rules of HCB-4000.

Subparagraph HCB-4100(b) states that components at elevated temperature service that meet the condition that creep and stress rupture effects need not be considered per Mandatory

Appendix HCB-III may use the rules of this article or Division 1-NC NC-4000 rules, which are approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, or the rules of HCB-4000.

Subparagraph HCB-4100(c) states that components at elevated temperature service that do not meet the requirements of HCB-4100(a) and HCB-4100(b) must comply with HCB-4000.

Subparagraph HCB-4100(d) states that components at elevated temperature service that use options of HCB-4100(a) through HCB-4100(c) must be identified in all phases of manufacturing and installation. Additionally, this will be explicitly shown in the Design Report.

Subsequent to the approval of ASME Code Case 1593, a substantial multi-year research effort was sponsored by the Department of Energy regarding the use of cold worked 304 and 316 stainless steels, as well as Nickel-Iron-Chromium Alloy 800H, for use in high-temperature environments. The purpose of this research was to provide a database for subsequent use by individuals or groups within the ASME BPVC committees. The data produced as a result of this research effort was likely used as the basis for Figure HCB-III-1000-1, *Time-Temperature Limits for Service Level A and B Events.*

Note:

> The use of Mandatory Appendix HCB-III is acceptable and is governed by the requirements and recommendations of NUMARK's report on Mandatory Appendix HCB-III *Time-Temperature Limits for Creep and Stress-Rupture Effects*.

HCB-4160, COMPONENTS CONTAINING LETHAL OR HAZARDOUS SUBSTANCES
It is recommended that the general design requirement of paragraph HCB-4160 be accepted as written. HCB-4160 states that components containing lethal substances or other hazardous substances must be post-weld heat treated in accordance with HCB-4000 when the pressure boundary material includes carbon or low-alloy steels. The approach given in HCB-4160 appears to be acceptable as welding and forming can induce residual stresses that can be relieved by heat treatment, which results in better defined design stresses for components containing lethal or hazardous substances.

HCB-4200

HCB-4210

HCB-4215, Additional Requirements for Forming and Bending Processes
It is recommended that paragraph HCB-4215 be accepted as written because it is fundamentally identical to paragraph HBB-4212. It is an acceptable approach to use the Class A pressure-retaining components construction Code for the Class B pressure-retaining components construction Code.

The rules of HCB-4215 provides additional requirements to those in NC-4212, and NC-4213. Additionally, HCB-4215 provides more detailed and acceptable requirements than those listed in Code Case 1593. Subsequent to ASME Code approval of Code Case 1593, a substantial multi-

year research effort was sponsored by the Department of Energy regarding the use of cold worked 304 and 315 stainless steels, as well as Nickel-Iron-Chromium Alloy 800H, for use in high-temperature environments. The purpose of this research was to provide a database for subsequent use by individuals or groups within the ASME BPVC committees. The data produced as a result of this research effort was likely used as the basis for Figure HCB-4215-1 *Permissible Time/Temperature Conditions for Material Which Has Been Cold Worked >5% and <20% and Subjected to Short-Time High Temperature Transients.*

Note:

> Reference changes have been made in HCB-4215 when compared to HBB-4212 for use with III-5-HCB. HCB-4215 references "NC-4212 and NC-4213," while HBB-4212 references "NB-4212 and NB-4213"; HCB-4215 references "Figure HCB-4215-1," while HBB-4212 references "Figure HBB-4212-1"; HCB-4215 references "Table NC-4622.1-1," while HBB-4212 references "Table NB-4622.1-1"; HCB-4215 references "NC-2211," while HBB-4212 references "NB-2211"; HCB-4215 references "NC-4213," while HBB-4212 references "NB-4213"; and HCB-4215 references "NC-2400," while HBB-4212 references "NB-2400."

HCB-4400

HCB-4420

HCB-4427, Shape and Size of Fillet Welds

It is recommended that HCB-4427 be accepted as written. HCB-4427(a) and HCB-4427(b) are fundamentally identical to III-1-NC NC-4427(a) and NC-4227(b), which are approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. HCB-4427(c) is fundamentally identical to HBB-4240. It is an acceptable approach to use the Class A pressure-retaining components construction Code for the Class B pressure-retaining components construction Code.

Note:

> For socket welded fittings used in pressure-retaining joints in accordance with 10 CFR 50.55a(b)(1)(ii), applicants and licensees may not apply the Section III provisions for welds with leg size less than 1.09* t_n, where t_n is the nominal pipe thickness.

4.2.3. ARTICLE HCB-5000, EXAMINATION

HCB-5100, GENERAL REQUIREMENTS FOR EXAMINATION

It is recommended that subarticle HCB-5100 be accepted as written because the subarticle stipulates that pressure-retaining material and material welded thereto shall meet the requirements of III-1 NC-5000, which are approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HCB-5160, COMPONENTS CONTAINING LETHAL OR HAZARDOUS SUBSTANCES
It is recommended that paragraph HCB-5160 be accepted as written. Paragraph HCB-5160 is clear and concise that all permitted welds at the pressure boundaries shall be radiographed. The volume to be radiographed is the defined weld and it is up to the designer to identify the type of permitted weld joints. This paragraph is more conservative than NC-5000 because all pressure boundary weld joints, regardless of the weld joint design, are required to be fully radiographed, i.e., 100 percent of the weld volume.

4.2.4. ARTICLE HCB-6000, TESTING

HCB-6100, GENERAL REQUIREMENTS
It is recommended that subarticle HCB-6100 be accepted as written because the subarticle stipulates that the requirements of III-1 NC-6000 be followed except as modified in HCB-6000. III-1 NC is approved for III-1 use by 10 CFR 50.55a with the 2017 Edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HCB-6110

HCB-6111, Scope of Pressure Testing
It is recommended that the general requirements of paragraph HCB-6111 be accepted as written because it is fundamentally identical to paragraph NC-6111, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Note that HCB-6111 has changed “hydrostatically tested” to the generic form of “pressure test.” This change is minor; therefore, it is recommended as acceptable.

It is recommended that the subparagraphs HCB-6111(a) and HCB-6111(b) be accepted as written because they are fundamentally identical to subparagraphs NC-6111(a) and NC-6111(b), which are approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

It is recommended that subparagraph HCB-6111(c) be accepted as written because it is fundamentally identical to subparagraph NC-6111(c), which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Note that HCB-6111(c) has changed “Class 2 Vessels, or the gaseous regions of MC containment vessels through spargers or spray nozzles” to strictly “Class B Vessels.” This change is minor and consistent with the use of III-5-HCB; therefore, it is recommended as acceptable.

It is recommended that subparagraph HCB-6111(d) be accepted as written. HCB-6111(d) adds a condition that states that a helium mass spectrometer test may replace the required pressure test under the special requirements of HCB-6630 and HCB-6640. This exemption is recommended as acceptable for the special conditions of HCB-6630 and HCB-6640 because pressure testing these welds can prove difficult, and a leak test on these welds will ensure there is no leak. Additionally, any welds not pressure tested will be discussed in depth in the Design Report.

HCB-6600

HCB-6630, ALTERNATIVE TESTS OF CLOSURE WELDS AND ACCESS HATCHES

It is recommended that paragraph HCB-6630 be accepted as written because it is analogous to what is stated in HBB-6117(a). HBB-6117(a) is fundamentally identical to subparagraph 6116(a) of Code Case 1595, which has been approved for use through NRC RG 1.87. HCB-6630 states the helium mass spectrometer test may be used as an alternative to the pressure test requirements of "NC-6110," which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, while HBB-6117(a) and Code Case 1595 6116(a) state "HBB-6112 and HBB-6113" and "6112 and 6113," respectively. The only difference is the Code section being referenced. Therefore, this paragraph is recommended as accepted because the language for Class B construction (III-5-HCB) is fundamentally identical to the language for Class A construction (III-5-HBB), which is a more stringent construction code.

It is recommended that subparagraph HCB-6630(a) be accepted as written because it is fundamentally identical to HBB-6117(a)(2). HBB-6117(a)(2) is fundamentally identical to subsubparagraph 6116(a)(3) of Code Case 1595, which has been approved for use through NRC RG 1.87. Therefore, this subparagraph is recommended as accepted because the language for Class B construction (III-5-HCB) is fundamentally identical to the language for Class A construction (III-5-HBB), which is a more stringent construction code.

It is recommended that subparagraph HCB-6630(b) be accepted as written because it directs the applicant to include any closure welds to which the alternative test procedure has been applied in the Design Report.

HCB-6640, ALTERNATIVE TESTS AT SPECIALLY DESIGNED WELDED SEALS

It is recommended that paragraph HCB-6640 be accepted as written because this is analogous to what is stated in HBB-6118(b). HBB-6118(b) is fundamentally identical to subparagraph 6116(c) of Code Case 1595, which has been approved for use through NRC RG 1.87. HCB-6640 states the helium mass spectrometer test may be used in lieu of the pressure test requirements of "NC-6110," which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, while HBB-6118(b) and Code Case 1595 6116(c) state "HBB-6112 and HBB-6113" and "6112 and 6113" respectively. The only difference is the Code section being referenced. Therefore, this paragraph is recommended as accepted because the language for Class B construction (III-5-HCB) is fundamentally identical to the language for Class A construction (III-5-HBB), which is a more stringent construction code.

It is recommended that subparagraphs HCB-6640(a) and HCB-6640(b) be accepted as written because they are fundamentally identical to subsubparagraphs HBB-6118(b)(1) and HBB-6118(b)(2) and subsubparagraphs 6116(c)(1) and 6116(c)(2) of Code Case 1595, which has been approved for use through NRC RG 1.87. Therefore, these subparagraphs are recommended as accepted because the language for Class B construction (III-5-HCB) is fundamentally identical to the language for Class A construction (III-5-HBB), which is a more stringent construction code.

4.3. SUBSECTION HG, CLASS A METALLIC CORE SUPPORT STRUCTURES, SUBPART B, ELEVATED TEMPERATURE SERVICE

4.3.1. ARTICLE HGB-3000, DESIGN

HGB-3100, GENERAL DESIGN
It is recommended that subarticle HGB-3100 be accepted as written because the subarticle stipulates that core support structure material and material welded thereto shall meet the requirements of III-1 NG-3000, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, except as modified in HGB-3000. Note that HGB-3200 completely replaces NG-3200.

HGB-3110

HGB-3112, Design Parameters
It is recommended that paragraph HGB-3112 be accepted as written because it is fundamentally identical to paragraph HBB-3112 and paragraph -3112 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

> Reference changes have been made in HGB-3112 when compared to HBB-3112 for use with III-5-HGB. HGB-3112 references “HGB-3113,” while HBB-3112 references “HBB-3113”; and HGB-3112 states “pressure difference,” while HBB-3112 states “pressure.”

HGB-3112.1, Specified Pressure Difference
It is recommended that subsubparagraph HGB-3112.1(a) be accepted as written.

The first written sentence is fundamentally identical to subsubparagraph HBB-3112.1(a) and subparagraph -3112.1 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

The second written sentence states that if the pressure differences during service can be predicted for different zones, then the pressure difference histories of the different zones may use the predicted pressure differences. This is an acceptable approach and is consistent with what is stated in NG-3112.1(a), which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

It is recommended that subsubparagraph HGB-3112.1(b) be accepted as written because it is fundamentally identical to subsubparagraph NG-3112.1(b), which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

It is recommended that subsubparagraph HGB-3112.1(c) be accepted as written because it is fundamentally identical to subsubparagraph HBB-3112.1(b) and subsubparagraph -3112.1(c) of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

> Reference changes have been made in HGB-3112.1 when compared to HBB-3112.1 for use with III-5-HGB. The title of HGB-3112.1 is “Specified Pressure Difference,” while the title of HBB-3112.1 is “Specified Pressure”; HGB-3112.1(a) states “pressure difference,” while HBB-3112.1(a) states “pressure”; HGB-3112.1(a) states “core support structure,” while HBB-3112.1(a) states “pressure boundary”; and HGB-3112.1(c) references “HGB-3200,” while HBB-3112.1(b) references “HBB-3200”.

HGB-3112.2, Specified Temperature

It is recommended that subparagraph HGB-3112.2 be accepted as written because it is fundamentally identical to subparagraph HBB-3112.2 and subparagraph -3112.2 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

> Reference changes have been made in HGB-3112.2 when compared to HBB-3112.2 for use with III-5-HGB. HGB-3112.2 references “HGB-3113.2,” while HBB-3112.2 references “HBB-3113.2”; HGB-3112.2 references “HGB-3200,” while HBB-3112.2 references “HBB-3200”; and HGB-3112.2(c) references “HGB-3200,” while HBB-3112.2(c) references “HBB-3200.”

HGB-3112.3, Specified Mechanical Load Forces

It is recommended that subparagraph HGB-3112.3 be accepted as written.

The first sentence is fundamentally identical to subparagraph HBB-3112.3 and subparagraph -3112.3 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

The remaining portion of subparagraph HGB-3112.3 lists other mechanical load forces to be considered. This is an acceptable approach and is fundamentally identical to NG-3112.3(a) through NG-3112.3(c), which are approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

Note:

> Reference changes have been made in HGB-3112.3 when compared to HBB-3112.3 for use with III-5-HGB. HGB-3112.3 references “HGB-3113,” while HBB-3112.3 references

"HBB-3113"; HGB-3112.3 references "HGB-3200," while HBB-3112.3 references "HBB-3200"; and HGB-3112.1(c) references "HGB-3200," while HBB-3112.1(b) references "HBB-3200."

HGB-3112.4, Design Stress Intensity Values

It is recommended that subparagraph HGB-3112.4 be accepted as written because it is fundamentally identical to NG-3112.4, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

Note:

The use of Tables HBB-I-14.3A through HBB-I-14.3E is governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

HGB-3113, Loading Categories

It is recommended that paragraph HGB-3113 be accepted as written because it is fundamentally identical to paragraph HBB-3113 and paragraph -3113 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures. Note that III-5-HGB does not have "Testing Loads."

HGB-3113.1, Design Loadings

It is recommended that subparagraph HGB-3113.1 be accepted as written because it is fundamentally identical to subparagraph HBB-3113.1 and subparagraph -3113.1 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

Reference changes have been made in HGB-3113.1 when compared to HBB-3113.1 for use with III-5-HGB. HGB-3113.1 references "HGB-3113.3," while HBB-3113.1 references "HBB-3113.3"; HGB-3113.1 references "HGB-3222," while HBB-3113.1 references "HBB-3222.1"; and HGB-3113.1 states "pressure difference," while HBB-3113.1 states "pressure."

HGB-3113.2, Service Loadings

It is recommended that subparagraph HGB-3113.2 be accepted as written because it is fundamentally identical to subparagraph HBB-3113.2 and subparagraph -3113.2 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3113.3, Level A Service Loadings

It is recommended that subparagraph HGB-3113.3 be accepted as written because it is fundamentally identical to subparagraph HBB-3113.3 and subparagraph -3113.3 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures. Note that III-5-HGB does not have “Testing Loads.”

HGB-3113.4, Level B Service Loadings (From Incidents of Moderate Frequency)

It is recommended that subparagraph HGB-3113.4 be accepted as written because it is fundamentally identical to subparagraph HBB-3113.4 and subparagraph -3113.4 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3113.5, Level C Service Loadings (From Infrequent Incidents)

It is recommended that subparagraph HGB-3113.5 be accepted as written because it is fundamentally identical to subparagraph HBB-3113.5 and subparagraph -3113.5 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3113.6, Level D Service Loadings (From Limiting Faults)

It is recommended that subparagraph HGB-3113.6 be accepted as written because it is fundamentally identical to subparagraph HBB-3113.6 and subparagraph -3113.6 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3114, Load Histogram

HGB-3114.1, Level A and B Service Events

It is recommended that subparagraph HGB-3114.1 be accepted as written because it is fundamentally identical to subparagraph HBB-3114.1 and subparagraph -3114.1 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

> Reference changes have been made in HGB-3114.1 when compared to HBB-3114.1 for use with III-5-HGB. HGB-3114.1 references “HGB-3200,” while HBB-3114.1 references “HBB-3200”; and HGB-3114.1 states “pressure difference,” while HBB-3114.1 states “pressure”.

HGB-3114.2, Level C Service Events

It is recommended that subparagraph HGB-3114.2 be accepted as written because it is fundamentally identical to subparagraph HBB-3114.2 and subparagraph -3114.2 of Code Case

1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

> Reference changes have been made in HGB-3114.2 when compared to HBB-3114.2 for use with III-5-HGB. HGB-3114.2 references “HGB-3200,” while HBB-3114.2 references “HBB-3200”; and HGB-3114.2 references “HGB-3213.15,” while HBB-3114.2 references “HBB-3213.15”.

HGB-3120

HGB-3122, Cladding
It is recommended that paragraph HGB-3122 be accepted as written. This paragraph explicitly states that the requirements of III-1 NG-3122 shall not be used. Cladding requirements are contained in HGB-3227.8.

HGB-3124, Environmental Effects
It is recommended that paragraph HGB-3124 be accepted as written.

Excluding the last sentence, paragraph HGB-3124 is fundamentally identical to NG-3124, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Additionally, HGB-3124 states the same information as HBB-3124 but worded differently.

The last sentence is recommended as acceptable. This sentence directs the applicant to account for the combined effects of exposure to elevated temperature, contacting fluid, and nuclear radiation on material properties (including creep).

HGB-3130

HGB-3132, Reinforcement for Openings
It is recommended that paragraph HGB-3132 be accepted as written.

The first part of paragraph HGB-3132 is fundamentally identical to paragraph NG-3132, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. The major difference between the first part of HGB-3132 and NG-3132 is the use of Class A and Class 1, respectively.

The remaining portion of paragraph HGB-3132 is recommended as acceptable. This conservatively only allows the rules of reinforcement for openings from Level A vessels and piping to be used for internal pressure difference loadings if not prohibited in the Design Specification. Analysis of other loadings must demonstrate satisfaction with the primary stress limits using the methods of HGB-3200.

HGB-3133, External Pressure Difference

It is recommended that paragraph HGB-3133 be accepted as written. This paragraph explicitly states that the requirements of III-1 NG-3133 shall not be used. Therefore, the applicant must explicitly state how any external pressure difference is to be evaluated, if applicable, in the Design Report.

HGB-3138, Elastic Follow-Up

It is recommended that paragraph HGB-3138 be accepted as written because it is fundamentally identical to paragraph HBB-3138 and paragraph -3138 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

> A reference change has been made in HGB-3138 when compared to HBB-3138 for use with III-5-HGB. HGB-3138 references “HGB-3250,” while HBB-3138 references “HBB-3250.”

HGB-3139, Welding

HGB-3139.1, Abrupt Changes in Mechanical Properties at Weld and Compression Contact Junctions

It is recommended that subparagraph HGB-3139.1 be accepted as written because it is fundamentally identical to subparagraph HBB-3139.1 and paragraph -3139 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

> A reference change has been made in HGB-3139.1 when compared to HBB-3139.1 for use with III-5-HGB. HGB-3139.1 references “HGB-3000,” while HBB-3139.1 references “HBB-3000.”

HGB-3139.2, Weld Design

It is recommended that the general requirement for design subparagraph HGB-3139.2 be accepted as written. This requirement directs the applicant to comply, at a minimum, with the rules of III-1 NG-3350, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, in addition to the other requirements of article HGB-3000. Additionally, this is analogous to what is stated in HBB-3139.2.

HGB-3200, DESIGN BY ANALYSIS

HGB-3210, DESIGN CRITERIA

HGB-3211, Requirements for Acceptability
It is recommended that paragraph HGB-3211 be accepted as written. This paragraph directs the applicant to meet the requirements of HGB-3211(a) through HGB-3211(d) for acceptability of a design based on analysis.

It is recommended that subparagraph HGB-3211(a) be accepted as written because it mandates that the calculated or experimentally determined stresses, strains, and deformations will not exceed the limits of HB-3200.

It is recommended that subparagraph HGB-3211(b) be accepted as written because it states the design shall conform to the rules of NG-3100 and NG-3350, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, in addition to the other requirements of article HGB-3000.

It is recommended that subparagraph HGB-3211(c) be accepted as written because it states that buckling shall be considered per HGB-3250 along with the requirements of HGB-3211(a) and HGB-3211(b) if compressive stresses occur.

It is recommended that subparagraph HGB-3211(d) be accepted as written because it mandates protection against nonductile fracture per HGB-3241.

HGB-3212, Basis for Determining Stress, Strain, and Deformation Quantities
It is recommended that paragraph HGB-3212 be accepted as written.

HGB-3212 is fundamentally identical to paragraph HBB-3212. Subparagraphs HBB-3212(a) and HBB-3212(b) are fundamentally identical to paragraph -3212 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Subparagraph HGB-3212(c) is fundamentally identical to Subparagraph HBB-3212(c). It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures. HGB-3212(c) refers to a Class A (Class 1 for III-1 use) material (9Cr-1Mo-V) allowed per the material requirements of III-5-HGB, Article HGB-2000 and III-1-NG, Article NG-2000. Therefore, it is recommended that subparagraph HGB-3212(c) be accepted as written.

Note:

> Paragraph HGB-3212 states 9Cr-1Mo-V has several unique characteristics that should be recognized and reflected in multiaxial stress–strain relationships. The use of this material is governed by the requirements and recommendations of ORNL's report on HBB-2000 *Material*.

HGB-3213, Terms Relating to Analysis
It is recommended that paragraph HGB-3213 be accepted as written because it is fundamentally identical to paragraph HBB-3213 and paragraph -3213 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

> A reference change has been made in HGB-3213 when compared to HBB-3213 for use with III-5-HGB. HGB-3213 references "HGB-3213," while HBB-3213 references "HBB-3213."

HGB-3213.1, Stress Intensity
It is recommended that subparagraph HGB-3213.1 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.1 and subparagraph -3213.1 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.2, Gross Structural Discontinuity
It is recommended that subparagraph HGB-3213.2 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.2 and subparagraph -3213.2 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.3, Local Structural Discontinuity
It is recommended that subparagraph HGB-3213.3 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.3 and subparagraph -3213.3 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.4, Normal Stress
It is recommended that subparagraph HGB-3213.4 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.4 and subparagraph -3213.4 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.5, Shear Stress
It is recommended that subparagraph HGB-3213.5 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.5 and subparagraph -3213.5 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to

use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.6, Membrane Stress

It is recommended that subparagraph HGB-3213.6 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.6 and subparagraph -3213.6 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.7, Bending Stress

It is recommended that subparagraph HGB-3213.7 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.7 and subparagraph -3213.7 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.8, Primary Stress

It is recommended that subparagraph HGB-3213.8 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.8 and subparagraph -3213.8, except for the added sentence and table reference, of Code Case 1592, which has been approved for use through NRC RG 1.87. Additionally, the definition is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(y) of the 2017 Code and III-1 NB-3213.8 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

> A reference change has been made in HGB-3213.8 when compared to HBB-3213.8 for use with III-5-HGB. HGB-3213.8 references “Table HGB-3217-1,” while HBB-3213.8 references “Table HBB-3217-1.”

HGB-3213.9, Secondary Stress

It is recommended that subparagraph HGB-3213.9 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.9. and subparagraph -3213.9, except for the added sentence and table reference, of Code Case 1592, which has been approved for use through NRC RG 1.87. Additionally, the definition is fundamentally identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(ab) of the 2017 Code and III-1 NB-3213.9 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

Reference changes have been made in HGB-3213.9 when compared to HBB-3213.9 for use with III-5-HGB. HGB-3213.9(a) references “HGB-3213.13(a),” while HBB-3213.9 references “HBB-3213.13(a)”; and HGB-3213.9 references “Table HGB-3217-1,” while HBB-3213.9 references “Table HBB-3217-1”.

HGB-3213.11, Peak Stress

It is recommended that subparagraph HGB-3213.11 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.11 and subparagraph -3213.11 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

A reference change has been made in HGB-3213.11 when compared to HBB-3213.11 for use with III-5-HGB. HGB-3213.11 references “HGB-3213.13(b),” while HBB-3213.11 references “HBB-3213.13(b).”

HGB-3213.13, Thermal Stress

It is recommended that subparagraph HGB-3213.13 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.13 and subparagraph -3213.13 of Code Case 1592, which has been approved for use through NRC RG 1.87. Additionally, the expansion of the thermal stress definition from -3213.13 to HGB-3213.13 is fundamentally identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(aj) of the 2017 Code and NB-3213.13 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

The reference to subparagraph HBB-T-1331(d) is acceptable because NUMARK recommends that paragraph HBB-T-1331 be accepted based on the summary given in Section 3, HBB-T-1331 *General Requirements* and the accompanying arguments in Section 4.

Reference changes have been made in HGB-3213.13 when compared to HBB-3213.13 for use with III-5-HGB. HGB-3213.13(a) references “HGB-3213.13(a),” while HBB-3213.13 references “HBB-3213.13(a)”; and HGB-3213.13 references “Table HGB-3217-1,” while HBB-3213.13 references “Table HBB-3217-1.”

HGB-3213.14, Total Stress

It is recommended that subparagraph HGB-3213.14 be accepted as written because it is fundamentally identical to subparagraph NG-3213.13, which is approved for III-1 use by 10 CFR

50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HGB-3213.15, Service Cycle

It is recommended that subparagraph HGB-3213.15 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.15 and subparagraph -3213.15 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

> A reference change has been made in HGB-3213.15 when compared to HBB-3213.15 for use with III-5-HGB. HGB-3213.15 references “HGB-3113,” while HBB-3213.15 references “HBB-3113.”

HGB-3213.16, Strain Cycle

It is recommended that subparagraph HGB-3213.16 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.16 and subparagraph -3213.16 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

> The reference to paragraph HBB-T-1413 is acceptable because NUMARK recommends that paragraph HBB-T-1413 be accepted based on the summary given in Section 3, HBB-T-1413 *Equivalent Strain Range* and the accompanying arguments in Section 4.

HGB-3213.17, Fatigue Strength Reduction Factor

It is recommended that subparagraph HGB-3213.17 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.17 and subparagraph -3213.17 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.18, Free End Displacement

It is recommended that subparagraph HGB-3213.18 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.18 and subparagraph -3213.19 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.20, Deformation

It is recommended that subparagraph HGB-3213.20 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.20. The definition given in this subparagraph defines a common engineering term and is identical to what is found in ASME

BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(d) of the 2017 Code and NB-3213.20 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Additionally, it is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.21, Inelasticity

It is recommended that subparagraph HGB-3213.21 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.21. The definition given in this subparagraph defines a common engineering term and is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(j) of the 2017 Code and NB-3213.21 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Additionally, it is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.22, Creep

It is recommended that subparagraph HGB-3213.22 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.22. The definition given in this subparagraph defines a common engineering term and is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(c) of the 2017 Code and NB-3213.22 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Additionally, it is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.23, Plasticity

It is recommended that subparagraph HGB-3213.23 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.23. The definition given in this subparagraph, excluding the last sentence involving 9Cr-1Mo-V, defines a common engineering term and is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(x) of the 2017 Code and NB-3213.23 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Additionally, it is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

> Paragraph HGB-3213.23 states that for 9Cr-1Mo-V, time-independent plasticity at higher temperature occurs only in limiting cases where strain rates are high relative to creep rates. The use of this material is governed by the requirements and recommendations of ORNL's report on HBB-2000 *Material*.

HGB-3213.24, Plastic Analysis

It is recommended that subparagraph HGB-3213.24 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.24. The definition given in this subparagraph, excluding the sentence regarding the use of 9Cr-1Mo-V, defines a common engineering analysis method and is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(t) of the 2017 Code and NB-3213.24 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Additionally, it is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

> Paragraph HGB-3213.24 states for 9Cr-1Mo-V, a plastic analysis must generally account for rate dependence and creep effects. The use of this material is governed by the requirements and recommendations of ORNL's report on HBB-2000 *Material*.

HGB-3213.25, Plastic Analysis – Collapse Load

It is recommended that subparagraph HGB-3213.25 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.25. The definition given in this subparagraph defines a common engineering analysis and is fundamentally identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(u) of the 2017 Code and NB-3213.25 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Additionally, it is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.26, Plastic Instability Load

It is recommended that subparagraph HGB-3213.26 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.26. The definition given in this subparagraph defines a common engineering term and is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(w) of the 2017 Code and NB-3213.26 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Additionally, it is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.27, Limit Analysis

It is recommended that subparagraph HGB-3213.27 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.27. The definition given in this subparagraph defines a common engineering analysis and is fundamentally identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(k) of the 2017 Code and NB-3213.27 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Additionally, it is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.28, Limit Analysis – Collapse Load

It is recommended that subparagraph HGB-3213.28 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.28 and subparagraph -3213.21 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.29, Calculated Collapse Load – Lower Bound

It is recommended that subparagraph HGB-3213.29 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.29 and subparagraph -3213.22 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.30, Plastic Hinge

It is recommended that subparagraph HGB-3213.30 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.30. The definition given in this subparagraph defines a common engineering term and is fundamentally identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(v) of the 2017 Code and NB-3213.30 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Additionally, it is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.31, Strain Limiting Load

It is recommended that subparagraph HGB-3213.31 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.31. The definition given in this subparagraph defines a common engineering term and is identical to what is found in ASME BPVC Sec. III, Mandatory Appendix XIII, XIII-1300(af) of the 2017 Code and NB-3213.31 of the 2015 Code, which is approved for III-1 use by 10 CFR 50.55a with the 2015 and 2017 editions of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. Additionally, it is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.33, Ratcheting

It is recommended that subparagraph HGB-3213.33 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.33 and subparagraph -3213.23 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.34, Shakedown

It is recommended that subparagraph HGB-3213.34 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.34 and subparagraph -3213.18 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable

approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

> A reference change has been made in HGB-3213.34 when compared to HBB-3213.34 for use with III-5-HGB. HGB-3213.34 references “HGB-3213.33,” while HBB-3213.34 references “HBB-3213.33.”

HGB-3213.36, Use-Fraction
It is recommended that subparagraph HGB-3213.36 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.36 and subparagraph -3213.25 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.37, Fatigue Damage
It is recommended that subparagraph HGB-3213.37 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.37 and subparagraph -3213.26 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.38, Creep Damage
It is recommended that subparagraph HGB-3213.38 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.38 and subparagraph -3213.27 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3213.39, Creep-Fatigue Interaction
It is recommended that subparagraph HGB-3213.39 be accepted as written because it is fundamentally identical to subparagraph HBB-3213.39 and subparagraph -3213.28 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3214, Stress Analysis
It is recommended that paragraph HGB-3214 be accepted as written because it is fundamentally identical to paragraph HBB-3214 and paragraph -3214 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

Reference changes have been made in HGB-3214 when compared to HBB-3214 for use with III-5-HGB. HGB-3214 references “HGB-3220 and HGB-3230,” while HBB-3214 references “HBB-3220 and HBB-3230”; HGB-3214 references “NG-3111,” while HBB-3214 references “HBB-3111”; and HGB-3214 states “core support structure,” while HBB-3214 states “component.”

HGB-3214.1, Elastic Analysis

It is recommended that subparagraph HGB-3214.1 be accepted as written because it is fundamentally identical to subparagraph HBB-3214.1 and subparagraph -3214.1 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

Reference changes have been made in HGB-3214.1 when compared to HBB-3214.1 for use with III-5-HGB. HGB-3214.1 references “HGB-3000,” while HBB-3214.1 references “NB-3000”; and HGB-3214.1 references “HGB-3211,” while HBB-3214.1 references “HBB-3211.”

HGB-3214.2, Inelastic Analysis

It is recommended that subparagraph HGB-3214.2 be accepted as written because it is fundamentally identical to subparagraph HBB-3214.2. and subparagraph HBB-3214.2 is an expanded version of subparagraph -3214.2 of Code Case 1592, which has been approved for use through NRC RG 1.87. The primary reason for this recommendation is based on the third paragraph, which states, “The basis for choosing the selected methods and relations used should be included in the Design Report.” Additionally, it is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

Paragraph HGB-3214.2 states for 9Cr-1Mo-V, decoupling of plastic and creep strains in the classical constitutive framework is generally a poor representation of the true material behavior. Unified constitutive equations, which do not distinguish between rate-dependent plasticity and time-dependent creep, represent the rate dependence and softening that occur, particularly at higher temperatures. The use of this material is governed by the requirements and recommendations of ORNL’s report on HBB-2000 *Material*.

The use of Nonmandatory Appendix HBB-T is acceptable and is governed by the requirements and recommendations of NUMARK’s report on Nonmandatory Appendix HBB-T *Rules for Strain, Deformation, and Fatigue Limits at Elevated Temperatures*.

HGB-3214.3, Mechanical Properties

It is recommended that subparagraph HGB-3214.3 be accepted as written because it is fundamentally identical to subparagraph HBB-3214.3 and subparagraph -3214.3 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

The reference to the mechanical and physical properties in Mandatory Appendix HBB-I-14 is acceptable. The use of these mechanical and physical properties is governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

The reference to the mechanical and physical properties in Nonmandatory Appendix HBB-T is acceptable. The use of these mechanical and physical properties is governed by the requirements and recommendations of NUMARK's report on Nonmandatory Appendix HBB-T *Rules for Strain, Deformation, and Fatigue Limits at Elevated Temperatures*.

A reference change has been made in HGB-3214.3 when compared to HBB-3214.3 for use with III-5-HGB. HGB-3214.3 has the title "Mechanical Properties," while HBB-3214.3 has the title "Mechanical and Physical Properties."

HGB-3215, Derivation of Stress Intensities

It is recommended that paragraph HGB-3215 be accepted as written because it is fundamentally identical to paragraph HBB-3215 and paragraph -3215 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

Reference changes have been made in HGB-3215 when compared to HBB-3215 for use with III-5-HGB. HGB-3215 has removed all discussion and reference to the local primary membrane stress component, P_L, because this stress is not present in core support structures; HGB-3215 references "HGB-3210," while HBB-3215 references "HBB-3210"; HGB-3215 references "HGB-3213.11," while HBB-3215 references "HBB-3213.11"; HGB-3215 references "HGB-3213.8," while HBB-3215 references "HBB-3213.8"; HGB-3215 references "HGB-3213.9," while HBB-3215 references "HBB-3213.9"; and HGB-3215 references "Table HGB-3217-1," while HBB-3215 references "Tables HBB-3217-1 and HBB-3217-2."

HGB-3216, Derivation of Stress Differences and Strain Differences

It is recommended that paragraph HGB-3216 be accepted as written because it is fundamentally identical to paragraph HBB-3216 and paragraph -3216 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use

the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

> A reference change has been made in HGB-3216 when compared to HBB-3216 for use with III-5-HGB. HGB-3216 references “HGB-3250,” while HBB-3216 references “HBB-3250.”

HGB-3217, Classification of Stresses

It is recommended that paragraph HGB-3217 be accepted as written because it is fundamentally identical to paragraph HBB-3217 and paragraph -3217 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

> Reference changes have been made in HGB-3217 when compared to HBB-3217 for use with III-5-HGB. HGB-3217 references “Table HGB-3217-1,” while HBB-3217 references “Tables HBB-3217-1 and HBB-3217-2”; and HGB-3217 references “NG-3000,” while HBB-3217 references “NB-3000.”.

It is recommended that Table HGB-3217-1 be accepted as written because it is fundamentally identical to Table HBB-3217-1.

The numbering system for the notes at the end of Table HGB-3217-1 is different from Table HBB-3217-1, but the same note is associated with the same table entry when the two tables are compared.

Table HGB-3217-1 does not include the Nozzle entries for the limits of reinforcement as shown in Table HBB-3217-1. This is considered acceptable because Table HGB-3217-1 is only examples of typical cases.

Table HGB-3217-1 has added a Nozzle entry not found in Table HBB-3217-1. This is considered acceptable because Table HGB-3217-1 includes only examples of typical cases.

Note:

> Table HGB-3217-1, cladding type of stress should be peak stress, as described in the 2017 edition of Sec. III Div. 1 Sub. NG Table NG-3217-1.

HGB-3220, DESIGN RULES AND LIMITS FOR LOAD-CONTROLLED STRESSES IN STRUCTURES OTHER THAN THREADED STRUCTURAL FASTENERS

HGB-3221, General Requirements

It is recommended that paragraph HGB-3221 be accepted as written because it is fundamentally identical to paragraph HBB-3221. The detailed explanation associated with the

use of HBB-3221 (refer to Section 3, HBB-3221, General Requirements) is also applicable to HGB-3221. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

> Reference changes have been made in HGB-3221 when compared to HBB-3221 for use with III-5-HGB. HGB-3221 has replaced all entries of the local primary membrane stress intensity allowable, P_L, with the general primary membrane stress intensity allowable, P_m; HGB-3221 references “HGB-3220,” while HBB-3221 references “HBB-3220”; and HGB-3221 references “HGB-3250,” while HBB-3221 references “HBB-3250.”

HGB-3222, Design Limits

It is recommended that paragraph HGB-3222 be accepted as written because it is fundamentally identical to subparagraph HBB-3221.1 and subparagraph -3222.1 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures. The requirement of HGB-3222.1(c), not present in -3222.1 of Code Case 1592, to account for adequate buckling strength is acceptable.

Note:

> Justification of the method(s) used to demonstrate there is an acceptable amount of buckling strength must be included by the applicant in the Design Report.
>
> Reference changes have been made in HGB-3222 when compared to HBB-3222 for use with III-5-HGB. HGB-3222 has replaced all entries of the local primary membrane stress intensity allowable, P_L, with the general primary membrane stress intensity allowable, P_m; HGB-3222 references “HGB-3113.1,” while HBB-3222.1 references “HBB-3113.1”; HGB-3222 references “HGB-3215(b),” while HBB-3222.1 references “HBB-3215(b)”; and HGB-3222 references “HGB-3250,” while HBB-3222.1 references “HBB-3250.”

HGB-3223, Level A and B Service Limits

It is recommended that paragraph HGB-3223 be accepted as written because it is fundamentally identical to paragraph HBB-3223 and paragraph -3223 of Code Case 1592, which has been approved for use through NRC RG 1.87. The detailed explanation associated with the use of HBB-3223 (refer to Section 3, HBB-3223, Level A and B Service Limits) is also applicable to HGB-3223. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

Reference changes have been made in HGB-3223 when compared to HBB-3223 for use with III-5-HGB. HGB-3223 has replaced all entries of the local primary membrane stress intensity allowable, P_L, with the general primary membrane stress intensity allowable, P_m; HGB-3223 references “HGB-3113.3 and HGB-3113.4,” while HBB-3223 references “HBB-3113.4”; HGB-3223(b) references “HGB-3224(b),” while HBB-3223(b) references “HBB-3224(b)”; HGB-3223(f) references “HGB-3224(d),” while HBB-3223(f) references “HBB-3224(d)”; and HGB-3223(g) references “HGB-3250,” while HBB-3223(g) references “HBB-3250.”

HGB-3224, Level C Service Limits

It is recommended that paragraph HGB-3224 be accepted as written because it is fundamentally identical to paragraph HBB-3224 and paragraph -3224 of Code Case 1592, which has been approved for use through NRC RG 1.87. The detailed explanation associated with the use of HBB-3224 (refer to Section 3, HBB-3224, Level C Service Limits) is also applicable to HGB-3224. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

Reference changes have been made in HGB-3224 when compared to HBB-3224 for use with III-5-HGB. HGB-3224 has replaced all entries of the local primary membrane stress intensity allowable, P_L, with the general primary membrane stress intensity allowable, P_m; HGB-3224(b) references “HGB-3211,” while HBB-3224(b) references “HBB-3211”; HGB-3224(b) references “Figure HGB-3224-1,” while HBB-3224(b) references “Figure HBB-3224-1”; HGB-3224(c) references “HGB-3223(c),” while HBB-3224(c) references “HBB-3223(c)”; and HGB-3224(d) references “Figure HGB-3224-2,” while HBB-3224(d) references “Figure HGB-3224-2.”

It is recommended that Figure HGB-3224-1 be accepted as written because it is fundamentally identical to Figure HBB-3224-1. The detailed explanation and notes associated with the use of Figure HBB-3224-1 (refer to Section 4, HBB-3224) are also applicable to Figure HGB-3224-1.

It is recommended that Figure HGB-3224-2 be accepted as written because it is fundamentally identical to Figure HBB-3224-2. The detailed explanation associated with the use of Figure HBB-3224-2 (refer to Section 4, HBB-3224) is also applicable to Figure HGB-3224-2.

HGB-3225, Level D Service Limits

It is recommended that paragraph HGB-3225 be accepted as written because it is fundamentally identical to paragraph HBB-3225. The detailed explanation associated with the use of HBB-3225 (refer to Section 3, HBB-3225, Level D Service Limits) is also applicable to HGB-3225. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

Reference changes have been made in HGB-3225 when compared to HBB-3225 for use with III-5-HGB. HGB-3225 has replaced all entries of the local primary membrane stress intensity allowable, P_L, with the general primary membrane stress intensity allowable, P_m; HGB-3225(a) references “HGB-3225,” while HBB-3225(a) references “HBB-3225”; HGB-3225(c) references “Subsection NG, as explained in HGB-3211,” while HBB-3225(c) references “Subsection NB, as explained in HBB-3211”; HGB-3225(c) references “Figure HGB-3224-1,” while HBB-3225(c) references “Figure HBB-3224-1”; HGB-3225(d) references “HGB-3223(c),” while HBB-3225(d) references “HBB-3223(c)”; and HGB-3225(e) references “Figure HGB-3224-2,” while HBB-3225(e) references “Figure HGB-3224-2.”

HGB-3227, Special Stress Limits

It is recommended that paragraph HGB-3227 be accepted as written because it is fundamentally identical to paragraph HBB-3227 and paragraph -3227 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

A reference change has been made in HGB-3227 when compared to HBB-3227 for use with III-5-HGB. HGB-3227 references “HGB-3227,” while HBB-3227 references “HBB-3227.”

HGB-3227.1, Bearing Loads

It is recommended that subparagraph HGB-3227.1 be accepted as written because it is fundamentally identical to subparagraph HBB-3227.1 and subparagraph -3227.1 of Code Case 1592, which has been approved for use through NRC RG 1.87. The detailed explanation associated with the use of HBB-3227.1 (refer to Section 3, HBB-3227.1, Bearing Loads) is also applicable to HGB-3227.1. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3227.2, Pure Shear

It is recommended that subparagraph HGB-3227.2 be accepted as written because it is fundamentally identical to subparagraph HBB-3227.2 and subparagraph -3227.2 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3227.3, Progressive Distortion of Nonintegral Connections

It is recommended that subparagraph HGB-3227.3 be accepted as written because it is fundamentally identical to subparagraph HBB-3227.3 and subparagraph -3227.3 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to

use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3227.4, Triaxial Stresses

It is recommended that subparagraph HGB-3227.4 be accepted as written because it is fundamentally identical to subparagraph HBB-3227.4 and subparagraph -3227.4 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3227.5, Nozzle Piping Transition

It is recommended that subparagraph HGB-3227.5 be accepted as written because it is fundamentally identical to subparagraph -3227.5 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

> Reference changes have been made in HGB-3227.5 when compared to HBB-3227.5 for use with III-5-HGB. HGB-3227.5 has replaced all entries of the local primary membrane stress intensity allowable, P_L, with the general primary membrane stress intensity allowable, P_m; and HGB-3227.5 references “HGB-3132,” while HBB-3227.5 references “NB-3334.”

HGB-3227.8, Cladding

It is recommended that subparagraph HGB-3227.8 be accepted as written, except for subsubparagraph HGB-3227.8(d), because it is fundamentally identical to subparagraph HBB-3227.8 and subparagraph -3227.8 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

It is recommended that subsubparagraph HGB-3227.8(d) be rejected as written and supplemented with the requirements of NG-3227.1 *Bearing Loads* (2017 edition) because this error has been identified and corrected in the 2017 edition of Sec. III Div. 1 Sub. NG.

Note:

> A reference change has been made in HGB-3227.8 when compared to HBB-3227.8 for use with III-5-HGB. HGB-3227.8(a) references “HGB-3200,” while HBB-3227.8(a) references “HBB-3200.”

HGB-3230, STRESS LIMITS FOR LOAD-CONTROLLED STRESSES IN THREADED STRUCTURAL FASTENERS

HGB-3231, General Requirements

It is recommended that the general requirement paragraph HGB-3231 be accepted as written.

Subparagraph HGB-3231(a) states that the rules of paragraph HGB-3231 apply to mechanical connections joining parts in core support structures within a pressure-retaining boundary and refers to this as threaded structural fasteners. Additionally, the design stress intensity values for S_{mt} for threaded structural fasteners are the values given in Tables HBB-I-14.3A through HBB-I-14.3E. This approach for threaded structural fasteners appears to be acceptable because the value of S_{mt} is the lesser of the time-independent value S_m and the time-dependent value S_t.

Subparagraph HGB-3231(b) is acceptable because it explicitly states that the special stress limits of HGB-3227 do not apply to threaded structural fasteners. This is also consistent with III-1 NG-3231(b), which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

Subparagraph HGB-3231(c) is acceptable because it states that connections that join parts of pressure-retaining boundaries are governed by the rules of III-5-HBB. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

> The use of Tables HBB-I-14.3A through HBB-I-14.3E for threaded structural fasteners is acceptable and is governed by the requirements and recommendations of ORNL's report on Mandatory Appendix HBB-I-14 *Tables and Figures*.

HGB-3232, Design and Level A Service Limits

It is recommended that paragraph HGB-3232 be accepted as written. This paragraph states that the number and cross-sectional area of threaded structural fasteners must be such that the stress intensity limits of the Design Loadings and Level A Service Limits are satisfied. The applicant will demonstrate this in the Design Report.

HGB-3232.1, Average Stress

It is recommended that subparagraph HGB-3232.1 be accepted as written because it is fundamentally identical to HBB-3233.1 and HBB-3233.2. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Subsubparagraph HGB-3232.1(a) is fundamentally identical to subparagraph HBB-3233.1 and subparagraph -3233.1 of Code Case 1592, which has been approved for use through NRC RG 1.87. There is one major difference in HGB-3232.1(a) when compared to -3233.1 of Code Case 1592. HGB-3232.1(a) has an additional allowable $0.5S_m$ that is not present in -3233.1. This is acceptable and will lead to a lower allowable stress value because HGB-3232.2 is the lesser of $0.5S_m$ and S_{mt}, while -3233.1 (HGB-3233.1) is just S_{mt}.

Subsubparagraph HGB-3232.1(b) is fundamentally identical to subparagraph HBB-3233.2 and subparagraph -3233.2 of Code Case 1592, which has been approved for use through NRC RG 1.87. There is one major difference in HGB-3232.1(b) when compared to -3233.2 of Code Case 1592. HGB-3232.1(a) does not have a multiplication factor on S_{mt}, while -3233.3 has a multiplication factor of s on S_{mt}. This is acceptable and will lead to an allowable stress value for threaded structural fasteners that is half the allowable stress value for bolted components on a

pressure-retaining boundary. Additionally, HGB-3232.1 states that stress intensity instead of maximum stress is to be used when threaded structural fasteners are loaded in transverse shear. This is an added requirement compared to -3233.2 but is considered acceptable because shear stress due to bending should be compared to stress intensity.

Subsubparagraph HGB-3232.1(b)(2) is recommended as acceptable because it stipulates that the preload shall be shown to be greater than the primary and secondary membrane stress if a tight joint is required.

HGB-3232.2, Maximum Stress

It is recommended that subparagraph HGB-3232.2 be accepted as written because it is fundamentally identical to subparagraph HBB-3233.3 and subparagraph -3233.3 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

There is one major difference in HGB-3232.2 compared to -3233.3 of Code Case 1592. HGB-3232.2 has a multiplication factor of 1.5 on S_{mt}, while -3233.3 has a multiplication factor of 3 on S_{mt}. The reduction of the multiplication factor by half is acceptable and will lead to a lower allowable stress value because HGB-3232.2 is the lesser of $1.5S_{mt}$ and K_tS_t and -3233.3 (HGB-3233.3) is the lesser of $3S_{mt}$ and K_tS_t. Additionally, HGB-3232.2 states that stress intensity instead of maximum stress is to be used when threaded structural fasteners are loaded in transverse shear. This is an added requirement compared to -3233.3 but is considered acceptable because shear stress due to bending should be compared to stress intensity.

Note:

> A reference change has been made in HGB-3232.2 when compared to HBB-3233.3 for use with III-5-HGB. HGB-3232.2 references “HGB-3224(d),” while HBB-3233.3 references “HBB-3224(d).”

HGB-3232.3, Nonductile Fracture

It is recommended that subparagraph HGB-3232.3 be accepted as written because it is fundamentally identical to subparagraph HBB-3233.4 and subparagraph -3233.4 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

> A reference change has been made in HGB-3232.3 when compared to HBB-3233.4 for use with III-5-HGB. HGB-3232.3 references “HGB-3241,” while HBB-3233.4 references “HBB-3241.”

HGB-3233, Level B Service Limits

It is recommended that paragraph HGB-3233 be accepted as written because it states that Level A Service Limits apply for Level B Service limits.

HGB-3234, Level C Service Limits for Threaded Structural Fasteners
It is recommended that paragraph HBB-3234 be accepted as written. This paragraph states that the number and cross-sectional area of threaded structural fasteners must be such that the requirements of HGB-3224 are satisfied for the Service Loadings for which Level C Service Limits are designated in the Design Specification. The applicant will demonstrate this in the Design Report.

HGB-3235, Level D Service Limits for Threaded Structural Fasteners
It is recommended that paragraph HBB-3235 be accepted as written. This paragraph states that the number and cross-sectional area of threaded structural fasteners must be such that the requirements of HGB-3225 are satisfied for the Service Loadings for which Level D Service Limits are designated in the Design Specification. The applicant will demonstrate this in the Design Report.

HGB-3240, SPECIAL REQUIREMENTS FOR ELEVATED TEMPERATURE COMPONENTS

HGB-3241, Nonductile Fracture
It is recommended that paragraph HGB-3241 be accepted as written because it is fundamentally identical to paragraph HBB-3241 and subparagraph -3241 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3250, LIMITS ON DEFORMATION-CONTROLLED QUANTITIES

HGB-3251, General Requirements
It is recommended that paragraph HGB-3251 be accepted as written because it is fundamentally identical to paragraph HBB-3251 and subparagraph -3251 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

HGB-3252, Criteria
It is recommended that paragraph HGB-3252 be accepted as written because it is fundamentally identical to paragraph HBB-3252 and subparagraph -3252 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

> The use of Nonmandatory Appendix HBB-T is acceptable and is governed by the requirements and recommendations of NUMARK's report on Nonmandatory Appendix HBB-T *Rules for Strain, Deformation, and Fatigue Limits at Elevated Temperatures*.

HGB-3300

HGB-3350

HGB-3352, Permissible Types of Welded Joints
It is recommended that paragraph HGB-3352 be accepted as written.

The first written sentence of HGB-3352 is fundamentally identical to the first written sentence of paragraph NG-3352, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

The remaining portion of HGB-3352 is similar to NG-3352 but is reworded and tailored to III-5-HGB use. The major differences are HGB-3352 calls out the appropriate III-5-HGB sections for the allowable stress limits instead of III-1-NG, and the fatigue factor, f, is considered a minimum stress concentration factor with a larger value to be used if obtained per HGB-3353(b).

HGB-3352.2, Type II Joints
It is recommended that subparagraph HGB-3352.2 be accepted as written because it is fundamentally identical to subparagraph NG-3352.2, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

Note:

> A reference change has been made in HGB-3352.2 when compared to NG-3352.2 for use with III-5-HGB. HGB-3352.2 references “HGB-3353(b),” while NG-3352.2 references “NG-3222.4.”

HGB-3353, Design of Welded Construction at Elevated Temperatures
It is recommended that paragraph HGB-3353 be accepted as written because it is fundamentally identical to paragraph HBB-3353 and subparagraph -3353 of Code Case 1592, which has been approved for use through NRC RG 1.87. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

> Reference changes have been made in HGB-3353 when compared to HBB-3353 for use with III-5-HGB. HGB-3353(b) references “HGB-3251,” while HBB-3353(b) references “HBB-3251”; and HGB-3353(b) has a last sentence that is not present in -3353(b) of Code Case 1592. This addition is acceptable because it states the assumed strain factor cannot be less than the applicable fatigue factor of III-1-NG Table NG-3352-1.

4.3.2. ARTICLE HGB-4000, FABRICATION AND INSTALLATION

HGB-4100, GENERAL REQUIREMENTS
It is recommended that subarticle HGB-4100 be accepted as written. It stipulates that core support structure material and material welded thereto shall meet the requirements of ASME

Code Section III Division 1, Article NG-4000, which is approved for Section III Division 1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, except as modified in HGB-4000.

HGB-4200

HGB-4210

HGB-4212, Forming and Bending Processes
It is recommended that paragraph HGB-4212 be accepted as written because it is fundamentally identical to paragraph HBB-4212. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

The rules of HGB-4212 provide additional requirements to those in NB-4212. HGB-4212 provides more detailed requirements than those listed in Code Case 1593. Subsequent to ASME Code approval of Code Case 1593, a substantial multi-year research effort was sponsored by the Department of Energy regarding the use of cold worked 304 and 316 stainless steels, as well as Nickel-Iron-Chromium Alloy 800H, for use in high-temperature environments. The purpose of this research was to provide a database for subsequent use by individuals or groups within the ASME BPVC committees. The data produced as a result of this research effort was likely used as the basis for the Figure HBB-4212-1 *Permissible Time/Temperature Conditions for Material Which Has Been Cold Worked>5% and <20% and Subjected to Short-Time High Temperature Transients.*

Note:

> Reference changes have been made in HGB-4212 when compared to HBB-4212 for use with III-5-HCB. HGB-4212 states “core support structure,” while HBB-4212 states “pressure-retaining”; HCB-4212 references “Table NG-4622.1-1,” while HBB-4212 references “Table NB-4622.1-1”; HCB-4212 references “NG-2211,” while HBB-4212 references “NB-2211”; HCB-4212 references “NG-4213,” while HBB-4212 references “NB-4213”; and HCB-4212 references “NG-2400,” while HBB-4212 references “NB-2400.”

HGB-4230

HGB-4233, Alignment Requirements When Component Inside Surface is Inaccessible
It is recommended that paragraph HGB-4233 be accepted as written because it is fundamentally identical to paragraphs NB-4233(a) through NB-4233(b), which are approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. It is an acceptable approach to use the Class 1 pressure-retaining components construction Code for Class A core support structures because this requirement is not temperature dependent.

Note:

Reference changes have been made in HGB-4233 when compared to NB-4233 for use with III-5-HGB. HGB-4233(a) references “NG-4232,” while NB-4233(a) references “NB-4232”; and HGB-4233(b) references “NG-4232,” while NB-4233(a) references “NB-4232.”

HGB-4400

HGB-4420

HGB-4424, Surfaces of Welds

It is recommended that paragraph HGB-4424 be accepted as written because it is fundamentally identical to paragraph NG-4424, which is approved for ASME Code Section III, Division 1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, with the added requirement that the surface geometry must be considered in the stress analysis in accordance with the rules for design of core support structures in elevated surface. HGB-4424 states that the as-welded surface geometry is permitted provided the surface geometry is considered in the stress analysis in accordance with the rules for design of Class A elevated temperature components. The requirement to include the surface geometry in the stress analysis will ensure the impact of as-welded surfaces will be appropriately accounted for by using the proper stress indices when performing analysis in accordance with HGB-3000.

Note:

A reference change has been made in HGB-4424 when compared to NG-4424 for use with III-5-HGB. HGB-4424 references “HBB-3000,” while NG-4424 references “NG-3000.”

4.3.3. ARTICLE HGB-5000, EXAMINATION

HGB-5100, GENERAL REQUIREMENTS FOR EXAMINATION

It is recommended that subarticle HGB-5100 be accepted as written because it stipulates that core support structure material and material welded thereto shall meet the requirements of III-1 NG-5000, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, except as modified in HGB-5000.

HGB-5200

HGB-5220, REQUIREMENTS FOR RADIOGRAPHY OR ULTRASONIC AND LIQUID PENETRANT OR MAGNETIC PARTICLE EXAMINATION

It is recommended that paragraph HGB-5220 be accepted as it is fundamentally identical to paragraph NG-5220, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156 and

because the NDE methods and examination volumes identified are consistent with those identified in HBB-5000.

HGB-5221, Category A Welded Joints
It is recommended that paragraph HGB-5221 be accepted as it is fundamentally identical to paragraph HBB-5210. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support.

HGB-5222, Category B Welded Joints
It is recommended that paragraph HGB-5222 be accepted as it is fundamentally identical to paragraph HBB-5220. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support.

Note:

> Reference changes have been made in HGB-5222 when compared to HBB-5220 for use with III-5-HGB. HGB-5222(a) references “NG-3351.2,” while HBB-5220(a) references “NB-3351.2”; and HGB-5222(a) references “HGB-5221,” while HBB-5220(a) references “HBB-5210.”
>
> There are slight differences in the ASME BPVC Section III, Division 1 Subsection NB and Subsection NG standards about how joint configurations are described and defined. In all cases, however, the descriptions are similar and provide a reasonable description of the condition and acceptable inspection requirements for those welds. These differences apply in all of the Categories.

HGB-5223, Category C Welded Joints
It is recommended that paragraph HGB-5223 be accepted as written because it is fundamentally identical to paragraph HBB-5230. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support.

Note:

> Reference changes have been made in HGB-5223 when compared to HBB-5230 for use with III-5-HGB. HGB-5223(a) references “NG-3351.3,” while HBB-5230(a) references “NB-3351.3”; HGB-5223(a) references “HGB-5221,” while HBB-5230(a) references “HBB-5210”; HGB-5223(c) references “Figure HGB-5223-1,” while HBB-5230(c) references “Figure NB-4243-1”; and HGB-5223(d) references “Figure HGB-5223-1,” while HBB-5230(d) references “Figure NB-4243-1.”

It is recommended that Figure HGB-5223-1 be accepted as written because it is fundamentally identical to III-1-NB Figure NB-4243-1, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HGB-5224, Category D Welded Joints

It is recommended that paragraph HGB-5224 be accepted as written because it is fundamentally identical to paragraph HBB-5240. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support.

Note:

> A reference change has been made in HGB-5224 when compared to HBB-5240 for use with III-5-HGB. HGB-5224 references "NG-3351.4," while HBB-5240 references "NB-3351.4." In both cases, the HGB and HBB sections take precedence over the requirements of the referenced sections for the same category of vessel welds.

HGB-5224.1, Butt-Welded Nozzles

It is recommended that subparagraph HGB-5224.1 be accepted as written because it is fundamentally identical to paragraph HBB-5242. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support.

Note:

> A reference change has been made in HGB-5224.1 when compared to HBB-5242 for use with III-5-HGB. HGB-5224.1 references "HGB-5221," while HBB-5242 references "HBB-5210." These two paragraphs contain the same general requirements for the inspection of welded joints and components.

HGB-5224.2, Full Penetration Corner-Welded Nozzles

It is recommended that subparagraph HGB-5224.2 be accepted as it is fundamentally identical to paragraph HBB-5243. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support.

Note:

> Reference changes have been made in HGB-5224.2 when compared to HBB-5243 for use with III-5-HGB. HGB-5224.2(a) references "HGB-5221," while HBB-5243(a) references "HBB-5210"; HGB-5224.2(b) references "Figure HGB-5224.2-1," while HBB-5243(b) references "Figure NB-4244(b)-1"; and HGB-5224.2(c) references "Figure HGB-5224.2-1," while HBB-5243(c) references "Figure NB-4244(b)-1."

It is recommended that Figure HGB-5224-2-1 be accepted as written because it is fundamentally identical to III-1-NB Figure NB-4244(b)-1, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. The differences in the figures are that HGB-5224-2.1 does not include the use of an optional backing ring that must be removed prior to inspection, and NB-4244(b)-1 shows the possible use but requires removal prior to inspection.

HGB-5224.3, Deposited Weld Metal as Reinforcement for Openings and Attachment of Nozzles
It is recommended that subparagraph HGB-5224.3 be accepted as written because it is fundamentally identical to paragraph HBB-5244. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support.

Note:

> Reference changes have been made in HGB-5224.3 when compared to HBB-5244 for use with III-5-HGB. HGB-5224.3(a) references “Figure HGB-5224.3-1,” while HBB-5243(a) references “Figure NB-4244(c)-1”; HGB-5224.3(b) references “Figure HGB-5224.3-1,” while HBB-5243(b) references “Figure NB-4244(c)-1.”

It is recommended that Figure HGB-5224.3-1 be accepted as it is fundamentally identical to III-1-NB Figure NB-4244(c)-1, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. The differences between the two figures is that NB-4244(c)-1 indicates that if a backing strip is used, then it shall be removed prior to inspection, and HGB-5244.3-1 does not include a backing strip.

HGB-5224.4, Full Penetration Welds at Oblique Connections
It is recommended that subparagraph HGB-5224.4 be accepted as it is fundamentally identical to paragraph HBB-5246. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support.

Note:

> Reference changes have been made in HGB-5224.4 when compared to HBB-5246 for use with III-5-HGB. HGB-5224.4(a) references “HGB-5221,” while HBB-5246(a) references “HBB-5210”; HGB-5224.4(b)(1) references “Figure HGB-5224.4-1,” while HBB-5246(b)(1) references “Figure NB-4244(e)-1”; and HGB-5224.4(b)(2) references “Figure HGB-5224.4-1,” while HBB-5246(b)(2) references “Figure NB-4244(e)-1.”

It is recommended that Figure HGB-5224.4-1 be accepted as written because it is fundamentally identical to III-1-NB Figure NB-4244(e)-1. The difference between the two figures is that NB-4244(e)-1 shows the possible use of a backing strip and notes that it is to be removed prior to inspection. With the backing strip removed, the figures show the same requirements. NB-4244(e)-1 is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

HGB-5225, Category E Welded Joints
It is recommended that paragraph HGB-5225 be accepted as written. HGB-5225 states that Category E welds are defined in III-1-NG NG-3351.5 and shall be examined in accordance with the requirements of HGB-5221. The requirements of HGB-5221 are detailed and sufficient to examine welds requiring considerably greater ability to handle stresses and loads as Category A components. This results in the Category E welds being examined with considerable rigor over the actual needs.

4.4. MANDATORY APPENDIX HGB-I, RULES FOR STRAIN, DEFORMATION, AND FATIGUE LIMITS AT ELEVATED TEMPERATURES

4.4.1. ARTICLE HGB-I-1000, INTRODUCTION

It is recommended that Mandatory Appendix HGB-1 be accepted as written because it provides rules that may be used by the applicant with respect to evaluation by analysis of strain, deformation, and fatigue limits for components whose load-controlled stresses are evaluated by the rules of III-5-HGB. Article HGB-I-1000 states that load-controlled stresses governed by III-5-HGB are to be evaluated under the rules contained in Nonmandatory Appendix HBB-T.

Note:

Article HGB-I-1000 gives a list of clarifications to Nonmandatory Appendix HBB-T with III-5-HGB. The following clarifications are recommended as acceptable and considered editorial in nature.

III-5-HGB does not use the local primary membrane stress intensity allowable, P_L; therefore, all P_L entries in HBB-T are to be replaced with the general primary membrane stress intensity allowable, P_m.

References to III-1-NB and III-5-HBB in HBB-T remain as referenced.

HBB-T-1325 and HBB-T-1434 do not apply to core support structure evaluations per III-5-HGB.

HBB-T-1435 reference III-A-XIII XIII-3450 is now III-1-NG NG-3228.3 and reference to NB-3653.6 is not applicable to core support structures.

HBB-T-1714 has an additional sentence that states that the stress concentration factor shall not be smaller than the applicable fatigue factor from Table NG-3352-1.

Reference to Test Loadings is not applicable to core support structures because there is no NG-6000.

4.5. MANDATORY APPENDIX HGB-II, RULES FOR CONSTRUCTION OF CORE SUPPORT STRUCTURES, EXTENDED FOR RESTRICTED SERVICE AT ELEVATED TEMPERATURE, WITHOUT EXPLICIT CONSIDERATION OF CREEP AND STRESS-RUPTURE

4.5.1. ARTICLE HGB-II-1000, INTRODUCTION

HGB-II-1100, GENERAL

It is recommended that paragraph HGB-II-1100 be accepted as written because it directs the applicant to use the rules of III-1-NG, which is approved for III-1 use by 10 CFR 50.55a with the

2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, except as modified by article HGB-II-1000.

HGB-II-1110, ASPECTS OF CONSTRUCTION COVERED BY THESE RULES
It is recommended that paragraph HGB-1110 be accepted as written. The purpose of this paragraph is to dictate the aspects of construction covered by these rules. This paragraph states that the rules of III-1-NG apply to core support structures whose service metal temperature does not exceed the III-1 continuous use temperature and that the rules of III-1-NG as modified in III-5-HGB HGB-II apply to core support structures for elevated temperature service.

4.5.2. ARTICLE HGB-II-2000, MATERIALS

HGB-II-2100
It is recommended that paragraph HGB-II-2100 be accepted as written because it directs the applicant to use the rules of III-1-NG, which are approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, except as modified by article HGB-II-2000.

HGB-II-2120

HGB-II-2121, Permitted Material Specifications
It is recommended that paragraph HGB-II-2121 be accepted as written because it is fundamentally identical to paragraph III-1-NG NG-2121, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, except for the minor modification of HGB-II-2121(a) when it is compared to NB-2121(a).

HGB-II-2121(a) is fundamentally identical to NG-2121(a) except for the addition of Table 4, which is for ASME BPVC Section II, Part D bolting materials, and the last sentence.

Note:

> The addition of Table 4 is appropriate for III-5-HGB because it defines design stress intensity values for bolting materials up to the continuous use temperature for III-1 use.
>
> The last sentence is recommended as approved because it solely states that core support structure materials at elevated service should also conform to the material specifications identified in the tables of this Article.

It is recommended that Table HGB-II-2121-1 be accepted as shown. Table HGB-II-2121-1 provides the design stress intensity values for ferritic steels at elevated temperatures in core support structure applications. From Tables HGB-II-3229-1 and HGB-II-3229-4, the yield and ultimate strength, respectively, from 750 °F to 1000 °F for these materials are shown to come from II-D Table Y-1 and Table U, respectively. II-D is an appropriate reference for ASME BPVC material properties that have factors of safety built in producing Code values that are lower than what is found in an applicant's Certified Material Test Report or Certificate of Conformance. For

the temperatures of 1050 °F and 1100 °F, the yield strength values for 2¼/Cr-1Mo are found in Table HGB-II-3229-1 and the ultimate strength can be found in Table HBB-3225-1. Note that the 1¼Cr-½Mo-Si nominal composition only has design stress intensity values up to 900 °F and 750 °F for forgings and plate, respectively. Using the yield and ultimate strength and following the criteria in ASME BPVC Section II, Part D, Mandatory Appendix 2, 2-110, the design stress intensity at temperature for materials of construction from Table 2A and 2B can be determined. The values in Table HGB-II-2121-1 (U.S. Customary Units) are shown to be similar to what is produced following the requirements from ASME BPVC Section II, Part D, Mandatory Appendix 2 as shown below. Discrepancies between values following this methodology and Table HGB-II-2121-1 can be attributed to rounding errors and using Code values listed in ASME BPVC Section II, Part D Certificate of Conformance the actual ASME Code Committee data could not be acquired.

ASME BPVC Table HGB-2121-1 comparison to ASME BPVC Section II Part D Methodology:

Design Stress Intensity [ksi] (Table HGB-II-2121-1 Comparison to Sec. II Part D Methodology)										
Nominal Composition	**Product Form**	**Spec. No.**	**Type/ Grade**	**Class/ Condition/ Temper**	**Min. Tensile Strength [ksi]**	**Min. Yield Strength [ksi]**	**750 °F**		**800 °F**	
							Sec. II Part D Methodology	**HGB-2121-1**	**Sec. II Part D Methodology**	**HGB-2121-1**
1 1/4Cr– 1/2Mo–Si	Forgings	SA–182	F11	2	70	40	19.7	19.7	19.2	19.2
1 1/4Cr– 1/2Mo–Si	Plate	SA–387	11	2	75	45	22.1	22.2		
2 1/4Cr–1Mo	Wld. pipe	SA–691	2 1/4CR	…	60	30	17.9	17.9	17.7	17.9
2 1/4Cr–1Mo	Smls. tube	SA–213	T22	…	60	30	17.9	17.9	17.7	17.9
2 1/4Cr–1Mo	Smls. pipe	SA–335	P22	…	60	30	17.9	17.9	17.7	17.9
2 1/4Cr–1Mo	Forgings	SA–336	F22	1	60	30	17.9	17.9	17.7	17.9
2 1/4Cr–1Mo	Forged pipe	SA–369	FP22	…	60	30	17.9	17.9	17.7	17.9
2 1/4Cr–1Mo	Forgings	SA–182	F22	1	60	30	17.9	17.9	17.7	17.9
2 1/4Cr–1Mo	Smls. & wld. ftgs.	SA–234	WP22	1	60	30	17.9	17.9	17.7	17.9
2 1/4Cr–1Mo	Plate	SA–387	22	1	60	30	17.9	17.9	17.7	17.9
2 1/4Cr–1Mo	Cast pipe	SA–426	CP22	…	70	40	21.5	21.6	20.9	21.0

Design Stress Intensity [ksi] (Table HGB-II-2121-1 Comparison to Sec. II Part D Methodology)										
Nominal Composition	**Product Form**	**Spec. No.**	**Type/ Grade**	**Class/ Condition/ Temper**	**Min. Tensile Strength [ksi]**	**Min. Yield Strength [ksi]**	**850 °F**		**900 °F**	
							Sec. II Part D Methodology	**HGB-2121-1**	**Sec. II Part D Methodology**	**HGB-2121-1**
1 1/4Cr– 1/2Mo–Si	Forgings	SA–182	F11	2	70	40	18.7	18.7	18.1	18.1
1 1/4Cr– 1/2Mo–Si	Plate	SA–387	11	2	75	45				
2 1/4Cr–1Mo	Wld. pipe	SA–691	2 1/4CR	…	60	30	17.5	17.6	17.1	17.2
2 1/4Cr–1Mo	Smls. tube	SA–213	T22	…	60	30	17.5	17.6	17.1	17.2
2 1/4Cr–1Mo	Smls. pipe	SA–335	P22	…	60	30	17.5	17.6	17.1	17.2
2 1/4Cr–1Mo	Forgings	SA–336	F22	1	60	30	17.5	17.6	17.1	17.2
2 1/4Cr–1Mo	Forged pipe	SA–369	FP22	…	60	30	17.5	17.6	17.1	17.2
2 1/4Cr–1Mo	Forgings	SA–182	F22	1	60	30	17.5	17.6	17.1	17.2
2 1/4Cr–1Mo	Smls. & wld. ftgs.	SA–234	WP22	1	60	30	17.5	17.6	17.1	17.2
2 1/4Cr–1Mo	Plate	SA–387	22	1	60	30	17.5	17.6	17.1	17.2
2 1/4Cr–1Mo	Cast pipe	SA–426	CP22	…	70	40	20.0	20.0	19.0	18.9

Design Stress Intensity [ksi] (Table HGB-II-2121-1 Comparison to Sec. II Part D Methodology)										
Nominal Composition	**Product Form**	**Spec. No.**	**Type/ Grade**	**Class/ Condition/ Temper**	**Min. Tensile Strength [ksi]**	**Min. Yield Strength [ksi]**	**950 °F**		**1000 °F**	
							Sec. II Part D Methodology	**HGB-2121-1**	**Sec. II Part D Methodology**	**HGB-2121-1**
1 1/4Cr– 1/2Mo–Si	Forgings	SA–182	F11	2	70	40				
1 1/4Cr– 1/2Mo–Si	Plate	SA–387	11	2	75	45				
2 1/4Cr–1Mo	Wld. pipe	SA–691	2 1/4CR	…	60	30	16.5	16.7	15.8	15.9
2 1/4Cr–1Mo	Smls. tube	SA–213	T22	…	60	30	16.5	16.7	15.8	15.9
2 1/4Cr–1Mo	Smls. pipe	SA–335	P22	…	60	30	16.5	16.7	15.8	15.9
2 1/4Cr–1Mo	Forgings	SA–336	F22	1	60	30	16.5	16.7	15.8	15.9
2 1/4Cr–1Mo	Forged pipe	SA–369	FP22	…	60	30	16.5	16.7	15.8	15.9
2 1/4Cr–1Mo	Forgings	SA–182	F22	1	60	30	16.5	16.7	15.8	15.9
2 1/4Cr–1Mo	Smls. & wld. ftgs.	SA–234	WP22	1	60	30	16.5	16.7	15.8	15.9
2 1/4Cr–1Mo	Plate	SA–387	22	1	60	30	16.5	16.7	15.8	15.9
2 1/4Cr–1Mo	Cast pipe	SA–426	CP22	…	70	40	17.6	17.6	16.0	16.0

Design Stress Intensity [ksi] (Table HGB-II-2121-1 Comparison to Sec. II Part D Methodology)										
Nominal Composition	**Product Form**	**Spec. No.**	**Type/ Grade**	**Class/ Condition/ Temper**	**Min. Tensile Strength [ksi]**	**Min. Yield Strength [ksi]**	**1050 °F**		**1100 °F**	
							Sec. II Part D Methodology	**HGB-2121-1**	**Sec. II Part D Methodology**	**HGB-2121-1**
1 1/4Cr– 1/2Mo–Si	Forgings	SA–182	F11	2	70	40				
1 1/4Cr– 1/2Mo–Si	Plate	SA–387	11	2	75	45				
2 1/4Cr–1Mo	Wld. pipe	SA–691	2 1/4CR	…	60	30	14.9	14.9	13.7	13.9
2 1/4Cr–1Mo	Smls. tube	SA–213	T22	…	60	30	14.9	14.9	13.7	13.9
2 1/4Cr–1Mo	Smls. pipe	SA–335	P22	…	60	30	14.9	14.9	13.7	13.9
2 1/4Cr–1Mo	Forgings	SA–336	F22	1	60	30	14.9	14.9	13.7	13.9
2 1/4Cr–1Mo	Forged pipe	SA–369	FP22	…	60	30	14.9	14.9	13.7	13.9
2 1/4Cr–1Mo	Forgings	SA–182	F22	1	60	30	14.9	14.9	13.7	13.9
2 1/4Cr–1Mo	Smls. & wld. ftgs.	SA–234	WP22	1	60	30	14.9	14.9	13.7	13.9
2 1/4Cr–1Mo	Plate	SA–387	22	1	60	30	14.9	14.9	13.7	13.9
2 1/4Cr–1Mo	Cast pipe	SA–426	CP22	…	70	40	16.4	14.5	14.6	12.7

It is recommended that Table HGB-II-2121-2 be accepted as shown. Table HGB-II-2121-2 provides the design stress intensity values for ferritic steels at elevated temperatures in threaded structural fastener applications. From Tables HGB-II-3229-2 and HGB-II-3229-5, the yield and ultimate strength, respectively, from 750 °F to 1000 °F for these materials are shown to come from ASME BPVC Section II, Part D Table Y-1 and Table U, respectively. ASME BPVC Section II, Part D is an appropriate reference for ASME BPVC material properties that have factors of safety built in producing Code values that are lower than what is found in an applicant's Certified Material Test Report or Certificate of Conformance. Note, the 2¼Cr-1Mo nominal composition only has design stress intensity values up to 900 °F. Using the yield and ultimate strength and following the criteria in II-D, Mandatory Appendix 2, 2-130 for determining the design stress intensity at temperature for bolting materials from ASME BPVC Section II, Part D Table 4 can be determined. The values in Table HGB-II-2121-2 (U.S. Customary Units) are shown to be approximately equal to or lower than what is produced using the requirements from ASME BPVC Section II, Part D, Mandatory Appendix 2 as shown below. Discrepancies between

values following this methodology and Table HGB-II-2121-2 can be attributed to rounding errors and using Code values listed in ASME BPVC Section II, Part D because the actual ASME Code Committee data could not be acquired.

ASME BPVC Table HGB-2121-2 comparison to ASME BPVC Section II Part D Methodology:

Design Stress Intensity [ksi] (Table HGB-II-2121-2 Comparison to Sec. II Part D Methodology)											
Nominal Composition	**Product Form**	**Spec. No.**	**Type/ Grade**	**Class/ Condition/ Temper**	**Size/ Thickness [in.]**	**Min. Tensile Strength [ksi]**	**Min. Yield Strength [ksi]**	**750 °F**		**800 °F**	
								Sec. II Part D Methodology	**HGB-2121-2**	**Sec. II Part D Methodology**	**HGB-2121-2**
1Cr– 1/2Mo–V	Bolting	SA–540	B21	5	2 < t ≤ 8	115	100	26.6	24.1	25.5	22.8
1Cr– 1/2Mo–V	Bolting	SA–540	B21	2	≤4	155	140	32.5	33.8	34.3	31.9
1Cr– 1/2Mo–V	Bolting	SA–540	B21	3	≤6	145	130	30.5	31.4	32.1	29.6
1Cr– 1/2Mo–V	Bolting	SA–540	B21	4	≤6	135	120	28.3	29.0	29.9	27.4
1Cr– 1/2Mo–V	Bolting	SA–540	B21	5	≤2	120	105	25.2	25.3	26.6	23.9
1Cr– 1/2Mo–V	Bolting	SA–193	B16	…	≤2 1/2	125	105	28.4	25.3	31.3	23.9
1Cr– 1/2Mo–V	Bolting	SA–193	B16	…	2 1/2 < t ≤ 4	110	95	23.1	22.9	24.4	21.7
1Cr– 1/2Mo–V	Bolting	SA–193	B16	…	4 < t ≤ 7	100	85	21.0	20.5	22.2	19.4
2 1/4Cr–1Mo	Forgings	SA–336	F22	1	…	60	30	17.9	17.9	17.7	17.9

Design Stress Intensity [ksi] (Table HGB-II-2121-2 Comparison to Sec. II Part D Methodology)											
Nominal Composition	**Product Form**	**Spec. No.**	**Type/ Grade**	**Class/ Condition/ Temper**	**Size/ Thickness [in.]**	**Min. Tensile Strength [ksi]**	**Min. Yield Strength [ksi]**	**850 °F**		**900 °F**	
								Sec. II Part D Methodology	**HGB-2121-2**	**Sec. II Part D Methodology**	**HGB-2121-2**
1Cr– 1/2Mo–V	Bolting	SA–540	B21	5	2 < t ≤ 8	115	100	24.3	21.1	22.9	19.4
1Cr– 1/2Mo–V	Bolting	SA–540	B21	2	≤4	155	140	32.7	29.5	30.9	27.1
1Cr– 1/2Mo–V	Bolting	SA–540	B21	3	≤6	145	130	30.6	27.4	28.9	25.2
1Cr– 1/2Mo–V	Bolting	SA–540	B21	4	≤6	135	120	28.5	25.3	26.9	23.2
1Cr– 1/2Mo–V	Bolting	SA–540	B21	5	≤2	120	105	25.4	22.1	23.9	20.3
1Cr– 1/2Mo–V	Bolting	SA–193	B16	…	≤2 1/2	125	105	31.3	22.1	24.9	20.3
1Cr– 1/2Mo–V	Bolting	SA–193	B16	…	2 1/2 < t ≤ 4	110	95	23.3	20.0	22.1	18.4
1Cr– 1/2Mo–V	Bolting	SA–193	B16	…	4 < t ≤ 7	100	85	21.2	17.9	20.1	16.5
2 1/4Cr–1Mo	Forgings	SA–336	F22	1	…	60	30	17.5	17.6	17.1	17.2

Design Stress Intensity [ksi] (Table HGB-II-2121-2 Comparison to Sec. II Part D Methodology)											
Nominal Composition	**Product Form**	**Spec. No.**	**Type/ Grade**	**Class/ Condition/ Temper**	**Size/ Thickness [in.]**	**Min. Tensile Strength [ksi]**	**Min. Yield Strength [ksi]**	**950 °F**		**1000 °F**	
								Sec. II Part D Methodology	**HGB-2121-2**	**Sec. II Part D Methodology**	**HGB-2121-2**
1Cr– 1/2Mo–V	Bolting	SA–540	B21	5	2 < t ≤ 8	115	100	21.8	17.1	20.4	14.9
1Cr– 1/2Mo–V	Bolting	SA–540	B21	2	≤4	155	140	29.3	23.9	27.5	20.8
1Cr– 1/2Mo–V	Bolting	SA–540	B21	3	≤6	145	130	27.4	22.2	25.7	19.3
1Cr– 1/2Mo–V	Bolting	SA–540	B21	4	≤6	135	120	25.6	20.5	24.0	17.8
1Cr– 1/2Mo–V	Bolting	SA–540	B21	5	≤2	120	105	22.7	18.0	21.3	15.6
1Cr– 1/2Mo–V	Bolting	SA–193	B16	…	≤2 1/2	125	105	23.7	18.0	22.2	15.6
1Cr– 1/2Mo–V	Bolting	SA–193	B16	…	2 1/2 < t ≤ 4	110	95	20.8	16.2	19.4	14.1
1Cr– 1/2Mo–V	Bolting	SA–193	B16	…	4 < t ≤ 7	100	85	18.9	14.5	17.6	12.6
2 1/4Cr–1Mo	Forgings	SA–336	F22	1	…	60	30				

It is recommended that Tables HGB-II-2121-3 and HGB-II-2121-4 be accepted as shown. Tables HGB-II-2121-3 and HGB-II-2121-4 are the design stress intensity values for austenitic and high nickel alloys at elevated temperatures in core support structure and threaded structural fastener applications. From Tables HGB-II-3229-3 and HGB-II-3229-6, the yield and ultimate strength, respectively, from 850 °F to 1000 °F for these materials are shown to come from ASME BPVC Section II, Part D Table Y-1 and Table U, respectively. ASME BPVC Section II, Part D is an appropriate reference for ASME BPVC material properties which have factors of safety built in producing Code values that are lower than what is found in an applicant's Certified

Material Test Report or Certificate of Conformance. The temperatures of 1050 °F and 1100 °F for 316SS and of 1050 °F, 1100 °F, 1150 °F, and 1200 °F for Alloy 800H, use the yield and tensile strength values found in Tables HGB-II-3229-3 and HGB-II-3229-6, respectively, and are not found in ASME BPVC Section II, Part D. Using the yield and ultimate strength and following the criteria in ASME BPVC Section II, Part D, Mandatory Appendix 2, 2-110, the design stress intensity at temperature for materials of construction from Table 2A and 2B can be determined. The values in Tables HGB-II-2121-3 (U.S. Customary Units) and HGB-II-2121-4 (U.S. Customary Units) are shown to be similar to what is produced using the requirements from ASME BPVC Section II, Part D as shown below. Discrepancies between values following this methodology and Tables HGB-II-2121-3 and HGB-II-2121-4 can be attributed to rounding errors and using Code values listed in ASME BPVC Section II, Part D because the actual ASME Code Committee data could not be acquired.

Note:

The material 304SS only has design stress intensity values up to 1000 °F.

The values in Table HGB-II-2121-4 follow this methodology because the materials of construction are not materials found in ASME BPVC Section II, Part D, Table 4.

The comparison table of the ASME BPVC Section II, Part D methodology to tables HGB-II-212-3 and HGB-II-2121-4 has been truncated and does not include every line because the allowable stress intensities are the same within any given material composition with the same yield and tensile strength.

ASME BPVC Tables HGB-2121-3 and HGB-2121-4 comparison to ASME BPVC Section II Part D Methodology:

Design Stress Intensity [ksi]										
Nominal Composition	**Min. Tensile Strength [ksi]**	**Min. Yield Strength [ksi]**	**850 °F**		**900 °F**		**950 °F**		**1000 °F**	
			Sec. II Part D Methodology	**HGB-2121-3 and HGB-2121-4**	**Sec. II Part D Methodology**	**HGB-2121-3 and HGB-2121-4**	**Sec. II Part D Methodology**	**HGB-2121-3 and HGB-2121-4**	**Sec. II Part D Methodology**	**HGB-2121-3 and HGB-2121-4**
18Cr–8Ni	75	30	14.9	14.8	14.6	14.6	14.3	14.3	14.0	14.0
18Cr–8Ni	70	30	14.9	14.8	14.6	14.6	14.3	14.3	14.0	14.0
16Cr–12Ni–2Mo	75	30	15.8	15.7	15.6	15.6	15.4	15.5	15.3	15.4
16Cr–12Ni–2Mo	70	30	15.8	15.7	15.6	15.6	15.4	15.5	15.3	15.4
33Ni–42Fe–21Cr	65	25	14.8	15.1	14.5	14.8	14.2	14.6	14.0	14.4

Design Stress Intensity [ksi]										
Nominal Composition	**Min. Tensile Strength [ksi]**	**Min. Yield Strength [ksi]**	**1050 °F**		**1100 °F**		**1150 °F**		**1200 °F**	
			Sec. II Part D Methodology	**HGB-2121-3 and HGB-2121-4**	**Sec. II Part D Methodology**	**HGB-2121-3 and HGB-2121-4**	**Sec. II Part D Methodology**	**HGB-2121-3 and HGB-2121-4**	**Sec. II Part D Methodology**	**HGB-2121-3 and HGB-2121-4**
18Cr–8Ni	75	30								
18Cr–8Ni	70	30								
16Cr–12Ni–2Mo	75	30	15.0	15.1	14.9	14.8				
16Cr–12Ni–2Mo	70	30	15.0	15.1	14.9	14.8				
33Ni–42Fe–21Cr	65	25	14.2	14.3	14.0	14.1	14.0	13.9	13.8	13.8

HGB-II-2400

HGB-II-2430

HGB-II-2433

HGB-II-2433.2, Acceptance Standards
It is recommended that subparagraph HGB-II-2433.2 be accepted as written because it is fundamentally identical to paragraph HBB-2433. It is an acceptable approach to use the Class A pressure-retaining components construction Code for Class A core support structures.

Note:

> A reference change has been made in HGB-II-2433.2 when compared to HBB-2433.2 for use with III-5-HGB-II. HGB-II-2433.2 references “NG-2130 or NG-4120,” while HBB-2433.2 references “NB-2130 or NB-4120.”

4.5.3. ARTICLE HGB-II-3000, DESIGN

HGB-II-3100
It is recommended that paragraph HGB-II-3100 be accepted as written because it directs the applicant to use the rules of III-1-NG NG-3000, which are approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, except as modified by article HGB-II-3000.

HGB-II-3110

HGB-II-3112

HGB-II-3112.4, Design Stress Intensity Values
It is recommended that subparagraph HGB-II-3112.4 be accepted as written because it is fundamentally identical, except for the extension of higher temperatures, to subparagraph NG-3112.4, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. The extension of the HGB-II-3112.4 from NB-3112.4 is the allowance of Tables HGB-II-2121-1 through HGB-2121-4, which are extensions of ASME BPVC Section II, Part D Subpart 1 Tables 2A and 2B.

HGB-II-3130

HGB-II-3132, Reinforcement for Openings
It is recommended that paragraph HGB-II-3132 be accepted as written because the first sentence is fundamentally identical to paragraph NG-3132, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. The remaining text specifies acceptable requirements that area replacement rules for Class A components can only be used for internal pressure loadings and that other loadings be accounted for by additional engineering analysis.

HGB-II-3133, External Pressure Difference
It is recommended that paragraph HGB-II-3133 be accepted as written because it directs the applicant to follow the rules of paragraph NG-3133, which are approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, or to follow HGB II-3133.7 when the rules of NG 3133 are not applicable due to the nature of the load or geometry.

HGB-II-3133.7, Alternate Rules for Buckling Loadings Due to External Pressure
It is recommended that subparagraph HGB-II-3133.7 be accepted as written because it directs the applicant to use the design factors of Appendix HGB-III to demonstrate compliance with the requirements of paragraph NG 3133.

HGB-II-3200

HGB-II-3210

HGB-II-3211, Requirements for Acceptability
It is recommended that paragraph HGB-II-3211 be accepted as written because it is fundamentally identical, except for additional information in HGB-II-3211(a), to paragraph NG-3211, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. The additional information in HGB-II-3211(a) is recommended as accepted. See Section 4, HGB-II-3211 for further detail.

It is recommended that subparagraph HGB-II-3211(a) be accepted as written because the first sentence is fundamentally identical to subparagraph NG-3211(a). The additional information in HGB-II-3211(a) is recommended as accepted because it directs the applicant to use the S_m values from Tables HGB-II-2121-1 through HGB-2121-4 and states the requirements of III-1-NG NG-2190 applies to austenitic materials that are solution annealed during fabrication and that experience elevated temperatures.

It is recommended that subparagraph HGB-II-3211(b) be accepted as written because it is fundamentally identical to subparagraph NG-3211(b).

It is recommended that subparagraph HGB-II-3211(c) be accepted as written because it is fundamentally identical to subparagraph NG-3211(c).

It is recommended that subparagraph HGB-II-3211(d) be accepted as written because it is fundamentally identical to subparagraph NG-3211(d).

HGB-II-3220
It is recommended that paragraph HGB-II-3220 be accepted as written. This paragraph directs the applicant to follow the rules of III-1-NG NG-3220 with a modification on Note (7) of Table NG-3221-1 that adds text directing the applicant to refer to Tables HGB-II-3222.4-1 through HGB-II-3222.4-4 in this appendix for elevated temperature applications.

HGB-II-3222

HGB-II-3222.4, Analysis for Cyclic Operation

It is recommended that subparagraph HGB-II-3222.4 be accepted as written because it is fundamentally identical, with slight modifications, to subparagraph NG-3222.4, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. The modifications are recommended as acceptable because they allow the applicant to extend III-A Mandatory Appendix I with Tables HGB-II-3222.4-1 through HGB-II-3222.4-4 for elevated temperature use.

It is recommended that Tables HGB-II-3222.4-1 through HGB-II-3222.4-4 for elevated temperature use be accepted as written. The values appear to be acceptable and logical, i.e., the values decrease with an increase in the number of cycles and temperature. It is believed that the additional values were developed in studies funded by the Department of Energy in the 1970s and 1980s during the development of these high-temperature alloys. This data was incorporated in databases for use by the ASME Code Committee for use in developing tables for these alloys.

It is recommended that subsubparagraph HGB-II-3222.4(a) be accepted as written because it is fundamentally identical to subsubparagraph NG-3222.4(a).

It is recommended that subsubparagraph HGB-II-3222.4(b) be accepted as written because it is fundamentally identical to subsubparagraph NG-3222.4(b).

It is recommended that subsubparagraph HGB-II-3222.4(c) be accepted as written because it is fundamentally identical, except for the last two sentences, to subsubparagraph NG-3222.4(c). The last two sentences are considered acceptable because they allow the applicant to extend III-A Mandatory Appendix I with Tables HGB-II-3222.4-1 through HGB-II-3222.4-4 for elevated temperature use.

It is recommended that subsubparagraph HGB-II-3222.4(d) be accepted as written because it is fundamentally identical to subsubparagraph NG-3222.4(d) with modifications for elevated temperature use.

Note:

HGB-II-3222.4(d)(1) is fundamentally identical to NG-3222.4(d)(1).

HGB-II-3222.4(d)(2) is fundamentally identical to NG-3222.4(d)(2) with the additional information allowing the applicant to extend III-A Mandatory Appendix I with Tables HGB-II-3222.4-1 through HGB-II-3222.4-4 for elevated temperature use.

HGB-II-3222.4(d)(2)(-a) is fundamentally identical to NG-3222.4(d)(2)(-a).

HGB-II-3222.4(d)(2)(-b) is fundamentally identical to NG-3222.4(d)(2)(-b).

HGB-II-3222.4(d)(3) is fundamentally identical to NG-3222.4(d)(3).

HGB-II-3222.4(d)(3)(-a) is fundamentally identical to NG-3222.4(d)(3)(-a).

HGB-II-3222.4(d)(3)(-b) is fundamentally identical to NG-3222.4(d)(3)(-b).

HGB-II-3222.4(d)(4) is fundamentally identical to NG-3222.4(d)(4) with additional information allowing the applicant to extend III-A Mandatory Appendix I with Tables HGB-II-3222.4-1 through HGB-II-3222.4-4 for elevated temperature use.

HGB-II-3222.4(d)(4)(-a) is fundamentally identical to NG-3222.4(d)(4)(-a).

HGB-II-3222.4(d)(4)(-b) is fundamentally identical to NG-3222.4(d)(4)(-b).

It is recommended that subsubparagraph HGB-II-3222.4(e) be accepted as written because it is fundamentally identical to subsubparagraph NG-3222.4(e) with modifications for elevated temperature use.

Note:

HGB-II-3222.4(e)(1) is fundamentally identical to NG-3222.4(e)(1).

HGB-II-3222.4(e)(2) is fundamentally identical to NG-3222.4(e)(2).

HGB-II-3222.4(e)(3) is fundamentally identical to NG-3222.4(e)(3) with additional information allowing the applicant to extend III-A Mandatory Appendix I with Tables HGB-II-3222.4-1 through HGB-II-3222.4-4 for elevated temperature use.

HGB-II-3222.4(e)(4) is fundamentally identical to NG-3222.4(e)(4) with additional information allowing the applicant to extend III-A Mandatory Appendix I with Tables HGB-II-3222.4-1 through HGB-II-3222.4-4 for elevated temperature use.

HGB-II-3222.4(e)(5) is fundamentally identical to NG-3222.4(e)(5).

HGB-II-3224

It is recommended that paragraph HGB-II-3224 be accepted as written. This paragraph directs the applicant to follow the rules of III-1-NG NG-3224.1 with a modification on Note (8) of Table NG-3224-1 that adds text directing the applicant to refer to Tables HGB-II-3229-4 through HGB-II-3229-6 in this appendix for elevated temperature applications.

HGB-II-3224.1, Stress Intensity Limits

It is recommended that subparagraph HGB-II-3224.1 be accepted as written because it is fundamentally identical, with slight modifications, to subparagraph NG-3224.1, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. The modifications are recommended as acceptable because they provide conditions, when all present, that may produce invalid and unconservative results when the Stress Ratio Analysis method is used.

It is recommended that subsubparagraph HGB-II-3224.1(a) be accepted as written because it is fundamentally identical to subsubparagraph NG-3224.1(a). Note that HGB-II-3224.1(a)(2) erroneously states NG-3221.3 when it should be NG-3221.2.

It is recommended that subsubparagraph HGB-II-3224.1(b) be accepted as written because it is fundamentally identical to subsubparagraph NG-3224.1(b).

It is recommended that subsubparagraph HGB-II-3224.1(c) be accepted as written because it is fundamentally identical to subsubparagraph NG-3224.1(c).

It is recommended that subsubparagraph HGB-II-3224.1(d) be accepted as written because it is fundamentally identical, with additional information, to subsubparagraph NG-3224.1(d). Note that HGB-II-3224.1(d) erroneously states NG-3213.23 when it should be NG-3213.22. The additional information is recommended as acceptable because it provides a set of conditions, when all present, that may produce invalid and unconservative results when the Stress Ratio Analysis method is used. These conditions are (-a) a low yield-strength-to-ultimate-tensile-strength ratio, (-b) a high uniform elongation value, and (-c) a cross section that can distort under load in a manner that reduces the moment of inertia or that increases the loading on the structure.

It is recommended that subsubparagraph HGB-II-3224.1(e) be accepted as written because it is fundamentally identical to subsubparagraph NG-3224.1(e).

HGB-II-3228

HGB-II-3228.3, Simplified Elastic-Plastic Analysis
It is recommended that subparagraph HGB-II-3228.3 be accepted as written because it is fundamentally identical, except for the permitted materials table and NG-3228.3(e), to subparagraph NG-3228.3, which is approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. The permitted materials and the exclusion of NG-3228.3(e) are recommended as acceptable because the materials listed are specific materials for III-5-HGB use instead of general materials and because NG-3228.3(e) states the III-1 temperature limits are not to be exceeded.

HGB-II-3229, Design Stress Values
It is recommended that paragraph HGB-II-3229 be accepted as written. The first paragraph of HGB-II-3229 is fundamentally identical to paragraph NG-3229 with the additional information allowing the applicant to extend III-A Mandatory Appendix I with Tables HGB-II-3222.4-1 through HGB-II-3222.4-4 for elevated temperature use. The second paragraph of HGB-II-3229 is recommended as acceptable because it details how the applicant extends the design stress intensity values for HGB-II use.

It is recommended that Tables HGB-II-3229-1 through HGB-II-3229-6 for elevated temperature use be accepted as written. The values appear to be acceptable and logical, i.e., points to II-D with the additional values decreasing as temperature increases. It is believed that the additional values were developed in studies funded by the Department of Energy in the 1970s and 1980s during the development of these high-temperature alloys. This data was incorporated in databases for use by the ASME Code Committee in developing tables for these alloys.

HGB-II-3230

HGB-II-3231, Design Conditions
It is recommended that paragraph HGB-II-3231 be accepted as written because it is fundamentally identical, with additional information for elevated temperature use, to paragraph

NG-3231. The additional information is recommended as accepted. See Section 4, HGB-II-3231 for further detail.

It is recommended that subparagraph HGB-II-3231(a) be accepted because it is fundamentally identical to NG-3231(a) with additional information on extending the values to elevated temperature use using the tables provided in this appendix.

It is recommended that subparagraph HGB-II-3231(b) be accepted as written because it is fundamentally identical to NG-3231(b).

It is recommended that subparagraph HGB-II-3231(c) be accepted as written because it adds a note that in evaluating adequacy of threaded structural fasteners, the N certificate holder must account for plastic strain associated with S_m limits for materials where Note 4 of Table HGB-II-2121-4 applies. This is an acceptable, additional requirement not found in NG-3231.

4.5.4. ARTICLE HGB-II-4000, FABRICATION AND INSTALLATION REQUIREMENTS

HGB-II-4100

It is recommended that paragraph HGB-II-4100 be accepted as written because it directs the applicant to use the rules of ASME Section III, Division 1, Article NG, NG-4000, which are approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156, except as modified by article HGB-II-4000.

HGB-II-4200

HGB-II-4230

HGB-II-4233, Alignment Requirements When Component Inside Surface is Inaccessible

It is recommended that paragraph HGB-II-4233 be accepted as written because it is fundamentally identical to paragraph HGB-4233, and HGB-4233 is fundamentally identical to NB-4233(a) and NB-4233(b), which are approved for III-1 use by 10 CFR 50.55a with the 2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156. It is an acceptable approach to use the Class 1 pressure-retaining components construction Code for Class A core support structures since this requirement is not temperature dependent.

Note:

> Reference changes have been made in HGB-4233 when compared to NB-4233 for use with III-5-HGB. HGB-4233(a) references “NG-4232,” while NB-4233(a) references “NB-4232”; and HGB-4233(b) references “NG-4232,” while NB-4233(a) references “NB-4232.”

4.5.5. ARTICLE HGB-II-5000, EXAMINATION REQUIREMENTS

It is recommended that article HGB-II-5000 be accepted as written because it directs the applicant to use the rules of III-1-NG, which is approved for III-1 use by 10 CFR 50.55a with the

2017 edition of the ASME BPVC expected to be incorporated by reference according to 83 FR 56156.

4.6. MANDATORY APPENDIX HGB-III, BUCKLING AND INSTABILITY

4.6.1. ARTICLE HGB-III-1000, GENERAL REQUIREMENTS

It is recommended that the general requirements of article HGB-III-1000 be accepted as written because it acceptably imposes additional limits to account for buckling or instability due to time-independent behavior, which is applicable to all specified Design and Service Loadings.

Specifically:

HGB-III-1000(a) states that the rules of this appendix provide additional limits that are applicable to all specified Design and Service Loadings.

HGB-III-1000(b) states that article HGB-III-2000 distinguishes between load-controlled buckling and strain-controlled buckling. Additionally, it defines the two types of buckling and states that strain-controlled buckling must be avoided to guard against failure of fatigue, excessive strain, and interaction with load-controlled instability. In some cases, relatively high (normally localized) strain is allowed under conditions that naturally limit total strain. Minor (localized) buckling or yielding is limited by the nature of the load and the design of the structure and so poses little risk. Therefore, the statement that strain-controlled buckling must be avoided is conservative.

HGB-III-1000(c) states that when strain-controlled and load-controlled buckling interact, then the Load Factors for load-controlled buckling are to be used for the combination of the two loads. This is conservative because the Load Factors for load-controlled buckling are larger and will guard against buckling in the interactive mode.

HGB-III-1000(d) states that the Load Factors applicable to load-controlled buckling shall be used for strain-controlled buckling when significant elastic follow-up may occur. Large strain concentrations due to elastic follow-up may occur when a small portion of the structure undergoes inelastic strains, while most of the structural system behaves in an elastic manner. This results when structural parts of different flexibility are in series and flexible portions are highly stressed. Therefore, it is conservative to use the Load Factors for load-controlled buckling to guard against buckling when significant elastic follow-up may occur.

HGB-III-1000(e) states that for load-controlled buckling, the effects of initial geometrical imperfections and tolerances shall be considered in the calculation of the instability load.

HGB-III-1000(f) states that for purely strain-controlled buckling, the effects of initial geometrical imperfections and tolerances need not be considered in the calculation of the instability strain.

HGB-III-1000(g) states that the expected minimum stress-strain curve for the material at temperature shall be used.

HGB-III-1000(h) states that the limits of HGB-III-2000 or HGB-III-3000 shall be satisfied for the specified Design and Service Loadings.

4.6.2. ARTICLE HGB-III-2000, BUCKLING LIMITS: TIME-INDEPENDENT BUCKLING

It is recommended that article HGB-III-2000 be accepted as written because the Load Factor for load-controlled buckling and the Strain Factor for strain-controlled buckling must be equal or exceed the values in Table HGB-III-2000-1 for the specified Design and Service Loading to guard against time-independent buckling. This is conservative because the Load/Strain Factors add factors of safety to the design of the core support structure.

It is recommended that Table HGB-III-2000-1 be accepted as written. This table shows the largest factors safety for the Design and Service Level A and B limits with a gradual decrease for the Level C and Level D Service Limits. However, the Time-Independent Buckling Limits in this table have not been independently verified because it is unknown where the ASME BPVC committee members acquired the raw data to populate this table.

4.6.3. ARTICLE HGB-III-3000, ALTERNATIVE PROCEDURES

It is recommended that article HGB-III-3000 be accepted as written because this provides an alternate procedure in lieu of HGB-III-2000, which is more conservative. HGB-III-3000 states that an evaluation of stresses, strains, and deformations resulting from buckling may be used to demonstrate that the component has remained structurally and functionally integral with the specified loads multiplied by the applicable Load Factor. This Article also stipulates that nonlinear, plastic, and initial imperfection effects shall be included. This is conservative because the load to be compared to the specified Design or Service Limits is amplified by the Load Factor, thus reducing the amount of load the core support structure can experience to sufficiently stay below the specified limit.

4.7. MANDATORY APPENDIX HGB-IV, TIME—TEMPERATURE LIMITS

4.7.1. ARTICLE HGB-IV-1000, TIME-TEMPERATURE LIMITS

It is recommended that article HGB-IV-1000 be accepted as written. The approach given in this article appears to be acceptable for a use fraction and is a similar approach to what is found in HGB-3000. HGB-IV-1000 gives the applicant the ability to determine the maximum allowable time at temperature where creep and stress rupture do not need to be acknowledged and states that this method cannot be used if the specified design lifetime exceeds 300,000 hrs.

It is recommended that Figure HGB-IV-1000-1 be accepted as written. The figure appears to be acceptable and shows an expected trend, i.e., time increases as temperature decreases. It is believed that the additional values were developed in studies funded by the Department of Energy in the 1970s and 1980s during the development of these high-temperature alloys. This data was incorporated in databases for use by the ASME Code Committee for use in developing tables for these alloys.

5. SUMMARY

5.1. SUBSECTION HB, CLASS A METALLIC PRESSURE BOUNDARY COMPONENTS, SUBPART B, ELEVATED TEMPERATURE SERVICE

ASME BPVC III-5 HBB-3000 *Design* is recommended for acceptance with a few recommended conditions. The recommended conditions are:

- It is recommended that subsubparagraph HBB-3227.8(d) be rejected as written and supplemented with the requirements of XIII-3710 *Bearing Loads* (2017 Edition) since this error has been identified and corrected in the 2017 Edition of Sec. III Appendices, Mandatory Appendix XIII.
- For socket welded fittings used in pressure-retaining joints in accordance with 10 CFR 50.55a(b)(1)(ii), applicants and licensees may not apply the Section III provisions for welds with leg size less than 1.09* t_n, where t_n is the nominal pipe thickness. This condition applies to Table HBB-3133-1, subparagraph HBB-3643.2, and subsubarticle HBB-3660.

There are notes for the treatment of 9Cr-1Mo-V alloy when it is explicitly called out in Article HBB-3000 with the use of this material governed by the requirements and recommendations of ORNL's report on HBB-2000 *Material*. Since this material was called out specifically in Article HBB-3000, PNNL deemed it necessary to capture this in the notes portion of the recommendation. Article HBB-3000 makes reference to Code Case 1592, ASME BPVC III-1-NB or to the technical judgement of subject matter experts in this area of the code to justify acceptance. Note that most of ASME BPVC III-5 HBB-3000 was identical to Code Case 1592.

ASME BPVC III-5 HBB-4000 *Fabrication and Installation* is recommended for acceptance. Nothing was recommended for rejection or required significant editing to be acceptable. Most of Article HBB-4000 makes reference to ASME BPVC III-1-NB or to the technical judgement of subject matter experts in this area of the code to justify acceptance. This was necessary since Article HBB-4000 was significantly different than the approved Code Case 1593.

ASME BPVC III-5 HBB-5000 *Examination* is recommended for acceptance. Nothing was recommended for rejection or required significant editing to be acceptable. Most of Article HBB-5000 makes reference to Code Case 1594, ASME BPVC III-1-NB or to the technical judgement of subject matter experts in this area of the code to justify acceptance. This was necessary since Article HBB-5000 added a significant amount of additional information than what is found in Code Case 1594. Note that the majority of Code Case 1594 was included in Article HBB-5000.

ASME BPVC III-5 HBB-6000 *Testing* is recommended for acceptance. Nothing was recommended for rejection or required significant editing to be acceptable. Article HBB-6000 makes reference to Code Case 1595, ASME BPVC III-1-NB or to the technical judgement of subject matter experts in this area of the code to justify acceptance. Note that the majority of Code Case 1595 was included in Article HBB-6000.

5.2. SUBSECTION HC, CLASS B METALLIC PRESSURE BOUNDARY COMPONENTS, SUBPART B, ELEVATED TEMPERATURE SERVICE

ASME BPVC III-5 HCB-3000 *Design* is recommended for acceptance with a few recommended conditions. Article HCB-3000 makes reference to ASME BPVC III-1-NC or to the technical judgement of subject matter experts in this area of the code to justify acceptance. The recommended conditions are:

- The information in subsubparagraph HCB-3141.4(b) states if significant geometrical imperfections are initially present, then effects of excessive deformation or strain caused by instability strain under pure strain-controlled buckling must be accounted for. It is recommended that the applicant should also demonstrate in the Design Report that the instability strain under pure stain-controlled buckling due to the effects of geometrical imperfections and tolerances, whether initially present or induced by service, is acceptable when compared to the deformation and strain limits. This is in contrast to what is stated in HCB-3141.4(b).
- For socket welded fittings used in pressure-retaining joints in accordance with 10 CFR 50.55a(b)(1)(ii), applicants and licensees may not apply the Section III provisions for welds with leg size less than 1.09* t_n, where t_n is the nominal pipe thickness. This condition applies to subsubarticle HCB-3150.

ASME BPVC III-5 HCB-4000 *Fabrication and Installation* is recommended for acceptance with one recommended condition. Nothing was recommended for rejection or required significant editing to be acceptable. Article HCB-4000 makes reference to ASME BPVC III-1-NC or to the technical judgement of subject matter experts in this area of the code to justify acceptance. The recommended condition is:

- For socket welded fittings used in pressure-retaining joints in accordance with 10 CFR 50.55a(b)(1)(ii), applicants and licensees may not apply the Section III provisions for welds with leg size less than 1.09* t_n, where t_n is the nominal pipe thickness. This exception applies to paragraph HCB-4427.

The two paragraphs in HCB-5000 *Examination* are recommended for acceptance. Nothing was recommended for rejection or required significant editing to be acceptable. Article HCB-5000 makes reference to ASME BPVC III-1-NC or to the technical judgement of subject matter experts in this area of the code to justify acceptance

ASME BPVC III-5 HCB-6000 *Testing* is recommended for acceptance. Nothing was recommended for rejection or required significant editing to be acceptable. Article HCB-6000 makes reference to ASME BPVC III-5-HBB, ASME BPVC III-1-NC or to the technical judgement of subject matter experts in this area of the code to justify acceptance.

5.3. SUBSECTION HG, CLASS A METALLIC CORE SUPPORT STRUCTURES, SUBPART B, ELEVATED TEMPERATURE SERVICE

ASME BPVC III-5 HGB-3000 *Design* is recommended for acceptance with a recommended condition. The recommended condition is:

- It is recommended that subsubparagraph HGB-3227.8(d) be rejected as written and supplemented with the requirements of NG-3227.1 Bearing Loads (2017 Edition) since this error has been identified and corrected in the 2017 Edition of Sec. III Div. 1 Sub. NG.

There are notes for the treatment of 9Cr-1Mo-V alloy when it is explicitly called out in Article HGB-3000 with the use of this material governed by the requirements and recommendations of ORNL's report on HGB-2000 *Material*. Since this material was called out specifically in Article HGB-3000, PNNL deemed it necessary to capture this in the notes portion of the recommendation. Article HGB-3000 makes reference to Code Case 1592, ASME BPVC III-5-HBB, ASME BPVC III-1-NB, ASME BPVC III-1-NG or to the technical judgement of subject matter experts in this area of the code to justify acceptance.

ASME BPVC III-5 HGB-4000 *Fabrication and Installation* is recommended for acceptance. Nothing was recommended for rejection or required significant editing to be acceptable. Article HGB-4000 makes reference to ASME BPVC III-5-HBB, ASME BPVC III-1-NB, ASME BPVC III-1-NG or to the technical judgement of subject matter experts in this area of the code to justify acceptance.

ASME BPVC III-5 HGB-5000 *Examination* is recommended for acceptance. Nothing was recommended for rejection or required significant editing to be acceptable. Article HGB-5000 makes reference to ASME BPVC III-5-HBB, ASME BPVC III-1-NB, ASME BPVC III-1-NG or to the technical judgement of subject matter experts in this area of the code to justify acceptance.

5.4. MANDATORY APPENDIX HGB-I, RULES FOR STRAIN, DEFORMATION, AND FATIGUE LIMITS AT ELEVATED TEMPERATURES

ASME BPVC Mandatory Appendix HGB-I *Rules for Strain Deformation, and Fatigue Limits at Elevated Temperatures* is recommended for acceptance with recommended conditions. Nothing was recommended for rejection or required significant editing to be acceptable. Article HGB-I-1000 used the technical judgement of subject matter experts in this area of the code to justify acceptance. The recommended conditions are:

- Article HGB-I-1000 gives a list of clarifications to Nonmandatory Appendix HBB-T with III-5-HGB. The following clarifications are recommended as acceptable and considered editorial in nature.

- III-5-HGB does not use the local primary membrane stress intensity allowable, P_L; therefore, all P_L entries in HBB-T are to be replaced with the general primary membrane stress intensity allowable, P_m.
- References to III-1-NB and III-5-HBB in HBB-T remain as referenced.
- HBB-T-1325 and HBB-T-1434 do not apply to core support structure evaluations per III-5-HGB.
- HBB-T-1435 reference III-A-XIII XIII-3450 is now III-1-NG NG-3228.3 and reference to NB-3653.6 is not applicable to core support structures.
- HBB-T-1714 will have an additional sentence that states the stress concentration factor shall not be smaller than the applicable fatigue factor from Table NG-3352-1.
- Reference to Test Loadings is not applicable to core support structures since there is no NG-6000.

5.5. MANDATORY APPENDIX HGB-II, RULES FOR CONSTRUCTION OF CORE SUPPORT STRUCTURES, EXTENDED FOR RESTRICTED SERVICE AT ELEVATED TEMPERATURE, WITHOUT EXPLICIT CONSIDERATION OF CREEP AND STRESS-RUPTURE

ASME BPVC III-5 HGB-II-1000 *Introduction* is recommended for acceptance. Nothing was recommended for rejection or required significant editing to be acceptable. Article HGB-II-1000 makes reference to ASME BPVC III-1-NG or to the technical judgement of subject matter experts in this area of the code to justify acceptance.

ASME BPVC III-5 HGB-II-2000 *Materials* is recommended for acceptance. Nothing was recommended for rejection or required significant editing to be acceptable. Article HGB-II-2000 makes reference to ASME BPVC III-1-NG or to the technical judgement of subject matter experts in this area of the code to justify acceptance.

ASME BPVC III-5 HGB-II-3000 *Design* is recommended for acceptance. Nothing was recommended for rejection or required significant editing to be acceptable. Article HGB-II-3000 makes reference to ASME BPVC III-5-HGB, ASME BPVC III-1-NB, ASME BPVC III-1-NG or to the technical judgement of subject matter experts in this area of the code to justify acceptance.

ASME BPVC III-5 HGB-II-4000 *Fabrication and Installation Requirements* is recommended for acceptance. Nothing was recommended for rejection or required significant editing to be acceptable. Article HGB-II-4000 makes reference to ASME BPVC III-5-HGB, ASME BPVC III-1-NB, ASME BPVC III-1-NG or to the technical judgement of subject matter experts in this area of the code to justify acceptance.

ASME BPVC III-5 HGB-II-5000 *Examination* is recommended for acceptance. Nothing was recommended for rejection or required significant editing to be acceptable. Article HGB-II-5000

makes reference to ASME BPVC III-1-NG or to the technical judgement of subject matter experts in this area of the code to justify acceptance.

5.6. MANDATORY APPENDIX HGB-III, BUCKLING AND INSTABILITY

ASME BPVC III-5 HGB-III-1000 *General Requirements* is recommended for acceptance. Nothing was recommended for rejection or required significant editing to be acceptable. Article HGB-III-1000 makes reference to the technical judgement of subject matter experts in this area of the code to justify acceptance.

ASME BPVC III-5 HGB-III-2000 *Buckling Limits* is recommended for acceptance. Nothing was recommended for rejection or required significant editing to be acceptable. Article HGB-III-2000 makes reference to the technical judgement of subject matter experts in this area of the code to justify acceptance.

ASME BPVC III-5 HGB-III-3000 *Alternative* is recommended for acceptance. Nothing was recommended for rejection or required significant editing to be acceptable. Article HGB-III-3000 makes reference to the technical judgement of subject matter experts in this area of the code to justify acceptance.

5.7. MANDATORY APPENDIX HGB-IV, TIME—TEMPERATURE LIMITS

ASME BPVC III-5 HGB-IV-1000 *Time-Temperature Limits* is recommended for acceptance. Nothing was recommended for rejection or required significant editing to be acceptable. Article HGB-IV-1000 makes reference to ASME BPVC III-5-HGB and to the technical judgement of subject matter experts in this area of the code to justify acceptance.

6. REFERENCES

1. ASME Boiler and Pressure Vessel Code, Section III, “Rules for Construction of Nuclear Power Plant Components,” Division I, American Society of Mechanical Engineers, New York, NY.[1]

2. ASTM A 262-70, “Standard Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels,” American Society for Testing and Materials, West Conshohocken, PA.[2]

3. ASTM A 708-74, “Practice for Detection of Susceptibility to Intergranular Corrosion in Severely Sensitized Austenitic Stainless Steels,” American Society for Testing and Materials, West Conshohocken, PA.[2]

4. Code of Federal Regulations, Title 10, Energy, Part 50, “Domestic Licensing of Production and Utilization Facilities” (10 CFR Part 50), U.S. Nuclear Regulatory Commission, Washington, DC.

5. NUREG/CR-3526, “Impact of Changes in Damping and Spectrum Peak Broadening on the Seismic Response of Piping Systems,” U.S. Nuclear Regulatory Commission, Washington, DC.

6. NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants (LWR Edition),” Section 9.5.1, “Fire Protection System,” U.S. Nuclear Regulatory Commission, Washington, DC.

7. Paperwork Reduction Act of 1995 (Public Law 104-13), United States Code, Title 44, “Public Printing and Documents,” Chapter 35, “Coordination of Federal Information Policy” (44 U.S.C. 3501 et seq.), 104th Congress of the United States of America, Washington, DC.[3]

8. Regulatory Guide 1.122, “Development of Floor Design Response Spectra for Seismic Design of Floor-Supported Equipment or Components,” U.S. Nuclear Regulatory Commission, Washington, DC.

9. Regulatory Guide 1.147, “Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1,” U.S. Nuclear Regulatory Commission, Washington, DC.

10. Regulatory Guide 1.192, “Operation and Maintenance Code Case Acceptability, ASME OM Code,” U.S. Nuclear Regulatory Commission, Washington, DC.

---

[1] Copies may be purchased from the American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990; phone (212) 591-8500; fax (212) 591-8501; www.asme.org.

[2] Copies of ASTM standards may be purchased from the American Society for Testing and Materials, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, Pennsylvania 19428-2959; phone (610) 832-9585. Purchase information is available through the ASTM Web site at www.astm.org.

[3] The Paperwork Reduction Act of 1995 (44 U.S.C. 3501 *et seq*.) is available electronically through the *Federal Register* Web site administered by the U.S. National Archives and Records Administration, at www.archives.gov.

11. Regulatory Guide 1.193, “ASME Code Cases Not Approved for Use,” U.S. Nuclear Regulatory Commission, Washington, DC.

12. Regulatory Guide 1.31, “Control of Ferrite Content in Stainless Steel Weld Metal,” U.S. Nuclear Regulatory Commission, Washington, DC.

13. Regulatory Guide 1.44, “Control of the Use of Sensitized Stainless Steel,” U.S. Nuclear Regulatory Commission, Washington, DC.

14. Regulatory Guide 1.61, “Damping Values for Seismic Design of Nuclear Power Plants,” U.S. Nuclear Regulatory Commission, Washington, DC.

15. Regulatory Guide 1.67, “Installation of Over-Pressure Protection Devices,” U.S. Nuclear Regulatory Commission, Washington, DC.