

**SECTION III**  
Rules for Construction of  
Nuclear Facility Components

**2021** ASME Boiler and  
Pressure Vessel Code  
An International Code

**Division 5**  
High Temperature Reactors

Markings such as “ASME,” “ASME Standard,” or any other marking including “ASME,” ASME logos, or the ASME Single Certification Mark shall not be used on any item that is not constructed in accordance with all of the applicable requirements of the Code or Standard. Use of the ASME Single Certification Mark requires formal ASME certification; if no certification program is available, such ASME markings may not be used. (For Certification and Accreditation Programs, see <https://www.asme.org/certification-accreditation>.)

Items produced by parties not formally possessing an ASME Certificate may not be described, either explicitly or implicitly, as ASME certified or approved in any code forms or other document.

AN INTERNATIONAL CODE

# 2021 ASME Boiler & Pressure Vessel Code

2021 Edition

July 1, 2021



## RULES FOR CONSTRUCTION OF NUCLEAR FACILITY COMPONENTS

### Division 5

---

### High Temperature Reactors

ASME Boiler and Pressure Vessel Committee  
on Construction of Nuclear Facility Components



The American Society of  
Mechanical Engineers

Two Park Avenue • New York, NY • 10016 USA

Date of Issuance: July 1, 2021

This international code or standard was developed under procedures accredited as meeting the criteria for American National Standards and it is an American National Standard. The Standards Committee that approved the code or standard was balanced to assure that individuals from competent and concerned interests have had an opportunity to participate. The proposed code or standard was made available for public review and comment that provides an opportunity for additional public input from industry, academia, regulatory agencies, and the public-at-large.

ASME does not “approve,” “certify,” “rate,” or “endorse” any item, construction, proprietary device, or activity.

ASME does not take any position with respect to the validity of any patent rights asserted in connection with any items mentioned in this document, and does not undertake to insure anyone utilizing a standard against liability for infringement of any applicable letters patent, nor assume any such liability. Users of a code or standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, is entirely their own responsibility.

Participation by federal agency representative(s) or person(s) affiliated with industry is not to be interpreted as government or industry endorsement of this code or standard.

ASME accepts responsibility for only those interpretations of this document issued in accordance with the established ASME procedures and policies, which precludes the issuance of interpretations by individuals.

The endnotes and preamble in this document (if any) are part of this American National Standard.



ASME Collective Membership Mark



ASME Single Certification Mark

"ASME" and the above ASME symbols are registered trademarks of The American Society of Mechanical Engineers.

No part of this document may be reproduced in any form, in an electronic retrieval system or otherwise, without the prior written permission of the publisher.

Library of Congress Catalog Card Number: 56-3934  
Printed in the United States of America

Adopted by the Council of The American Society of Mechanical Engineers, 1914; latest edition 2021.

The American Society of Mechanical Engineers  
Two Park Avenue, New York, NY 10016-5990

Copyright © 2021 by  
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS  
All rights reserved

# TABLE OF CONTENTS

List of Sections .....	xxv
Foreword .....	xxvii
Statement of Policy on the Use of the ASME Single Certification Mark and Code Authorization in Advertising .....	xxix
Statement of Policy on the Use of ASME Marking to Identify Manufactured Items .....	xxix
Submittal of Technical Inquiries to the Boiler and Pressure Vessel Standards Committees .....	xxx
Personnel .....	xxxiii
Organization of Section III .....	liv
Summary of Changes .....	lvii
List of Changes in Record Number Order .....	lxi
Cross-Referencing and Stylistic Changes in the Boiler and Pressure Vessel Code .....	lxii
<b>Subsection HA</b>	
<b>Subpart A</b>	
<b>Article HAA-1000</b>	
HAA-1100	
HAA-1110	
HAA-1120	
HAA-1130	
<b>Article HAA-2000</b>	
HAA-2100	
HAA-2120	
HAA-2130	
<b>Article HAA-3000</b>	
HAA-3100	
HAA-3120	
HAA-3200	
HAA-3250	
<b>Article HAA-7000</b>	
HAA-7100	
<b>Article HAA-8000</b>	
HAA-8100	
HAA-8110	
HAA-8200	
HAA-8210	
HAA-8300	
HAA-8310	
HAA-8400	
HAA-8410	
<b>Article HAA-9000</b>	
HAA-9100	
HAA-9200	
<b>General Requirements</b> .....	1
<b>Metallic Materials</b> .....	1
<b>Introduction</b> .....	1
General .....	1
Scope .....	1
Definitions .....	1
Limits of These Rules .....	1
<b>Classification of Components and Supports</b> .....	3
.....	3
Purpose of Classifying Items of a Nuclear Power Plant .....	3
Classifications and Rules of Division 5 .....	3
<b>Responsibilities and Duties</b> .....	4
.....	4
Certification .....	4
.....	4
Provision of Design Specifications .....	4
<b>Reference Standards</b> .....	5
General Requirements .....	5
<b>Nameplates, Stamping With the Certification Mark, and Reports</b> .....	6
Authorization to Perform Code Activities .....	6
General .....	6
Nameplates and Stamping With Certification Mark .....	6
General Requirements .....	6
Certification Mark .....	6
General Requirements .....	6
Data Reports .....	6
General Requirements .....	6
<b>Glossary</b> .....	10
Introduction .....	10
Definitions .....	10

<b>Subpart B</b>	<b>Graphite and Composite Materials</b> .....	11
<b>Article HAB-1000</b>	<b>Introduction</b> .....	11
HAB-1100	General .....	11
HAB-1110	Scope .....	11
HAB-1120	Definitions .....	11
HAB-1130	Limits of These Rules .....	11
HAB-1140	Use of Code Editions and Cases .....	11
HAB-1150	Units of Measurement .....	12
HAB-1200	General Requirements for Items and Installation .....	12
HAB-1210	Core Assembly .....	12
HAB-1220	Materials .....	12
HAB-1280	Installation .....	12
<b>Article HAB-2000</b>	<b>Classification of Core Components</b> .....	13
HAB-2100	General Requirements .....	13
HAB-2110	Scope .....	13
HAB-2130	Code Classes and Rules of Division 5 .....	13
HAB-2140	Design Basis .....	13
<b>Article HAB-3000</b>	<b>Responsibilities and Duties</b> .....	15
HAB-3100	General .....	15
HAB-3110	Responsibilities Versus Legal Liabilities .....	15
HAB-3120	Certification .....	15
HAB-3200	Owner's Responsibilities .....	16
HAB-3220	Categories of the Owner's Responsibilities .....	16
HAB-3230	Owner's Certificate .....	16
HAB-3240	Provision of Adequate Supporting Structures .....	17
HAB-3250	Provision of Design Specifications .....	17
HAB-3260	Review of Design Report .....	18
HAB-3280	Owner's Data Report and Filing .....	18
HAB-3290	Owner's Responsibility for Records .....	18
HAB-3300	Responsibilities of a Designer .....	18
HAB-3320	Categories of the Designer's Responsibility .....	18
HAB-3330	Obtaining a Certificate .....	18
HAB-3340	Design Drawings and Construction Specification .....	18
HAB-3350	Requirements for Design Output Documents .....	19
HAB-3360	Certification of the Construction Specification, Design Drawings, and Design Report .....	19
HAB-3370	Revision of Design Drawings and Construction Specification ...	19
HAB-3380	Certification of Construction Report .....	19
HAB-3400	Responsibilities of a GC Certificate Holder .....	20
HAB-3420	Categories of the GC Certificate Holder's Responsibilities .....	20
HAB-3430	Obtaining a Certificate .....	20
HAB-3440	Compliance With This Subpart and <a href="#">Subsection HH</a> .....	20
HAB-3450	Construction Documents .....	20
HAB-3460	Responsibility for Quality Assurance .....	21
HAB-3800	Material Organizations .....	21
HAB-3820	Certification or Qualification of Material Organizations .....	21
HAB-3830	Responsibilities of Material Organizations .....	21
HAB-3840	Evaluation of the Program .....	21
HAB-3860	Certification Requirements .....	23
<b>Article HAB-4000</b>	<b>Quality Assurance Requirements</b> .....	25
HAB-4100	Requirements .....	25
HAB-4110	Scope and Applicability .....	25
HAB-4120	Definitions .....	25
HAB-4130	Establishment and Implementation .....	25

HAB-4500	Graphite and Composite Material Organization Quality System	
	Program Requirements	29
HAB-4550	Quality System Program Requirements	29
<b>Article HAB-5000</b>	<b>Authorized Inspection</b>	34
HAB-5100	Introduction	34
HAB-5110	Applicability	34
HAB-5120	Performance of Inspection	34
HAB-5130	Access for Inspection Agency Personnel	35
HAB-5200	Duties of Inspectors	35
HAB-5210	General Inspection Duties	35
HAB-5220	Categories of Duties for Inspectors	35
HAB-5230	Scope of Work, Design Specifications, and Design Reports	35
HAB-5240	Quality Assurance Programs	36
HAB-5250	Qualification Records	36
HAB-5260	Materials and Core Components	36
HAB-5270	Examinations and Tests	36
HAB-5290	Data Reports and Construction Reports	36
HAB-5300	Responsibilities of the Authorized Inspection Agency	37
<b>Article HAB-7000</b>	<b>Reference Standards</b>	38
HAB-7100	General Requirements	38
<b>Article HAB-8000</b>	<b>Certificates and Data Reports</b>	39
HAB-8100	Authorization to Perform Code Activities	39
HAB-8110	General	39
HAB-8120	Scope of Certificates	39
HAB-8130	Inspection Agreement Required	39
HAB-8140	Quality Assurance Program Requirements	39
HAB-8150	Application for Certification	39
HAB-8160	Evaluation	39
HAB-8170	Issuance	39
HAB-8180	Renewal	40
HAB-8200	Nameplates	40
HAB-8400	Data Reports	40
HAB-8410	General Requirements	40
HAB-8420	Owner's Data Report	40
<b>Article HAB-9000</b>	<b>Glossary</b>	42
HAB-9100	Introduction	42
HAB-9200	Definitions	42
<b>Subsection HB</b>	<b>Class A Metallic Pressure Boundary Components</b>	45
<b>Subpart A</b>	<b>Low Temperature Service</b>	45
<b>Article HBA-1000</b>	<b>Introduction</b>	45
HBA-1100	General	45
HBA-1110	Scope	45
<b>Article HBA-7000</b>	<b>Overpressure Protection</b>	46
HBA-7800	Marking, Stamping With Certification Mark, and Data Reports	46
HBA-7810	Pressure Relief Valves	46
<b>Article HBA-8000</b>	<b>Nameplates, Stamping With the Certification Mark, and Reports</b>	47
HBA-8100	Requirements	47
<b>Subpart B</b>	<b>Elevated Temperature Service</b>	48
<b>Article HBB-1000</b>	<b>Introduction</b>	48
HBB-1100	General	48

HBB-1110	Scope .....	48
HBB-1120	Temperature and Service Life Limits .....	49
HBB-1130	Organization of <a href="#">Subsection HB, Subpart B</a> .....	49
<b>Article HBB-2000</b>	<b>Material</b> .....	50
HBB-2100	.....	50
HBB-2120	Pressure-Retaining Materials .....	50
HBB-2160	Deterioration of Material in Service .....	50
HBB-2400	.....	51
HBB-2430	.....	51
HBB-2500	.....	52
HBB-2530	.....	52
HBB-2800	Fatigue Acceptance Test .....	52
<b>Article HBB-3000</b>	<b>Design</b> .....	53
HBB-3100	General Requirements for Design .....	53
HBB-3110	Scope, Acceptability, and Loadings .....	53
HBB-3120	Special Considerations .....	55
HBB-3130	General Design Rules .....	55
HBB-3200	Design by Analysis .....	57
HBB-3210	Design Criteria .....	57
HBB-3220	Design Rules and Limits for Load-Controlled Stresses in Structures Other Than Bolts .....	62
HBB-3230	Stress Limits for Load-Controlled Stresses on Bolts .....	75
HBB-3240	Special Requirements for Elevated Temperature Components ..	75
HBB-3250	Limits on Deformation-Controlled Quantities .....	76
HBB-3300	Vessel Designs .....	76
HBB-3310	General Requirements .....	76
HBB-3330	Openings and Reinforcement .....	76
HBB-3350	Design of Welded Construction .....	77
HBB-3360	Special Vessel Requirements .....	80
HBB-3400	Design of Class A Pumps .....	81
HBB-3410	General Requirements .....	81
HBB-3420	Design Considerations .....	82
HBB-3430	Pump Types .....	83
HBB-3500	Design of Class A Valves .....	83
HBB-3510	Design Requirements .....	83
HBB-3520	.....	83
HBB-3540	.....	83
HBB-3550	Cyclic Loading Requirements .....	83
HBB-3600	Piping Design .....	84
HBB-3610	General Requirements .....	84
HBB-3620	Design Considerations .....	84
HBB-3640	Pressure Design of Components .....	85
HBB-3650	Analysis of Piping Components .....	86
HBB-3660	Design of Welds .....	86
HBB-3670	Special Piping Requirements .....	87
<b>Article HBB-4000</b>	<b>Fabrication and Installation</b> .....	88
HBB-4100	General Requirements .....	88
HBB-4110	Introduction .....	88
HBB-4200	.....	88
HBB-4210	.....	88
HBB-4240	Special Joints and Fittings — Added Rules for Division 1, NB-4240	89
HBB-4400	.....	89
HBB-4420	.....	89

<b>Article HBB-5000</b>	<b>Examination</b> .....	90
HBB-5100	General Requirements for Examination .....	90
HBB-5110	General Requirements .....	90
HBB-5130	Examination of Weld Edge Preparation Surfaces .....	90
HBB-5200	Required Examination of Welds .....	90
HBB-5210	Category A Vessel Welded Joints and Longitudinal Welded Joints in Other Components .....	90
HBB-5220	Category B Vessel Welded Joints and Circumferential Welded Joints in Other Components .....	90
HBB-5230	Category C Vessel Welded Joints and Similar Welded Joints in Other Components .....	91
HBB-5240	Category D Vessel Welded Joints and Branch and Piping Connec- tions in Other Components .....	91
HBB-5260	Fillet, Socket, and Attachment Welds .....	92
<b>Article HBB-6000</b>	<b>Testing</b> .....	93
HBB-6100	General Requirements .....	93
HBB-6110	Scope of Testing .....	93
HBB-6120	Preparation for Testing .....	94
HBB-6200	Hydrostatic Tests .....	95
HBB-6210	Hydrostatic Testing Procedure .....	95
HBB-6220	Hydrostatic Test Pressure Requirements .....	95
HBB-6300	Pneumatic Tests .....	96
HBB-6310	Pneumatic Testing Procedures .....	96
HBB-6320	Pneumatic Test Pressure Requirements .....	96
HBB-6400	Pressure Test Gages .....	97
<b>Article HBB-7000</b>	<b>Overpressure Protection</b> .....	98
HBB-7100	General Requirements .....	98
HBB-7110	Scope .....	98
HBB-7130	Verification of the Operation of Pressure Relief Devices .....	98
HBB-7170	Permitted Use of Pressure Relief Devices .....	98
HBB-7200	Content of Overpressure Protection Report .....	98
HBB-7300	Relieving Capacity .....	98
HBB-7600	Nonreclosing Pressure Relief Devices .....	99
HBB-7610	Use of Rupture Disk Devices .....	99
HBB-7620	.....	99
HBB-7800	Marking, Stamping With Certification Mark, and Data Reports ..	99
HBB-7810	Pressure Relief Valves .....	99
<b>Article HBB-8000</b>	<b>Nameplates, Stamping With the Certification Mark, and     Reports</b> .....	100
HBB-8100	Requirements .....	100
<b>Mandatory Appendix HBB-I-14</b>	<b>Tables and Figures</b> .....	101
<b>Mandatory Appendix HBB-II</b>	<b>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</b> .....	145
<b>Article HBB-II-1000</b>	<b>Scope</b> .....	145
<b>Article HBB-II-2000</b>	<b>Material</b> .....	146
<b>Article HBB-II-3000</b>	<b>Design</b> .....	147
<b>Article HBB-II-4000</b>	<b>Fabrication and Installation</b> .....	164
<b>Article HBB-II-5000</b>	<b>Examination</b> .....	165
<b>Article HBB-II-6000</b>	<b>Testing</b> .....	166

<b>Article HBB-II-7000</b>	<b>Overpressure Protection</b> .....	167
<b>Nonmandatory Appendix HBB-T</b>	<b>Rules for Strain, Deformation, and Fatigue Limits at Elevated Temperatures</b> .....	168
HBB-T-1100	Introduction .....	168
HBB-T-1200	Deformation Limits for Functional Requirements .....	168
HBB-T-1300	Deformation and Strain Limits for Structural Integrity .....	168
HBB-T-1400	Creep–Fatigue Evaluation .....	174
HBB-T-1500	Buckling and Instability .....	193
HBB-T-1700	Special Requirements .....	194
HBB-T-1800	Isochronous Stress–Strain Relations .....	199
<b>Nonmandatory Appendix HBB-U</b>	<b>Guidelines for Restricted Material Specifications to Improve Performance in Certain Service Applications</b> .....	284
HBB-U-1100	Scope .....	284
HBB-U-1200	Service Conditions .....	284
HBB-U-1300	Recommended Restrictions .....	284
<b>Nonmandatory Appendix HBB-Y</b>	<b>Guidelines for Design Data Needs for New Materials</b> .....	286
<b>Article HBB-Y-1000</b>	<b>Introduction</b> .....	286
HBB-Y-1100	Scope .....	286
<b>Article HBB-Y-2000</b>	<b>Load-Controlled Limits</b> .....	287
HBB-Y-2100	Time-Independent Data .....	287
HBB-Y-2200	Time-Dependent Data .....	287
HBB-Y-2300	Requirements for Welded Construction .....	288
<b>Article HBB-Y-3000</b>	<b>Deformation-Controlled Limits</b> .....	289
HBB-Y-3100	Isochronous Stress–Strain Curves .....	289
HBB-Y-3200	Relaxation Strength .....	289
HBB-Y-3300	Creep–Fatigue Data .....	289
HBB-Y-3400	Creep–Fatigue Data for Weldments .....	290
HBB-Y-3500	Cyclic Stress–Strain Curves .....	290
HBB-Y-3600	Inelastic Constitutive Model .....	291
HBB-Y-3700	Huddleston Multiaxial Failure Criterion .....	291
HBB-Y-3800	Time–Temperature Limits for External Pressure Charts .....	291
<b>Article HBB-Y-4000</b>	<b>Other Considerations</b> .....	292
HBB-Y-4100	Cold-Forming Limits .....	292
HBB-Y-4200	Environmental Effects .....	292
<b>Subsection HC</b>	<b>Class B Metallic Pressure Boundary Components</b> .....	293
<b>Subpart A</b>	<b>Low Temperature Service</b> .....	293
<b>Article HCA-1000</b>	<b>Introduction</b> .....	293
HCA-1100	General .....	293
HCA-1110	Scope .....	293
<b>Article HCA-8000</b>	<b>Nameplates, Stamping With the Certification Mark, and Reports</b> .....	294
HCA-8100	Requirements .....	294
<b>Subpart B</b>	<b>Elevated Temperature Service</b> .....	295
<b>Article HCB-1000</b>	<b>Introduction</b> .....	295
HCB-1100	General .....	295
HCB-1110	Scope .....	295
HCB-1120	Alternative Rules .....	296

<b>Article HCB-2000</b>	<b>Material</b> .....	297
HCB-2100	General Requirements for Material .....	297
HCB-2400	.....	297
HCB-2430	.....	297
HCB-2500	.....	297
HCB-2570	.....	297
<b>Article HCB-3000</b>	<b>Design</b> .....	298
HCB-3100	General Design .....	298
HCB-3110	.....	298
HCB-3140	Buckling Instability Loadings .....	298
HCB-3150	Limitations on Use .....	299
HCB-3160	Components Containing Lethal or Hazardous Substances .....	299
HCB-3300	Vessel Design .....	299
HCB-3310	General Requirements .....	299
HCB-3400	Pump Design .....	300
HCB-3500	Valve Design .....	300
HCB-3510	General Requirements .....	300
HCB-3600	Piping Design .....	300
HCB-3630	General Requirements .....	300
<b>Article HCB-4000</b>	<b>Fabrication and Installation</b> .....	302
HCB-4100	General Requirements .....	302
HCB-4160	Components Containing Lethal or Hazardous Substances .....	302
HCB-4200	.....	302
HCB-4210	.....	302
HCB-4400	.....	303
HCB-4420	.....	303
<b>Article HCB-5000</b>	<b>Examination</b> .....	305
HCB-5100	General Requirements for Examination .....	305
HCB-5160	Components Containing Lethal or Hazardous Substances .....	305
<b>Article HCB-6000</b>	<b>Testing</b> .....	306
HCB-6100	General Requirements .....	306
HCB-6110	.....	306
HCB-6600	.....	306
HCB-6630	Alternative Tests of Closure Welds and Access Hatches .....	306
HCB-6640	Alternative Tests at Specially Designed Welded Seals .....	306
<b>Article HCB-7000</b>	<b>Overpressure Protection</b> .....	307
HCB-7100	General Requirements .....	307
HCB-7110	Scope .....	307
HCB-7140	.....	307
HCB-7200	.....	308
HCB-7220	Content of Report .....	308
HCB-7600	.....	308
HCB-7610	.....	308
HCB-7620	.....	308
<b>Article HCB-8000</b>	<b>Nameplates, Stamping With the Certification Mark, and Reports</b> .....	309
HCB-8100	Requirements .....	309
<b>Mandatory Appendix HCB-I</b>	<b>Stress Range Reduction Factor for Piping</b> .....	310
<b>Article HCB-I-1000</b>	<b>Stress Range Reduction Factor</b> .....	310
<b>Article HCB-I-2000</b>	<b>Maximum Number of Allowable Cycles With <math>f = 1</math></b> .....	311
<b>Article HCB-I-3000</b>	<b>Equivalent Cycle</b> .....	312

<b>Mandatory Appendix HCB-II</b>	<b>Allowable Stress Values for Class B Components</b> .....	313
<b>Article HCB-II-1000</b>	<b>Scope</b> .....	313
<b>Article HCB-II-2000</b>	<b>Service With Negligible Creep Effects</b> .....	315
<b>Article HCB-II-3000</b>	<b>Service That May Include Creep Effects</b> .....	332
<b>Mandatory Appendix HCB-III</b>	<b>Time-Temperature Limits for Creep and Stress-Rupture Effects</b> .....	342
<b>Article HCB-III-1000</b>	<b>Introduction</b> .....	342
HCB-III-1100	Service Level A and B Loadings .....	342
HCB-III-1200	Service Level C Events .....	342
<b>Subsection HF</b>	<b>Class A and Class B Metallic Supports</b> .....	344
<b>Subpart A</b>	<b>Low Temperature Service</b> .....	344
<b>Article HFA-1000</b>	<b>Introduction</b> .....	344
HFA-1100	General .....	344
HFA-1110	Scope .....	344
<b>Subsection HG</b>	<b>Class SM Metallic Core Support Structures</b> .....	346
<b>Subpart A</b>	<b>Low Temperature Service</b> .....	346
<b>Article HGA-1000</b>	<b>Introduction</b> .....	346
HGA-1100	General .....	346
HGA-1110	Scope .....	346
<b>Article HGA-8000</b>	<b>Nameplates, Stamping With the Certification Mark, and Reports</b> .....	347
HGA-8100	Requirements .....	347
<b>Subpart B</b>	<b>Elevated Temperature Service</b> .....	348
<b>Article HGB-1000</b>	<b>Introduction</b> .....	348
HGB-1100	General .....	348
HGB-1110	Scope .....	348
HGB-1120	.....	349
<b>Article HGB-2000</b>	<b>Material</b> .....	350
HGB-2100	General Requirements for Material .....	350
HGB-2120	.....	350
HGB-2160	Deterioration of Material in Service .....	350
HGB-2400	.....	350
HGB-2430	.....	350
<b>Article HGB-3000</b>	<b>Design</b> .....	351
HGB-3100	General Design .....	351
HGB-3110	.....	351
HGB-3120	.....	352
HGB-3130	.....	353
HGB-3200	Design by Analysis .....	353
HGB-3210	Design Criteria .....	353
HGB-3220	Design Rules and Limits for Load-Controlled Stresses in Structures Other Than Threaded Structural Fasteners .....	358
HGB-3230	Stress Limits for Load-Controlled Stresses in Threaded Structural Fasteners .....	364
HGB-3240	Special Requirements for Elevated Temperature Components ..	365
HGB-3250	Limits on Deformation-Controlled Quantities .....	365
HGB-3300	.....	366
HGB-3350	.....	366

<b>Article HGB-4000</b>	<b>Fabrication and Installation</b> .....	367
HGB-4100	General Requirements .....	367
HGB-4200	.....	367
HGB-4210	.....	367
HGB-4230	.....	367
HGB-4400	.....	368
HGB-4420	.....	368
<b>Article HGB-5000</b>	<b>Examination</b> .....	369
HGB-5100	General Requirements for Examination .....	369
HGB-5200	.....	369
HGB-5220	Requirements for Radiography or Ultrasonic and Liquid Penetrant or Magnetic Particle Examination .....	369
<b>Article HGB-8000</b>	<b>Nameplates, Stamping With the Certification Mark, and Reports</b> .....	375
HGB-8100	Requirements .....	375
<b>Mandatory Appendix HGB-I</b>	<b>Rules for Strain, Deformation, and Fatigue Limits at Elevated Temperatures</b> .....	376
<b>Article HGB-I-1000</b>	<b>Introduction</b> .....	376
<b>Mandatory Appendix HGB-II</b>	<b>Rules for Construction of Core Support Structures, Extended for Restricted Service at Elevated Temperature, Without Explicit Consideration of Creep and Stress-Rupture</b> .....	377
<b>Article HGB-II-1000</b>	<b>Introduction</b> .....	377
HGB-II-1100	General .....	377
<b>Article HGB-II-2000</b>	<b>Materials</b> .....	378
HGB-II-2100	.....	378
HGB-II-2400	.....	378
<b>Article HGB-II-3000</b>	<b>Design</b> .....	388
HGB-II-3100	.....	388
HGB-II-3200	.....	388
<b>Article HGB-II-4000</b>	<b>Fabrication and Installation Requirements</b> .....	406
HGB-II-4100	.....	406
HGB-II-4200	.....	406
<b>Article HGB-II-5000</b>	<b>Examination Requirements</b> .....	407
<b>Mandatory Appendix HGB-III</b>	<b>Buckling and Instability</b> .....	408
<b>Article HGB-III-1000</b>	<b>General Requirements</b> .....	408
<b>Article HGB-III-2000</b>	<b>Buckling Limits: Time-Independent Buckling</b> .....	409
<b>Article HGB-III-3000</b>	<b>Alternative Procedures</b> .....	410
<b>Mandatory Appendix HGB-IV</b>	<b>Time-Temperature Limits</b> .....	411
<b>Article HGB-IV-1000</b>	<b>Time-Temperature Limits</b> .....	411
<b>Subsection HH</b>	<b>Class SN Nonmetallic Core Components</b> .....	413
<b>Subpart A</b>	<b>Graphite Materials</b> .....	413
<b>Article HHA-1000</b>	<b>Introduction</b> .....	413
HHA-1100	Scope .....	413
HHA-1110	Aspects Covered .....	413
HHA-1120	Environmental Effects and Limits .....	413

HHA-1200	Requirements .....	413
HHA-1210	General .....	413
HHA-1220	Materials .....	413
HHA-1230	Design .....	414
HHA-1240	Graphite Core Component Machining .....	414
HHA-1250	Installation .....	414
HHA-1260	Responsibilities .....	414
HHA-1300	Application of These Rules .....	414
HHA-1400	Boundaries of Jurisdiction .....	414
HHA-1410	Boundary Between Graphite Core Components and Core Support Structures .....	414
HHA-1420	Boundary Between Graphite Core Components and Fuel Pebbles or Compacts .....	414
HHA-1430	Other Boundaries .....	414
<b>Article HHA-2000</b>	<b>Materials</b> .....	417
HHA-2100	General Requirements .....	417
HHA-2110	Material for Graphite Core Components .....	417
HHA-2120	Certification of Material .....	417
HHA-2130	Deterioration of Materials During Service .....	417
HHA-2140	Material Identification .....	418
HHA-2200	Material Properties for Design .....	418
HHA-2210	As-Manufactured Material Properties .....	418
HHA-2220	Irradiated Material Properties .....	418
HHA-2230	Oxidized Material Properties .....	418
HHA-2300	Sampling .....	418
HHA-2310	General Requirements .....	418
HHA-2400	Material Manufacturer's Quality System Program .....	419
HHA-2500	Examination and Repair of Graphite Core Component Material .	419
HHA-2510	Examination .....	419
HHA-2520	Repair .....	419
HHA-2600	Packaging, Transportation, and Storage .....	419
<b>Article HHA-3000</b>	<b>Design</b> .....	420
HHA-3100	General Design .....	420
HHA-3110	Graphite Core Components .....	420
HHA-3120	Loading Criteria .....	421
HHA-3130	Nomenclature .....	421
HHA-3140	Special Considerations .....	422
HHA-3200	Design by Analysis — Graphite Core Components .....	423
HHA-3210	Design Criteria for Graphite Core Components .....	423
HHA-3220	Stress Limits for Graphite Core Component — Simplified Assessment .....	427
HHA-3230	Probability of Failure Limits for Graphite Core Components — Full Assessment .....	430
HHA-3240	Experimental Limits — Design-by-Test .....	431
HHA-3300	Requirements for Design of the Graphite Core Assembly .....	432
HHA-3310	General Requirements .....	432
HHA-3320	Design Considerations .....	432
HHA-3330	Design of the Graphite Core Assembly .....	432
<b>Article HHA-4000</b>	<b>Machining, Examination, and Testing</b> .....	436
HHA-4100	General Requirements .....	436
HHA-4110	Introduction .....	436
HHA-4120	Certification of Materials and Machining by the Graphite Core Component Manufacturer .....	436
HHA-4130	Joining .....	436

HHA-4200	Machining, Examination, and Testing .....	436
HHA-4210	Procedures, Qualification, and Evaluation .....	436
HHA-4220	Graphite Core Component Machining .....	437
HHA-4230	Graphite Core Component Examination .....	437
HHA-4240	Graphite Core Component Testing .....	438
HHA-4250	Graphite Core Component Packaging .....	438
<b>Article HHA-5000</b>	<b>Installation and Examination</b> .....	440
HHA-5100	General Requirements .....	440
HHA-5110	Introduction .....	440
HHA-5200	Storage, Unpackaging, and Examination .....	440
HHA-5210	Storage and Unpackaging .....	440
HHA-5220	Examination of Graphite Core Components .....	440
HHA-5300	Installation .....	441
HHA-5310	Documentation .....	441
HHA-5400	Examination During Installation .....	441
HHA-5500	Examination Post-Installation .....	441
<b>Article HHA-8000</b>	<b>Nameplates, Stamping, and Reports</b> .....	442
HHA-8100	Requirements .....	442
<b>Mandatory Appendix HHA-I</b>	<b>Graphite Material Specifications</b> .....	443
<b>Article HHA-I-1000</b>	<b>Introduction</b> .....	443
HHA-I-1100	Scope .....	443
<b>Mandatory Appendix HHA-II</b>	<b>Requirements for Preparation of a Material Data Sheet</b> ....	444
<b>Article HHA-II-1000</b>	<b>Introduction</b> .....	444
<b>Article HHA-II-2000</b>	<b>Material Data Sheet Forms</b> .....	445
<b>Article HHA-II-3000</b>	<b>Detailed Requirements for Derivation of the Material Data Sheet — As-Manufactured Properties</b> .....	450
HHA-II-3100	Material Reliability Curve Parameters (Two Parameter for Simple Assessment) .....	450
HHA-II-3200	Material Reliability Curve Parameters (Three Parameter for Full Assessment) .....	450
HHA-II-3300	Design Allowable Stress Value .....	451
<b>Article HHA-II-4000</b>	<b>Detailed Requirements for Derivation of the Material Data Sheet — Irradiated Material Properties</b> .....	453
HHA-II-4100	General .....	453
<b>Mandatory Appendix HHA-III</b>	<b>Requirements for Generation of Design Data for Graphite Grades</b> .....	454
<b>Article HHA-III-1000</b>	<b>Scope</b> .....	454
<b>Article HHA-III-2000</b>	<b>General Requirements</b> .....	455
<b>Article HHA-III-3000</b>	<b>Properties to Be Determined</b> .....	456
HHA-III-3100	As-Manufactured Graphite .....	456
HHA-III-3200	Oxidized Graphite .....	456
HHA-III-3300	Irradiated Graphite .....	456
<b>Article HHA-III-4000</b>	<b>Requirement for Representative Data</b> .....	457
HHA-III-4100	As-Manufactured Graphite .....	457
HHA-III-4200	Irradiated or Oxidized Graphite .....	457
<b>Article HHA-III-5000</b>	<b>Use of Historical Data</b> .....	458

<b>Nonmandatory Appendix HHA-A</b>	<b>Graphite as a Structural Material</b> .....	459
<b>Article HHA-A-1000</b>	<b>Introduction</b> .....	459
HHA-A-1100	Manufacture .....	459
<b>Nonmandatory Appendix HHA-B</b>	<b>Environmental Effects in Graphite</b> .....	462
<b>Article HHA-B-1000</b>	<b>Introduction</b> .....	462
<b>Article HHA-B-2000</b>	<b>Radiation Damage</b> .....	463
<b>Article HHA-B-3000</b>	<b>Gas Coolant-Graphite Interactions (Oxidation)</b> .....	464
<b>Article HHA-B-4000</b>	<b>Salt Coolant-Graphite Interactions</b> .....	465
<b>Article HHA-B-5000</b>	<b>References</b> .....	466
<b>Nonmandatory Appendix HHA-D</b>	<b>Guidance on Defects and Flaws in Graphite</b> .....	468
<b>Subpart B</b>	<b>Composite Materials</b> .....	469
<b>Article HHB-1000</b>	<b>Introduction</b> .....	469
HHB-1100	Scope .....	469
HHB-1110	Aspects Covered .....	469
HHB-1120	Environmental Effects and Limits .....	469
HHB-1200	Requirements .....	469
HHB-1210	General .....	469
HHB-1220	Materials .....	469
HHB-1230	Design .....	469
HHB-1240	Machining and Installation .....	470
HHB-1250	Examination .....	470
HHB-1260	Testing .....	470
HHB-1270	Responsibilities .....	470
HHB-1300	Application of These Rules, and Definitions .....	470
HHB-1310	Application of These Rules .....	470
HHB-1320	Definitions .....	470
HHB-1400	Boundaries of Jurisdiction .....	470
HHB-1410	Boundary Between Composite Core Components and Other Components .....	470
HHB-1420	Other Boundaries .....	470
<b>Article HHB-2000</b>	<b>Composite Materials</b> .....	471
HHB-2100	General Requirements .....	471
HHB-2110	Ceramic Composite Materials for Composite Core Components .	471
HHB-2120	Certification of Ceramic Composite Materials .....	471
HHB-2130	Deterioration of Ceramic Composite Materials During Service .	472
HHB-2140	Material Identification .....	472
HHB-2200	Ceramic Composite Material Properties for Design .....	473
HHB-2210	As-Manufactured Ceramic Composite Material Properties .....	473
HHB-2220	Irradiated Ceramic Composite Material Properties .....	473
HHB-2230	Ceramic Composite Material Properties and Chemical Attack/ Oxidation .....	473
HHB-2240	STT Effects on Ceramic Composite Material Properties — Creep, Stress Rupture, Slow Crack Growth, and Fatigue .....	474
HHB-2300	Sampling .....	474
HHB-2310	General Requirements .....	474
HHB-2400	Material Manufacturer’s Quality System Program .....	474
HHB-2500	Examination and Repair of Composite Core Component Material	474
HHB-2510	Examination .....	474
HHB-2520	Repair .....	474
HHB-2600	Packaging, Transportation, and Storage .....	474

<b>Article HHB-3000</b>	<b>Design</b> .....	475
HHB-3100	General Design .....	475
HHB-3110	Composite Core Components .....	475
HHB-3120	Loading Criteria .....	476
HHB-3130	Nomenclature .....	477
HHB-3140	Special Considerations .....	477
HHB-3200	Design by Analysis — Composite Core Components .....	478
HHB-3210	Design Criteria for Composite Core Components .....	478
HHB-3220	Stress Limits for Composite Core Components .....	480
HHB-3240	Experimental Limits — Design by Test .....	483
HHB-3300	Requirements for Design of the Core Assembly .....	484
HHB-3310	General Requirements .....	484
<b>Article HHB-4000</b>	<b>Machining and Installation</b> .....	485
HHB-4100	Scope and General Requirements .....	485
HHB-4110	Scope .....	485
HHB-4120	General Requirements .....	485
HHB-4200	Identification of Materials and Machined Composite Core Components .....	485
HHB-4210	Materials .....	485
HHB-4220	Machined Composite Core Components .....	485
HHB-4300	Composite Core Component Machining .....	485
HHB-4310	General .....	485
HHB-4320	Machining Facilities and Tools .....	486
HHB-4330	Joining .....	486
HHB-4340	Rework .....	486
HHB-4350	Other Processing Steps .....	486
HHB-4360	Certification of Composite Core Components .....	486
HHB-4370	Composite Core Component Packaging .....	486
HHB-4400	Transportation, Storage, and Unpackaging .....	487
HHB-4500	Installation .....	487
<b>Article HHB-5000</b>	<b>Examination</b> .....	488
HHB-5100	Scope .....	488
HHB-5200	General Requirements .....	488
HHB-5210	Nondestructive Examination Procedures .....	488
HHB-5220	Qualifications of Examination Personnel .....	488
HHB-5300	Examination After Machining .....	488
HHB-5310	General .....	488
HHB-5320	Dimensional Examination .....	488
HHB-5330	Examination for Material Imperfections and Damage .....	488
HHB-5400	Examination Before Installation .....	489
HHB-5500	Examination During Installation .....	489
HHB-5600	Examination Post-Installation .....	489
<b>Article HHB-6000</b>	<b>Testing</b> .....	490
HHB-6100	Scope .....	490
HHB-6200	General Requirements .....	490
HHB-6300	Specific Requirements .....	490
<b>Article HHB-8000</b>	<b>Nameplates, Stamping, and Reports</b> .....	491
HHB-8100	Requirements .....	491
<b>Mandatory Appendix HHB-I</b>	<b>Composite Material Specifications</b> .....	492
<b>Article HHB-I-1000</b>	<b>Introduction</b> .....	492
HHB-I-1100	Scope .....	492
<b>Article HHB-I-2000</b>	<b>Material Specifications for Composite Materials</b> .....	495

<b>Mandatory Appendix HHB-II</b>	<b>Requirements for Preparation of a Material Data Sheet . . . .</b>	<b>496</b>
<b>Article HHB-II-1000</b>	<b>Introduction . . . . .</b>	<b>496</b>
<b>Article HHB-II-2000</b>	<b>Material Data Sheet Forms . . . . .</b>	<b>497</b>
<b>Article HHB-II-3000</b>	<b>Detailed Requirements for Derivation of the Material Data Sheet — As-Manufactured Properties . . . . .</b>	<b>531</b>
HHB-II-3100	Introduction . . . . .	531
HHB-II-3200	Definition of Material Failure Strength for Ceramic Composite Materials . . . . .	531
HHB-II-3300	Damage Tolerance and Brittle Elastic and Pseudo-Ductile Stress–Strain Curves in Ceramic Composite Materials . . . . .	531
HHB-II-3400	Material Reliability Curve Parameters (Two Parameters for Simple Assessment) . . . . .	532
HHB-II-3500	Material Reliability Curve Parameters (Three Parameters for Full Assessment) . . . . .	534
HHB-II-3600	Design Allowable Stress Value . . . . .	534
<b>Article HHB-II-4000</b>	<b>Detailed Requirements for Derivation of the Material Data Sheet — Irradiated Material Properties . . . . .</b>	<b>535</b>
HHB-II-4100	General . . . . .	535
<b>Article HHB-II-5000</b>	<b>Detailed Requirements for Derivation of the Material Data Sheet — Material Properties Subject to Chemical Attack/Oxidation . . . . .</b>	<b>536</b>
HHB-II-5100	General . . . . .	536
<b>Article HHB-II-6000</b>	<b>Detailed Requirements for Derivation of the Material Data Sheet — Material Properties Subject to STT Effects . . . . .</b>	<b>537</b>
HHB-II-6100	General . . . . .	537
<b>Article HHB-II-7000</b>	<b>Reference . . . . .</b>	<b>538</b>
<b>Mandatory Appendix HHB-III</b>	<b>Requirements for Generation of Design Data for Ceramic Composite Materials . . . . .</b>	<b>539</b>
<b>Article HHB-III-1000</b>	<b>Scope . . . . .</b>	<b>539</b>
<b>Article HHB-III-2000</b>	<b>General Requirements . . . . .</b>	<b>540</b>
<b>Article HHB-III-3000</b>	<b>Properties to Be Determined . . . . .</b>	<b>541</b>
HHB-III-3100	As-Manufactured Ceramic Composite Material . . . . .	541
HHB-III-3200	Irradiated Ceramic Composite Material . . . . .	541
HHB-III-3300	Ceramic Composite Materials and Chemical Attack/Oxidation . . . . .	541
HHB-III-3400	STT Exposure of Ceramic Composite Materials . . . . .	542
<b>Article HHB-III-4000</b>	<b>Requirement for Representative Data . . . . .</b>	<b>543</b>
HHB-III-4100	As-Manufactured Ceramic Composite Material . . . . .	543
HHB-III-4200	Irradiated, Chemical Attack/Oxidation, and STT Ceramic Composite Material . . . . .	543
<b>Nonmandatory Appendix HHB-A</b>	<b>Classification of Ceramic Composite Materials for Nuclear Applications . . . . .</b>	<b>544</b>
<b>Article HHB-A-1000</b>	<b>Scope . . . . .</b>	<b>544</b>
<b>Article HHB-A-2000</b>	<b>Materials . . . . .</b>	<b>545</b>
<b>Nonmandatory Appendix HHB-B</b>	<b>Composition, Structure, Manufacture, and Properties of Ceramic Matrix Composites . . . . .</b>	<b>546</b>
<b>Article HHB-B-1000</b>	<b>Introduction . . . . .</b>	<b>546</b>
HHB-B-1100	Ceramic Matrix Composites . . . . .	546
HHB-B-1200	Definitions . . . . .	547

HHB-B-1300	Composition and Structure of CMCS .....	547
HHB-B-1400	Manufacturing of Preforms, Densification, and Postprocessing ..	549
HHB-B-1500	Mechanical, Thermal, Irradiation, and Degradation Properties ..	553
<b>Article HHB-B-2000</b>	<b>Summary</b> .....	557
<b>Article HHB-B-3000</b>	<b>References</b> .....	558
HHB-B-3100	Applications of CMCS .....	558
HHB-B-3200	Fabrication and Manufacturing of CMCS .....	558
HHB-B-3300	Mechanical Properties .....	559
HHB-B-3400	Thermal Properties .....	559
HHB-B-3500	Degradation — Thermal, Environmental, Irradiation .....	560
<b>Nonmandatory Appendix HHB-C</b>	<b>Fracture and Damage Mechanisms in SiC-SiC CMCS</b> .....	561
<b>Article HHB-C-1000</b>	<b>Introduction</b> .....	561
HHB-C-1100	Fracture and Damage Mechanisms .....	561
HHB-C-1200	Definitions .....	561
HHB-C-1300	Overview of Fracture and Damage Mechanisms of SiC-SiC CMCS	562
HHB-C-1400	Summary .....	566
HHB-C-1500	References .....	567

## FIGURES

HBB-3221-1	Flow Diagram for Elevated Temperature Analysis .....	66
HBB-3224-1	Use-Fractions for Membrane Stress .....	68
HBB-3224-2	Use-Fractions for Membrane Plus Bending Stress .....	69
HBB-3351-1	Welded Joint Locations Typical of Categories A, B, C, and D .....	78
HBB-3352-1	Typical Butt Joints .....	79
HBB-3354-1	Permissible Attachment Weld Location .....	80
HBB-3361-1	Category A and B Joints Between Sections of Unequal Thickness .....	80
HBB-3410.2-1	Typical Single Volute Casing .....	81
HBB-3410.2-2	Typical Double Volute Casing .....	81
HBB-3421.11-1	Minimum Tangential Inlet and Outlet Wall Thickness .....	82
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 ..	89
HBB-I-14.3A	$S_{mt}$ — Type 304 SS .....	104
HBB-I-14.3B	$S_{mt}$ — Type 316 SS .....	106
HBB-I-14.3C	$S_{mt}$ — Ni-Fe-Cr (Alloy 800H) .....	108
HBB-I-14.3D	$S_{mt}$ — 2 <sup>1</sup> / <sub>4</sub> Cr-1Mo .....	110
HBB-I-14.3E	$S_{mt}$ — 9Cr-1Mo-V .....	112
HBB-I-14.4A	$S_t$ — Type 304 SS .....	113
HBB-I-14.4B	$S_t$ — Type 316 SS .....	115
HBB-I-14.4C	$S_t$ — Ni-Fe-Cr (Alloy 800H) .....	117
HBB-I-14.4D	$S_t$ — 2 <sup>1</sup> / <sub>4</sub> Cr-1Mo .....	119
HBB-I-14.4E	$S_t$ — 9Cr-1Mo-V .....	121
HBB-I-14.6A	Minimum Stress-to-Rupture .....	124
HBB-I-14.6B	Minimum Stress-to-Rupture .....	126
HBB-I-14.6C	Minimum Stress-to-Rupture — Ni-Fe-Cr (Alloy 800H) .....	128
HBB-I-14.6D	2 <sup>1</sup> / <sub>4</sub> Cr-1Mo — 100% of the Minimum Stress-to-Rupture .....	130
HBB-I-14.6E	Minimum Stress-to-Rupture, Alloy 718 .....	131
HBB-I-14.6F	9Cr-1Mo-V — Expected Minimum Stress-to-Rupture, ksi (MPa) .....	132
HBB-I-14.13A	$S_{mt}$ — Allowable Stress Intensity, Type 304 SS, Bolting .....	143
HBB-I-14.13B	$S_{mt}$ — Allowable Stress Intensity, Type 316 SS, Bolting .....	143
HBB-I-14.13C	$S_{mt}$ — Allowable Stress, Alloy 718, Bolting .....	144
HBB-II-3000-1	$S_{mt}$ Values for SA-533 Type B, Class 1 and SA-508 Grade 3, Class 1 .....	148
HBB-II-3000-2	$S_t$ Allowable Stress Intensity Values for SA-533 Type B, Class 1 and SA-508 Grade 3, Class 1 .....	149
HBB-II-3000-3	Stress-to-Rupture (Minimum) for SA-533 Type B, Class 1 and SA-508 Grade 3, Class 1 ..	150

HBB-II-3000-4	Isochronous Stress–Strain Curves for 700°F (371°C) for SA-533 Type B, Class 1 and SA-508 Grade 3, Class 1	151
HBB-II-3000-5	Isochronous Stress–Strain Curves for 750°F (399°C) for SA-533 Type B, Class 1 and SA-508 Grade 3, Class 1	152
HBB-II-3000-6	Isochronous Stress–Strain Curves for 800°F (427°C) for SA-533 Type B, Class 1 and SA-508 Grade 3, Class 1	153
HBB-II-3000-7	Isochronous Stress–Strain Curves for 850°F (454°C) for SA-533 Type B, Class 1 and SA-508 Grade 3, Class 1	154
HBB-II-3000-8	Isochronous Stress–Strain Curves for 900°F (482°C) for SA-533 Type B, Class 1 and SA-508 Grade 3, Class 1	155
HBB-II-3000-9	Isochronous Stress–Strain Curves for 950°F (510°C) for SA-533 Type B, Class 1 and SA-508 Grade 3, Class 1	156
HBB-II-3000-10	Isochronous Stress–Strain Curves for 1,000°F (538°C) for SA-533 Type B, Class 1 and SA-508 Grade 3, Class 1	157
HBB-II-3000-11	Design Fatigue Strain Range for SA-533 Type B, Class 1 and SA-508 Grade 3, Class 1	158
HBB-II-3000-12	Creep–Fatigue Damage Envelope for SA-533 Type B, Class 1 and SA-508 Grade 3, Class 1	159
HBB-II-3000-13	$S_t$ Versus Time–Isothermal Curves for SA-533 Type B, Class 1 and SA-508 Grade 3, Class 1	160
HBB-II-3000-14	Minimum Stress Rupture as a Function of Time and Temperature for SA-533 Type B, Class 1 and SA-508 Grade 3, Class 1	161
HBB-T-1332-1	Effective Creep Stress Parameter $Z$ for Simplified Inelastic Analysis Using Test No. B-1	172
HBB-T-1332-2	Effective Creep Stress Parameter $Z$ for Simplified Inelastic Analysis Using Test No. B-2	173
HBB-T-1420-1A	Design Fatigue Strain Range, $\epsilon_{t_i}$ , for 304 SS	176
HBB-T-1420-1B	Design Fatigue Strain Range, $\epsilon_{t_i}$ , for 316 SS	178
HBB-T-1420-1C	Design Fatigue Strain Range, $\epsilon_{t_i}$ , for Ni-Fe-Cr Alloy 800H	180
HBB-T-1420-1D	Design Fatigue Strain Range, $\epsilon_{t_i}$ , for 2 <sup>1</sup> / <sub>4</sub> Cr-1Mo Steel	182
HBB-T-1420-1E	Design Fatigue Strain Range, $\epsilon_{t_i}$ , for 9Cr-1Mo-V Steel	183
HBB-T-1420-2	Creep–Fatigue Damage Envelope	185
HBB-T-1432-1	Stress–Strain Relationship	187
HBB-T-1432-2	Inelastic Multiaxial Adjustments	188
HBB-T-1432-3	Adjustment for Inelastic Biaxial Poisson’s Ratio	189
HBB-T-1433-1	Methods of Determining Relaxation	190
HBB-T-1433-2	Stress-Relaxation Limits for Creep Damage	191
HBB-T-1433-3	Stress-Relaxation Limits for Creep Damage	191
HBB-T-1433-4	Envelope Stress-Time History for Creep Damage Assessment	192
HBB-T-1522-1	Time–Temperature Limits for Application of Section II External Pressure Charts	195
HBB-T-1522-2	Time–Temperature Limits for Application of Section II External Pressure Charts	196
HBB-T-1522-3	Temperature Limits for Application of Section II External Pressure Charts	197
HBB-T-1831-1	Average Isochronous Stress–Strain Curves	203
HBB-T-1831-2	Average Isochronous Stress–Strain Curves	204
HBB-T-1831-3	Average Isochronous Stress–Strain Curves	205
HBB-T-1831-4	Average Isochronous Stress–Strain Curves	206
HBB-T-1831-5	Average Isochronous Stress–Strain Curves	207
HBB-T-1831-6	Average Isochronous Stress–Strain Curves	208
HBB-T-1831-7	Average Isochronous Stress–Strain Curves	209
HBB-T-1831-8	Average Isochronous Stress–Strain Curves	210
HBB-T-1831-9	Average Isochronous Stress–Strain Curves	211
HBB-T-1831-10	Average Isochronous Stress–Strain Curves	212
HBB-T-1831-11	Average Isochronous Stress–Strain Curves	213
HBB-T-1831-12	Average Isochronous Stress–Strain Curves	214
HBB-T-1831-13	Average Isochronous Stress–Strain Curves	215
HBB-T-1831-14	Average Isochronous Stress–Strain Curves	216
HBB-T-1831-15	Average Isochronous Stress–Strain Curves	217
HBB-T-1831-16	Average Isochronous Stress–Strain Curves	218
HBB-T-1831-17	Average Isochronous Stress–Strain Curves	219
HBB-T-1832-1	Average Isochronous Stress–Strain Curves	225
HBB-T-1832-2	Average Isochronous Stress–Strain Curves	226

HBB-T-1832-3	Average Isochronous Stress–Strain Curves .....	227
HBB-T-1832-4	Average Isochronous Stress–Strain Curves .....	228
HBB-T-1832-5	Average Isochronous Stress–Strain Curves .....	229
HBB-T-1832-6	Average Isochronous Stress–Strain Curves .....	230
HBB-T-1832-7	Average Isochronous Stress–Strain Curves .....	231
HBB-T-1832-8	Average Isochronous Stress–Strain Curves .....	232
HBB-T-1832-9	Average Isochronous Stress–Strain Curves .....	233
HBB-T-1832-10	Average Isochronous Stress–Strain Curves .....	234
HBB-T-1832-11	Average Isochronous Stress–Strain Curves .....	235
HBB-T-1832-12	Average Isochronous Stress–Strain Curves .....	236
HBB-T-1832-13	Average Isochronous Stress–Strain Curves .....	237
HBB-T-1832-14	Average Isochronous Stress–Strain Curves .....	238
HBB-T-1832-15	Average Isochronous Stress–Strain Curves .....	239
HBB-T-1832-16	Average Isochronous Stress–Strain Curves .....	240
HBB-T-1832-17	Average Isochronous Stress–Strain Curves .....	241
HBB-T-1833-1	Average Isochronous Stress–Strain Curves .....	244
HBB-T-1833-2	Average Isochronous Stress–Strain Curves .....	245
HBB-T-1833-3	Average Isochronous Stress–Strain Curves .....	246
HBB-T-1833-4	Average Isochronous Stress–Strain Curves .....	247
HBB-T-1833-5	Average Isochronous Stress–Strain Curves .....	248
HBB-T-1833-6	Average Isochronous Stress–Strain Curves .....	249
HBB-T-1833-7	Average Isochronous Stress–Strain Curves .....	250
HBB-T-1833-8	Average Isochronous Stress–Strain Curves .....	251
HBB-T-1833-9	Average Isochronous Stress–Strain Curves .....	252
HBB-T-1833-10	Average Isochronous Stress–Strain Curves .....	253
HBB-T-1833-11	Average Isochronous Stress–Strain Curves .....	254
HBB-T-1833-12	Average Isochronous Stress–Strain Curves .....	255
HBB-T-1833-13	Average Isochronous Stress–Strain Curves .....	256
HBB-T-1834-1	Average Isochronous Stress–Strain Curves .....	260
HBB-T-1834-2	Average Isochronous Stress–Strain Curves .....	261
HBB-T-1834-3	Average Isochronous Stress–Strain Curves .....	262
HBB-T-1834-4	Average Isochronous Stress–Strain Curves .....	263
HBB-T-1834-5	Average Isochronous Stress–Strain Curves .....	264
HBB-T-1834-6	Average Isochronous Stress–Strain Curves .....	265
HBB-T-1834-7	Average Isochronous Stress–Strain Curves .....	266
HBB-T-1834-8	Average Isochronous Stress–Strain Curves .....	267
HBB-T-1834-9	Average Isochronous Stress–Strain Curves .....	268
HBB-T-1834-10	Average Isochronous Stress–Strain Curves .....	269
HBB-T-1834-11	Average Isochronous Stress–Strain Curves .....	270
HBB-T-1835-1	Average Isochronous Stress–Strain Curves .....	273
HBB-T-1835-2	Average Isochronous Stress–Strain Curves .....	274
HBB-T-1835-3	Average Isochronous Stress–Strain Curves .....	275
HBB-T-1835-4	Average Isochronous Stress–Strain Curves .....	276
HBB-T-1835-5	Average Isochronous Stress–Strain Curves .....	277
HBB-T-1835-6	Average Isochronous Stress–Strain Curves .....	278
HBB-T-1835-7	Average Isochronous Stress–Strain Curves .....	279
HBB-T-1835-8	Average Isochronous Stress–Strain Curves .....	280
HBB-T-1835-9	Average Isochronous Stress–Strain Curves .....	281
HBB-T-1835-10	Average Isochronous Stress–Strain Curves .....	282
HBB-T-1835-11	Average Isochronous Stress–Strain Curves .....	283
HBB-Y-3000-1	Conceptual Creep–Fatigue Damage Envelope .....	290
HCB-4215-1	Permissible Time/Temperature Conditions for Material That Has Been Cold Worked >5% and <20% and Subjected to Short-Time, High-Temperature Transients .....	304
HCB-II-1000-1	Determination of Allowable Stress, $S$ , for Class B Components .....	314
HCB-III-1000-1	Time–Temperature Limits for Service Level A and B Events .....	343
HGB-3224-1	Use-Fractions for Membrane Stress .....	362

HGB-3224-2	Use-Fractions for Membrane Plus Bending Stress .....	362
HGB-5223-1	Full Penetration Corner Weld Details for Category C Joints .....	371
HGB-5224.2-1	Nozzles Joined by Full Penetration Corner Welds .....	372
HGB-5224.3-1	Deposited Weld Metal Used as Reinforcement of Openings for Nozzles .....	373
HGB-5224.4-1	Oblique Connections .....	374
HGB-IV-1000-1	Time at Elevated Temperature, hr .....	412
HHA-1400-1	Jurisdictional Boundary for Graphite Core Components and Assemblies — Circumferential Section View .....	415
HHA-1400-2	Jurisdictional Boundary for Graphite Core Components and Assemblies — Longitudinal Section View .....	416
HHA-3141-1	Dependence of Strength on Weight Loss in Uniformly Oxidized Graphite of Classes IIHP or INHP .....	434
HHA-3141-2	Dependence of Strength on Weight Loss in Uniformly Oxidized Graphite of Classes EIHP, ENHP, MIHP, and MNHP .....	434
HHA-3221-1	Design Allowable Stresses Flowchart for SRC-1 Graphite Core Component .....	435
HHA-II-3100-1	Correction Factor $T$ of the Shape Parameter $M$ of Two-Parameter Weibull Distribution ( $\gamma = 0.95$ ) .....	451
HHA-II-3100-2	Correction Factor $T'$ of the Characteristic Value $S_c$ of Two-Parameter Weibull Distribution ( $\gamma = 0.95$ ) .....	452
HHA-A-1100-1	.....	459
HHA-1160-1	Extrusion .....	461
HHA-1160-2	Molding .....	461
HHB-3221-1	Allowable Stresses Flowchart for SRC-1 and SRC-3 Composite Core Components .....	481
HHB-II-3300-1	Stress–Strain Curves for WIC Composites .....	532
HHB-II-3300-2	On-Axis (0 deg/90 deg) and Off-Axis ( $\pm 45$ deg) Tensile Loading .....	533
HHB-II-3300-3	Stress–Strain Curves for WMC Composites .....	533
HHB-B-1100-1	Three Commonly Accepted Classifications of Composites Based on Type of Matrix .....	547
HHB-B-1100-2	Comparison of Tensile Stress–Strain Response of Monolithic and Composite Ceramics Along With Fracture Surfaces of CMCs Showing Artifacts of Energy-Absorptive Mechanisms (i.e., Fiber Debond and Pullout) .....	548
HHB-B-1310-1	Specific Strength as a Function of Temperature (Note Advantages of CMCs) .....	550
HHB-B-1310-2	Damage and Fracture in a CMC Showing the Fiber Reinforcement, Interfacial Coating (Interphase), and the Matrix .....	550
HHB-B-1430-1	Examples of Fiber Architectures .....	552
HHB-B-1511-1	Tensile Stress–Strain Response of a 2D Woven CMC Showing Strain-Softening Behavior .....	554
HHB-B-1513-1	Circumferential (Hoop) and Longitudinal Stress–Strain Response of an Interlocked 3D Braided SiC–SiC CMC .....	555
HHB-B-1520-1	Thermal Conductivity Parallel and Perpendicular to Fibers in a C–C–SiC CMC .....	556
HHB-C-1300-1	Microcrack Initiation and Propagation in a 2D CMC Reflecting Cumulative Damage Process at Increasing Strain .....	563
HHB-C-1300-2	Fracture Surfaces of a CMC Resulting From Macrocrack Propagation Culminating in Fiber Debond/Pullout .....	563
HHB-C-1310-1	Comparison of Tensile Stress–Strain Response of Unreinforced Matrix (i.e., Monolithic) and Composite Ceramic With Callouts for Various Energy-Absorptive Fracture Surfaces in CMCs .....	565
HHB-C-1320-1	Load/Unload/Reload Stress–Strain Curves and Cumulative Damage for a 2D Woven SiC–SiC CMC .....	566
HHB-C-1320-2	Stress–Strain Curve, Acoustic Emission Energy, and Maximum and Residual Resistance Changes Versus Strain .....	567
<b>TABLES</b>		
HAA-1130-1	Values of $T_{max}$ for Various Classes of Permitted Materials .....	2
HAA-7100-1	Standards and Specifications Referenced in Division 5 Associated With Metallic Components .....	5
HAA-8110-1	Certificates and Certification Mark Issued by the Society for Construction of High Temperature Reactor Metallic Components .....	7

HAB-3255-1	Document Distribution for Design and Construction of Core Components and Assemblies	24
HAB-4134.17-1	Lifetime Quality Assurance Records	28
HAB-4134.17-2	Nonpermanent Quality Assurance Records	28
HAB-7100-1	Standards and Specifications Referenced in This Subpart and <a href="#">Subsection HH</a>	38
HAB-8100-1	Certificates Issued by the Society for Construction of Nuclear Core Components and Core Assemblies	41
HBB-3133-1	Size Restrictions on Connections	56
HBB-3217-1	Classification of Stress Intensity in Vessels for Some Typical Cases	63
HBB-3217-2	Classification of Stress Intensity in Piping, Typical Cases	65
HBB-3225-1	Tensile Strength Values, $S_u$	71
HBB-3225-2	Tensile and Yield Strength Reduction Factor Due to Long Time Prior Elevated Temperature Service	72
HBB-3225-3A	Yield Strength Reduction Factors for 2 <sup>1</sup> / <sub>4</sub> Cr-1Mo	72
HBB-3225-3B	Tensile Strength Reduction Factors for 2 <sup>1</sup> / <sub>4</sub> Cr-1Mo	73
HBB-3225-4	Tensile Strength Reduction Factors for 9Cr-1Mo-V	74
HBB-3642.1-1	Bend Radius Versus Thickness	85
HBB-I-14.1(a)	Permissible Base Materials for Structures Other Than Bolting	101
HBB-I-14.1(b)	Permissible Weld Materials	102
HBB-I-14.2	$S_o$ — Maximum Allowable Stress Intensity, ksi (MPa), for Design Condition Calculations	103
HBB-I-14.3A	$S_{mt}$ — Allowable Stress Intensity Values, 1,000 psi, Type 304 SS — 30-YS, 75-UTS (30-YS, 70-UTS)	105
HBB-I-14.3B	$S_{mt}$ — Allowable Stress Intensity Values, 1,000 psi, Type 316 SS — 30-YS, 75-UTS (30-YS, 70-UTS)	107
HBB-I-14.3C	$S_{mt}$ — Allowable Stress Intensity Values, ksi (MPa), Ni-Fe-Cr (Alloy 800H)	109
HBB-I-14.3D	$S_{mt}$ — Allowable Stress Intensity Values, ksi (MPa), 2 <sup>1</sup> / <sub>4</sub> Cr-1Mo	111
HBB-I-14.3E	$S_{mt}$ — Allowable Stress Intensity Values, ksi (MPa), 9Cr-1Mo-V	113
HBB-I-14.4A	$S_t$ — Allowable Stress Intensity Values, 1,000 psi (MPa), Type 304 SS	114
HBB-I-14.4B	$S_t$ — Allowable Stress Intensity Values, 1,000 psi (MPa), Type 316 SS	116
HBB-I-14.4C	$S_t$ — Allowable Stress Intensity Values, ksi (MPa), Ni-Fe-Cr (Alloy 800H)	118
HBB-I-14.4D	$S_t$ — Allowable Stress Intensity Values, ksi (MPa), 2 <sup>1</sup> / <sub>4</sub> Cr-1Mo	120
HBB-I-14.4E	$S_t$ — Allowable Stress Intensity Values, ksi (MPa), 9Cr-1Mo-V	122
HBB-I-14.5	Yield Strength Values, $S_y$ , Versus Temperature	123
HBB-I-14.6A	Expected Minimum Stress-to-Rupture Values, 1,000 psi (MPa), Type 304 SS	125
HBB-I-14.6B	Expected Minimum Stress-to-Rupture Values, 1,000 psi (MPa), Type 316 SS	127
HBB-I-14.6C	Expected Minimum Stress-to-Rupture Values, ksi (MPa), Ni-Fe-Cr (Alloy 800H)	129
HBB-I-14.6D	2 <sup>1</sup> / <sub>4</sub> Cr-1Mo — Expected Minimum Stress-to-Rupture Values, ksi (MPa)	130
HBB-I-14.6E	Expected Minimum Stress-to-Rupture Values, ksi (MPa), Ni-Cr-Fe-Mo-Cb (Alloy 718)	131
HBB-I-14.6F	9Cr-1Mo-V, $S_r$ — Expected Minimum Stress-to-Rupture Values, ksi (MPa)	133
HBB-I-14.10A-1	Stress Rupture Factors for Type 304 Stainless Steel Welded With SFA-5.22 E 308T and E 308LT; SFA-5.4 E 308 and E 308L; and SFA-5.9 ER 308 and ER 308L	134
HBB-I-14.10A-2	Stress Rupture Factors for Type 304 Stainless Steel Welded With SFA-5.22 EXXXT-G (16-8-2 Chemistry); SFA-5.4 E 16-8-2; and SFA-5.9 ER 16-8-2	134
HBB-I-14.10A-3	Stress Rupture Factors for Type 304 Stainless Steel Welded With SFA-5.22 E 316T and E 316LT-1, -2, and -3; SFA-5.4 E 316 and E 316L; and SFA-5.9 ER 316 and ER 316L	135
HBB-I-14.10B-1	Stress Rupture Factors for Type 316 Stainless Steel Welded With SFA-5.22 E 308T and E 308L T; SFA-5.4 E 308 and E 308L; and SFA-5.9 ER 308 and ER 308L	136
HBB-I-14.10B-2	Stress Rupture Factors for Type 316 Stainless Steel Welded With SFA-5.22 EXXXT-G (16-8-2 Chemistry); SFA-5.4 E 16-8-2; and SFA-5.9 ER 16-8-2	137
HBB-I-14.10B-3	Stress Rupture Factors for Type 316 Stainless Steel Welded With SFA-5.22 E 316T and E 316LT-1 and -2; SFA-5.4 E 316 and E 316L; and SFA-5.9 ER 316 and ER 316L	138
HBB-I-14.10C-1	Stress Rupture Factors for Alloy 800H Welded With SFA-5.11 ENiCrFe-2 (INCO A)	139
HBB-I-14.10C-2	Stress Rupture Factors for Alloy 800H Welded With SFA-5.14 ERNiCr-3 (INCO 82)	140
HBB-I-14.10D-1	Stress Rupture Factors for 2 <sup>1</sup> / <sub>4</sub> Cr-1Mo (60/30) Welded With SFA-5.28 E 90C-B3; SFA-5.28 ER 90S-B3; SFA-5.5 E 90XX-B3 (>0.05C); SFA-5.23 EB 3; SFA-5.23 ECB 3 (>0.05C); SFA-5.29 E 90T1-B3 (>0.05C)	141

HBB-I-14.10E-1	Stress Rupture Factors for 9Cr-1Mo-V Welded With SFA-5.28 ER 90S-B9; SFA-5.5 E90XX-B9; SFA-5.23 EB9 .....	141
HBB-I-14.11	Permissible Materials for Bolting .....	142
HBB-I-14.12	$S_o$ Values for Design Conditions Calculation of Bolting Materials $S_o$ Maximum Allowable Stress Intensity, ksi (MPa) .....	142
HBB-I-14.13C	$S_{mt}$ — Allowable Stress Values, ksi (MPa), Alloy 718, Bolting .....	144
HBB-II-3000-1	$S_{mt}$ — Allowable Stress Intensity Values for SA-533 Type B, Class 1 and SA-508 Grade 3, Class 1, ksi (MPa) .....	161
HBB-II-3000-2	$S_t$ — Allowable Stress Intensity Values for SA-533 Type B, Class 1 and SA-508 Grade 3, Class 1, ksi (MPa) .....	162
HBB-II-3000-3	Allowable Stress Intensity Values for SA-533 Type B, Class 1 and SA-508 Grade 3, Class 1, $S_m$ Yield Strength and Tensile Strength Versus Temperature .....	162
HBB-II-3000-4	Expected Minimum Stress-to-Rupture Values for SA-533 Type B, Class 1 and SA-508 Grade 3, Class 1, ksi (MPa) .....	162
HBB-II-3000-5	Modulus of Elasticity Versus Temperature for SA-533 Type B, Class 1 and SA-508 Grade 3, Class 1 .....	162
HBB-II-3000-6	Instantaneous Coefficient of Thermal Expansion Versus Temperature for SA-533 Type B, Class 1 and SA-508 Grade 3, Class 1 .....	163
HBB-II-3000-7	Mean Coefficient of Thermal Expansion Versus Temperature for SA-533 Type B, Class 1 and SA-508 Grade 3, Class 1 .....	163
HBB-II-3000-8	Design Fatigue Strain Range for SA-533 Type B, Class 1 and SA-508 Grade 3, Class 1 Up to 1,000°F (540°C) .....	163
HBB-T-1323	Temperatures at Which $S_m = S_t$ at 10 <sup>5</sup> hr .....	169
HBB-T-1324	Values of the $r$ and $s$ Parameters .....	170
HBB-T-1411-1	.....	174
HBB-T-1521-1	Time-Independent Buckling Factors .....	194
HBB-T-1522-1	Time-Dependent Load-Controlled Buckling Factors .....	194
HBB-T-1820-1	Temperature and Time Limits for Alloys in Isochronous Stress–Strain Curves .....	199
HBB-T-1831-1	.....	201
HBB-T-1831-2	.....	201
HBB-T-1831-3	.....	201
HBB-T-1831-4	.....	202
HBB-T-1832-1	.....	221
HBB-T-1832-2	.....	221
HBB-T-1832-3	.....	222
HBB-T-1832-4	.....	222
HBB-T-1832-5	.....	223
HBB-T-1832-6	.....	223
HBB-T-1832-7	.....	224
HBB-T-1832-8	.....	224
HBB-T-1833-1	.....	243
HBB-T-1834-1	.....	259
HBB-T-1834-2	.....	259
HBB-T-1835-1	.....	272
HBB-T-1835-2	.....	272
HBB-U-1	Recommended Restrictions .....	285
HCB-I-2000-1	Stress Range Reduction Factor .....	311
HCB-I-2000-2	Maximum Number of Cycles, $N_1$ , Permissible With $f = 1$ .....	311
HCB-II-2000-1	Allowable Stress Values for Ferritic Steel Class B Components .....	316
HCB-II-2000-2	Allowable Stress Values for Class B Bolting Materials .....	321
HCB-II-2000-3	Allowable Stress Values for Austenitic Steel Class B Components .....	323
HCB-II-2000-4	Allowable Stress Values for High-Nickel Alloy Class B Components .....	330
HCB-II-2000-5	Reduction Factors for Aging .....	331
HCB-II-3000-1	Allowable Stress Values for Ferritic Steel Class B Components .....	332
HCB-II-3000-2	Allowable Stress Values for Class B Bolting .....	335
HCB-II-3000-3	Allowable Stress Values for Austenitic Steel Class B Components .....	336

HCB-II-3000-4	Allowable Stress Values for High-Nickel Alloy Class B Components .....	339
HCB-II-3000-5	Reduction Factors to Be Applied to Parent Metal Allowable Stresses for 304 SS Weldments .....	340
HCB-II-3000-6	Reduction Factors to Be Applied to Parent Metal Allowable Stresses for 316 SS Weldments .....	340
HCB-II-3000-7	Reduction Factors to Be Applied to Parent Metal Allowable Stresses for Alloy 800H Weldments .....	341
HCB-II-3000-8	Reduction Factors to Be Applied to Parent Metal Allowable Stresses for 2 <sup>1</sup> / <sub>4</sub> Cr-1Mo Weldments .....	341
HCB-II-3000-9	Reduction Factors to Be Applied to Parent Metal Allowable Stresses for Modified 9Cr-1Mo Weldments .....	341
HCB-III-1000-1	Maximum Metal Temperatures During Level C Events .....	343
HGB-3217-1	Classification of Stress Intensity for Some Typical Cases .....	359
HGB-II-2121-1	Design Stress Intensity Values, $S_m$ , for Ferritic Steels at Elevated Temperatures in Core Support Structure Applications .....	379
HGB-II-2121-2	Design Stress Intensity Values, $S_m$ , for Ferritic Steels at Elevated Temperatures in Threaded Structural Fastener Applications .....	381
HGB-II-2121-3	Design Stress Intensity Values, $S_m$ , for Austenitic and High Nickel Alloys at Elevated Temperatures in Core Support Structure Applications .....	383
HGB-II-2121-4	Design Stress Intensity Values, $S_m$ , for Austenitic and High Nickel Alloys at Elevated Temperatures in Threaded Structural Fastener Applications .....	386
HGB-II-3222.4-1	Design Fatigue Limits for Solution Annealed Type 304 SS .....	393
HGB-II-3222.4-2	Design Fatigue Limits for Solution Annealed Type 316 SS .....	394
HGB-II-3222.4-3	Design Fatigue Limits for Ni-Cr-Fe Alloy 800H .....	395
HGB-II-3222.4-4	Design Fatigue Limits for 2 <sup>1</sup> / <sub>4</sub> Cr-1Mo Steel .....	396
HGB-II-3229-1	Yield Strength Values, $S_y$ , for Ferritic Steels at Elevated Temperatures in Core Support Structure Applications .....	397
HGB-II-3229-2	Yield Strength Values, $S_y$ , for Ferritic Steels at Elevated Temperatures in Threaded Structural Fastener Applications .....	399
HGB-II-3229-3	Yield Strength Values, $S_y$ , for Austenitic and High Nickel Alloys at Elevated Temperatures in Core Support Structure and Threaded Structural Fastener Applications .....	401
HGB-II-3229-4	Tensile Strength Values, $S_u$ , for Ferritic Steels at Elevated Temperatures in Core Support Structure Applications .....	402
HGB-II-3229-5	Tensile Strength Values, $S_u$ , for Ferritic Steels at Elevated Temperatures in Threaded Structural Fastener Applications .....	404
HGB-II-3229-6	Tensile Strength Values, $S_u$ , for Austenitic and High Nickel Alloys at Elevated Tempera- tures in Core Support Structure and Threaded Structural Fastener Applications .....	405
HGB-III-2000-1	Time-Independent Buckling Limits .....	409
HHA-3221-1	Design Allowable Probability of Failure .....	435
HHA-4222-1	Prohibited and Controlled Substances .....	439
HHA-II-2000-1	Notes on Material Data Sheet, <a href="#">Forms MDS-1</a> and <a href="#">MDS-2</a> .....	448
HHB-3221-1	Allowable Probability of Failure .....	481
HHB-I-1120-1	Mandatory Ceramic Composite Material Descriptors and Properties .....	494
HHB-II-2000-1	Notes on Material Data Sheet, <a href="#">Forms MDS-3</a> and <a href="#">MDS-4</a> .....	528
HHB-III-3100-1	Properties of As-Manufactured Ceramic Composite Materials .....	542
HHB-B-1410-1	Examples of Key Properties of SiC-Based Fibers for High Temperature CMCs .....	551
HHB-B-1512-1	Comparison of Strengths for 2D Woven CMCs .....	555
HHB-B-1520-1	Examples of Thermal and Electrical Response for Selected 2D Woven CMCs .....	556
HHB-B-2000-1	CMCs in Nuclear Applications .....	557

**FORMS**

MDS-1	Material Data Sheet (SI Units) .....	446
MDS-2	Material Data Sheet (U.S. Customary Units) .....	447
MDS-3	Material Data Sheet — Ceramic Composite Material (SI Units) .....	498
MDS-4	Material Data Sheet — Ceramic Composite Material (U.S. Customary Units) .....	513

<b>ENDNOTES</b> .....	573
-----------------------	-----

# LIST OF SECTIONS

(21)

## SECTIONS

- I Rules for Construction of Power Boilers
- II Materials
  - Part A — Ferrous Material Specifications
  - Part B — Nonferrous Material Specifications
  - Part C — Specifications for Welding Rods, Electrodes, and Filler Metals
  - Part D — Properties (Customary)
  - Part D — Properties (Metric)
- III Rules for Construction of Nuclear Facility Components
  - Subsection NCA — General Requirements for Division 1 and Division 2
  - Appendices
  - Division 1
    - Subsection NB — Class 1 Components
    - Subsection NCD — Class 2 and Class 3 Components\*
    - Subsection NE — Class MC Components
    - Subsection NF — Supports
    - Subsection NG — Core Support Structures
  - Division 2 — Code for Concrete Containments
  - Division 3 — Containment Systems for Transportation and Storage of Spent Nuclear Fuel and High-Level Radioactive Material
  - Division 5 — High Temperature Reactors
- IV Rules for Construction of Heating Boilers
- V Nondestructive Examination
- VI Recommended Rules for the Care and Operation of Heating Boilers
- VII Recommended Guidelines for the Care of Power Boilers
- VIII Rules for Construction of Pressure Vessels
  - Division 1
  - Division 2 — Alternative Rules
  - Division 3 — Alternative Rules for Construction of High Pressure Vessels
- IX Welding, Brazing, and Fusing Qualifications
- X Fiber-Reinforced Plastic Pressure Vessels
- XI Rules for Inservice Inspection of Nuclear Power Plant Components
  - Division 1 — Rules for Inspection and Testing of Components of Light-Water-Cooled Plants
  - Division 2 — Requirements for Reliability and Integrity Management (RIM) Programs for Nuclear Power Plants
- XII Rules for Construction and Continued Service of Transport Tanks
- XIII Rules for Overpressure Protection

---

\* In the 2021 Edition, Subsections NC and ND have been incorporated into one publication, Subsection NCD (BPVC.III.1.NCD), Class 2 and Class 3 Components.

## **INTERPRETATIONS**

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

## **CODE CASES**

The Boiler and Pressure Vessel Code committees meet regularly to consider proposed additions and revisions to the Code and to formulate Cases to clarify the intent of existing requirements or provide, when the need is urgent, rules for materials or constructions not covered by existing Code rules. Those Cases that have been adopted will appear in the appropriate 2021 Code Cases book: "Boilers and Pressure Vessels" or "Nuclear Components." Each Code Cases book is updated with seven Supplements. Supplements will be sent or made available automatically to the purchasers of the Code Cases books up to the publication of the 2023 Code. Annulments of Code Cases become effective six months after the first announcement of the annulment in a Code Case Supplement or Edition of the appropriate Code Case book. Code Case users can check the current status of any Code Case at <http://go.asme.org/BPVCCDatabase>. Code Case users can also view an index of the complete list of Boiler and Pressure Vessel Code Cases and Nuclear Code Cases at <http://go.asme.org/BPVCC>.

# FOREWORD\*

(21)

In 1911, The American Society of Mechanical Engineers established the Boiler and Pressure Vessel Committee to formulate standard rules for the construction of steam boilers and other pressure vessels. In 2009, the Boiler and Pressure Vessel Committee was superseded by the following committees:

- (a) Committee on Power Boilers (I)
- (b) Committee on Materials (II)
- (c) Committee on Construction of Nuclear Facility Components (III)
- (d) Committee on Heating Boilers (IV)
- (e) Committee on Nondestructive Examination (V)
- (f) Committee on Pressure Vessels (VIII)
- (g) Committee on Welding, Brazing, and Fusing (IX)
- (h) Committee on Fiber-Reinforced Plastic Pressure Vessels (X)
- (i) Committee on Nuclear Inservice Inspection (XI)
- (j) Committee on Transport Tanks (XII)
- (k) Committee on Overpressure Protection (XIII)
- (l) Technical Oversight Management Committee (TOMC)

Where reference is made to “the Committee” in this Foreword, each of these committees is included individually and collectively.

The Committee’s function is to establish rules of safety relating to pressure integrity, which govern the construction\*\* of boilers, pressure vessels, transport tanks, and nuclear components, and the inservice inspection of nuclear components and transport tanks. For nuclear items other than pressure-retaining components, the Committee also establishes rules of safety related to structural integrity. The Committee also interprets these rules when questions arise regarding their intent. The technical consistency of the Sections of the Code and coordination of standards development activities of the Committees is supported and guided by the Technical Oversight Management Committee. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks, or nuclear components, or the inservice inspection of nuclear components or transport tanks. Users of the Code should refer to the pertinent codes, standards, laws, regulations, or other relevant documents for safety issues other than those relating to pressure integrity and, for nuclear items other than pressure-retaining components, structural integrity. Except for Sections XI and XII, and with a few other exceptions, the rules do not, of practical necessity, reflect the likelihood and consequences of deterioration in service related to specific service fluids or external operating environments. In formulating the rules, the Committee considers the needs of users, manufacturers, and inspectors of components addressed by the Code. The objective of the rules is to afford reasonably certain protection of life and property, and to provide a margin for deterioration in service to give a reasonably long, safe period of usefulness. Advancements in design and materials and evidence of experience have been recognized.

This Code contains mandatory requirements, specific prohibitions, and nonmandatory guidance for construction activities and inservice inspection and testing activities. The Code does not address all aspects of these activities and those aspects that are not specifically addressed should not be considered prohibited. The Code is not a handbook and cannot replace education, experience, and the use of engineering judgment. The phrase *engineering judgment* refers to technical judgments made by knowledgeable engineers experienced in the application of the Code. Engineering judgments must be consistent with Code philosophy, and such judgments must never be used to overrule mandatory requirements or specific prohibitions of the Code.

The Committee recognizes that tools and techniques used for design and analysis change as technology progresses and expects engineers to use good judgment in the application of these tools. The designer is responsible for complying with Code rules and demonstrating compliance with Code equations when such equations are mandatory. The Code

---

\* The information contained in this Foreword is not part of this American National Standard (ANS) and has not been processed in accordance with ANSI’s requirements for an ANS. Therefore, this Foreword may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to the Code.

\*\* *Construction*, as used in this Foreword, is an all-inclusive term comprising materials, design, fabrication, examination, inspection, testing, certification, and overpressure protection.

neither requires nor prohibits the use of computers for the design or analysis of components constructed to the requirements of the Code. However, designers and engineers using computer programs for design or analysis are cautioned that they are responsible for all technical assumptions inherent in the programs they use and the application of these programs to their design.

The rules established by the Committee are not to be interpreted as approving, recommending, or endorsing any proprietary or specific design, or as limiting in any way the manufacturer's freedom to choose any method of design or any form of construction that conforms to the Code rules.

The Committee meets regularly to consider revisions of the rules, new rules as dictated by technological development, Code Cases, and requests for interpretations. Only the Committee has the authority to provide official interpretations of this Code. Requests for revisions, new rules, Code Cases, or interpretations shall be addressed to the Secretary in writing and shall give full particulars in order to receive consideration and action (see Submittal of Technical Inquiries to the Boiler and Pressure Vessel Standards Committees). Proposed revisions to the Code resulting from inquiries will be presented to the Committee for appropriate action. The action of the Committee becomes effective only after confirmation by ballot of the Committee and approval by ASME. Proposed revisions to the Code approved by the Committee are submitted to the American National Standards Institute (ANSI) and published at <http://go.asme.org/BPVCPublicReview> to invite comments from all interested persons. After public review and final approval by ASME, revisions are published at regular intervals in Editions of the Code.

The Committee does not rule on whether a component shall or shall not be constructed to the provisions of the Code. The scope of each Section has been established to identify the components and parameters considered by the Committee in formulating the Code rules.

Questions or issues regarding compliance of a specific component with the Code rules are to be directed to the ASME Certificate Holder (Manufacturer). Inquiries concerning the interpretation of the Code are to be directed to the Committee. ASME is to be notified should questions arise concerning improper use of the ASME Single Certification Mark.

When required by context in this Section, the singular shall be interpreted as the plural, and vice versa, and the feminine, masculine, or neuter gender shall be treated as such other gender as appropriate.

The words "shall," "should," and "may" are used in this Standard as follows:

- *Shall* is used to denote a requirement.
- *Should* is used to denote a recommendation.
- *May* is used to denote permission, neither a requirement nor a recommendation.

## **STATEMENT OF POLICY ON THE USE OF THE ASME SINGLE CERTIFICATION MARK AND CODE AUTHORIZATION IN ADVERTISING**

ASME has established procedures to authorize qualified organizations to perform various activities in accordance with the requirements of the ASME Boiler and Pressure Vessel Code. It is the aim of the Society to provide recognition of organizations so authorized. An organization holding authorization to perform various activities in accordance with the requirements of the Code may state this capability in its advertising literature.

Organizations that are authorized to use the ASME Single Certification Mark for marking items or constructions that have been constructed and inspected in compliance with the ASME Boiler and Pressure Vessel Code are issued Certificates of Authorization. It is the aim of the Society to maintain the standing of the ASME Single Certification Mark for the benefit of the users, the enforcement jurisdictions, and the holders of the ASME Single Certification Mark who comply with all requirements.

Based on these objectives, the following policy has been established on the usage in advertising of facsimiles of the ASME Single Certification Mark, Certificates of Authorization, and reference to Code construction. The American Society of Mechanical Engineers does not “approve,” “certify,” “rate,” or “endorse” any item, construction, or activity and there shall be no statements or implications that might so indicate. An organization holding the ASME Single Certification Mark and/or a Certificate of Authorization may state in advertising literature that items, constructions, or activities “are built (produced or performed) or activities conducted in accordance with the requirements of the ASME Boiler and Pressure Vessel Code,” or “meet the requirements of the ASME Boiler and Pressure Vessel Code.” An ASME corporate logo shall not be used by any organization other than ASME.

The ASME Single Certification Mark shall be used only for stamping and nameplates as specifically provided in the Code. However, facsimiles may be used for the purpose of fostering the use of such construction. Such usage may be by an association or a society, or by a holder of the ASME Single Certification Mark who may also use the facsimile in advertising to show that clearly specified items will carry the ASME Single Certification Mark.

## **STATEMENT OF POLICY ON THE USE OF ASME MARKING TO IDENTIFY MANUFACTURED ITEMS**

The ASME Boiler and Pressure Vessel Code provides rules for the construction of boilers, pressure vessels, and nuclear components. This includes requirements for materials, design, fabrication, examination, inspection, and stamping. Items constructed in accordance with all of the applicable rules of the Code are identified with the ASME Single Certification Mark described in the governing Section of the Code.

Markings such as “ASME,” “ASME Standard,” or any other marking including “ASME” or the ASME Single Certification Mark shall not be used on any item that is not constructed in accordance with all of the applicable requirements of the Code.

Items shall not be described on ASME Data Report Forms nor on similar forms referring to ASME that tend to imply that all Code requirements have been met when, in fact, they have not been. Data Report Forms covering items not fully complying with ASME requirements should not refer to ASME or they should clearly identify all exceptions to the ASME requirements.

## (21) SUBMITTAL OF TECHNICAL INQUIRIES TO THE BOILER AND PRESSURE VESSEL STANDARDS COMMITTEES

### 1 INTRODUCTION

(a) The following information provides guidance to Code users for submitting technical inquiries to the applicable Boiler and Pressure Vessel (BPV) Standards Committee (hereinafter referred to as the Committee). See the guidelines on approval of new materials under the ASME Boiler and Pressure Vessel Code in Section II, Part D for requirements for requests that involve adding new materials to the Code. See the guidelines on approval of new welding and brazing materials in Section II, Part C for requirements for requests that involve adding new welding and brazing materials (“consumables”) to the Code.

Technical inquiries can include requests for revisions or additions to the Code requirements, requests for Code Cases, or requests for Code Interpretations, as described below:

(1) *Code Revisions.* Code revisions are considered to accommodate technological developments, to address administrative requirements, to incorporate Code Cases, or to clarify Code intent.

(2) *Code Cases.* Code Cases represent alternatives or additions to existing Code requirements. Code Cases are written as a Question and Reply, and are usually intended to be incorporated into the Code at a later date. When used, Code Cases prescribe mandatory requirements in the same sense as the text of the Code. However, users are cautioned that not all regulators, jurisdictions, or Owners automatically accept Code Cases. The most common applications for Code Cases are as follows:

(-a) to permit early implementation of an approved Code revision based on an urgent need

(-b) to permit use of a new material for Code construction

(-c) to gain experience with new materials or alternative requirements prior to incorporation directly into the Code

(3) *Code Interpretations*

(-a) Code Interpretations provide clarification of the meaning of existing requirements in the Code and are presented in Inquiry and Reply format. Interpretations do not introduce new requirements.

(-b) Interpretations will be issued only if existing Code text is ambiguous or conveys conflicting requirements. If a revision of the requirements is required to support the Interpretation, an Intent Interpretation will be issued in parallel with a revision to the Code.

(b) Code requirements, Code Cases, and Code Interpretations established by the Committee are not to be considered as approving, recommending, certifying, or endorsing any proprietary or specific design, or as limiting in any way the freedom of manufacturers, constructors, or Owners to choose any method of design or any form of construction that conforms to the Code requirements.

(c) Inquiries that do not comply with the following guidance or that do not provide sufficient information for the Committee’s full understanding may result in the request being returned to the Inquirer with no action.

### 2 INQUIRY FORMAT

Submittals to the Committee should include the following information:

(a) *Purpose.* Specify one of the following:

(1) request for revision of present Code requirements

(2) request for new or additional Code requirements

(3) request for Code Case

(4) request for Code Interpretation

(b) *Background.* The Inquirer should provide the information needed for the Committee’s understanding of the Inquiry, being sure to include reference to the applicable Code Section, Division, Edition, Addenda (if applicable), paragraphs, figures, and tables. This information should include a statement indicating why the included paragraphs, figures, or tables are ambiguous or convey conflicting requirements. Preferably, the Inquirer should provide a copy of, or relevant extracts from, the specific referenced portions of the Code.

(c) *Presentations.* The Inquirer may desire to attend or be asked to attend a meeting of the Committee to make a formal presentation or to answer questions from the Committee members with regard to the Inquiry. Attendance at a BPV Standards Committee meeting shall be at the expense of the Inquirer. The Inquirer's attendance or lack of attendance at a meeting will not be used by the Committee as a basis for acceptance or rejection of the Inquiry by the Committee. However, if the Inquirer's request is unclear, attendance by the Inquirer or a representative may be necessary for the Committee to understand the request sufficiently to be able to provide an Interpretation. If the Inquirer desires to make a presentation at a Committee meeting, the Inquirer should provide advance notice to the Committee Secretary, to ensure time will be allotted for the presentation in the meeting agenda. The Inquirer should consider the need for additional audiovisual equipment that might not otherwise be provided by the Committee. With sufficient advance notice to the Committee Secretary, such equipment may be made available.

### 3 CODE REVISIONS OR ADDITIONS

Requests for Code revisions or additions should include the following information:

(a) *Requested Revisions or Additions.* For requested revisions, the Inquirer should identify those requirements of the Code that they believe should be revised, and should submit a copy of, or relevant extracts from, the appropriate requirements as they appear in the Code, marked up with the requested revision. For requested additions to the Code, the Inquirer should provide the recommended wording and should clearly indicate where they believe the additions should be located in the Code requirements.

(b) *Statement of Need.* The Inquirer should provide a brief explanation of the need for the revision or addition.

(c) *Background Information.* The Inquirer should provide background information to support the revision or addition, including any data or changes in technology that form the basis for the request, that will allow the Committee to adequately evaluate the requested revision or addition. Sketches, tables, figures, and graphs should be submitted, as appropriate. The Inquirer should identify any pertinent portions of the Code that would be affected by the revision or addition and any portions of the Code that reference the requested revised or added paragraphs.

### 4 CODE CASES

Requests for Code Cases should be accompanied by a statement of need and background information similar to that described in 3(b) and 3(c), respectively, for Code revisions or additions. The urgency of the Code Case (e.g., project underway or imminent, new procedure) should be described. In addition, it is important that the request is in connection with equipment that will bear the ASME Single Certification Mark, with the exception of Section XI applications. The proposed Code Case should identify the Code Section and Division, and should be written as a Question and a Reply, in the same format as existing Code Cases. Requests for Code Cases should also indicate the applicable Code Editions and Addenda (if applicable) to which the requested Code Case applies.

### 5 CODE INTERPRETATIONS

(a) Requests for Code Interpretations should be accompanied by the following information:

(1) *Inquiry.* The Inquirer should propose a condensed and precise Inquiry, omitting superfluous background information and, when possible, composing the Inquiry in such a way that a "yes" or a "no" Reply, with brief limitations or conditions, if needed, can be provided by the Committee. The proposed question should be technically and editorially correct.

(2) *Reply.* The Inquirer should propose a Reply that clearly and concisely answers the proposed Inquiry question. Preferably, the Reply should be "yes" or "no," with brief limitations or conditions, if needed.

(3) *Background Information.* The Inquirer should include a statement indicating why the included paragraphs, figures, or tables are ambiguous or convey conflicting requirements. The Inquirer should provide any need or background information, such as described in 3(b) and 3(c), respectively, for Code revisions or additions, that will assist the Committee in understanding the proposed Inquiry and Reply.

If the Inquirer believes a revision of the Code requirements would be helpful to support the Interpretation, the Inquirer may propose such a revision for consideration by the Committee. In most cases, such a proposal is not necessary.

(b) Requests for Code Interpretations should be limited to an Interpretation of a particular requirement in the Code or in a Code Case. Except with regard to interpreting a specific Code requirement, the Committee is not permitted to consider consulting-type requests such as the following:

(1) a review of calculations, design drawings, welding qualifications, or descriptions of equipment or parts to determine compliance with Code requirements

- (2) a request for assistance in performing any Code-prescribed functions relating to, but not limited to, material selection, designs, calculations, fabrication, inspection, pressure testing, or installation
- (3) a request seeking the rationale for Code requirements

## 6 SUBMITTALS

(a) *Submittal.* Requests for Code Interpretation should preferably be submitted through the online Interpretation Submittal Form. The form is accessible at <http://go.asme.org/InterpretationRequest>. Upon submittal of the form, the Inquirer will receive an automatic e-mail confirming receipt. If the Inquirer is unable to use the online form, the Inquirer may mail the request to the following address:

Secretary  
ASME Boiler and Pressure Vessel Committee  
Two Park Avenue  
New York, NY 10016-5990

All other Inquiries should be mailed to the Secretary of the BPV Committee at the address above. Inquiries are unlikely to receive a response if they are not written in clear, legible English. They must also include the name of the Inquirer and the company they represent or are employed by, if applicable, and the Inquirer's address, telephone number, fax number, and e-mail address, if available.

(b) *Response.* The Secretary of the appropriate Committee will provide a written response, via letter or e-mail, as appropriate, to the Inquirer, upon completion of the requested action by the Committee. Inquirers may track the status of their Interpretation Request at <http://go.asme.org/Interpretations>.

# PERSONNEL

## ASME Boiler and Pressure Vessel Standards Committees, Subgroups, and Working Groups

January 1, 2021

### TECHNICAL OVERSIGHT MANAGEMENT COMMITTEE (TOMC)

R. E. McLaughlin, <i>Chair</i>	J. F. Henry
N. A. Finney, <i>Vice Chair</i>	R. B. Keating
S. J. Rossi, <i>Staff Secretary</i>	B. Linnemann
G. Auriolles, Sr.	W. M. Lundy
R. W. Barnes	D. I. Morris
T. L. Bedeaux	T. P. Pastor
D. A. Bowers	M. D. Rana
C. Brown	S. C. Roberts
D. B. DeMichael	F. J. Schaaf, Jr.
R. P. Deubler	G. Scribner
P. D. Edwards	W. J. Sperko
J. G. Feldstein	D. Srnica
G. W. Galanes	R. W. Swayne
J. A. Hall	M. Wadkinson
T. E. Hansen	J. E. Batey, <i>Contributing Member</i>
G. W. Hembree	

### Subgroup on Research and Development (TOMC)

S. C. Roberts, <i>Chair</i>	B. Hrubala
S. J. Rossi, <i>Staff Secretary</i>	R. B. Keating
R. W. Barnes	R. E. McLaughlin
N. A. Finney	T. P. Pastor
J. F. Henry	D. Andrei, <i>Contributing Member</i>
W. Hoffelner	

### Subgroup on Strategic Initiatives (TOMC)

N. A. Finney, <i>Chair</i>	M. H. Jawad
S. J. Rossi, <i>Staff Secretary</i>	R. B. Keating
R. W. Barnes	R. E. McLaughlin
T. L. Bedeaux	T. P. Pastor
G. W. Hembree	S. C. Roberts
J. F. Henry	

### Task Group on Remote Inspection and Examination (SI-TOMC)

S. C. Roberts, <i>Chair</i>	M. Tannenbaum
P. J. Coco	J. Cameron, <i>Alternate</i>
N. A. Finney	P. Lang, <i>Contributing Member</i>
S. A. Marks	J. Pang, <i>Contributing Member</i>
R. Rockwood	S. J. Rossi, <i>Contributing Member</i>
C. Stevens	C. A. Sanna, <i>Contributing Member</i>

### Special Working Group on High Temperature Technology (TOMC)

D. Dewees, <i>Chair</i>	B. F. Hantz
F. W. Brust	J. F. Henry
T. D. Burchell	R. I. Jetter
P. R. Donavin	P. Smith

### ADMINISTRATIVE COMMITTEE

R. E. McLaughlin, <i>Chair</i>	R. B. Keating
N. A. Finney, <i>Vice Chair</i>	B. Linnemann
S. J. Rossi, <i>Staff Secretary</i>	M. D. Rana
D. A. Bowers	S. C. Roberts
J. Cameron	R. R. Stevenson
D. B. DeMichael	R. W. Swayne
J. A. Hall	

### MARINE CONFERENCE GROUP

E. Lawson, <i>Staff Secretary</i>	H. N. Patel
J. G. Hungerbuhler, Jr.	N. Prokopuk
G. Nair	J. D. Reynolds

### CONFERENCE COMMITTEE

C. B. Cantrell — Nebraska, <i>Chair</i>	A. M. Lorimor — South Dakota
J. T. Amato — Ohio, <i>Secretary</i>	M. Mailman — Northwest Territories, Canada
W. Anderson — Mississippi	W. McGivney — City of New York, New York
P. Bearden — Minnesota	S. F. Noonan — Maryland
R. Becker — Colorado	A. K. Oda — Washington
T. D. Boggs — Missouri	B. S. Oliver — New Hampshire
R. A. Boillard — Indiana	J. L. Oliver — Nevada
R. J. Bunte — Iowa	M. Poehlmann — Alberta, Canada
J. H. Burpee — Maine	P. B. Polick — Illinois
S. Chapman — Tennessee	J. F. Porcella — West Virginia
T. G. Clark — Oregon	C. F. Reyes — California
B. J. Crawford — Georgia	W. J. Ross — Pennsylvania
E. L. Creaser — New Brunswick, Canada	M. J. Ryan — City of Chicago, Illinois
J. J. Dacanay — Hawaii	M. H. Sansone — New York
R. DeLury — Manitoba, Canada	T. S. Seime — North Dakota
C. Dinic — Ontario, Canada	C. S. Selinger — Saskatchewan, Canada
D. Eastman — Newfoundland and Labrador, Canada	J. E. Sharier — Ohio
D. A. Ehler — Nova Scotia, Canada	R. Spiker — North Carolina
S. D. Frazier — Washington	D. J. Stenrose — Michigan
T. J. Granneman II — Oklahoma	R. J. Stimson II — Kansas
S. Harder — Arizona	R. K. Sturm — Utah
E. G. Hilton — Virginia	D. K. Sullivan — Arkansas
M. L. Jordan — Kentucky	J. Taveras — Rhode Island
R. Kamboj — British Columbia, Canada	G. Teel — California
E. Kawa, Jr. — Massachusetts	S. R. Townsend — Prince Edward Island, Canada
A. Khassasi — Quebec, Canada	R. D. Trout — Texas
D. Kinney — North Carolina	D. M. Warburton — Florida
J. Klug — City of Milwaukee, Wisconsin	M. Washington — New Jersey
K. S. Lane — Alaska	E. Wiggins — Alabama
J. LeSage, Jr. — Louisiana	

**INTERNATIONAL INTEREST REVIEW GROUP**

V. Felix  
 Y.-G. Kim  
 S. H. Leong  
 W. Lin  
 O. F. Manafa

C. Minu  
 Y.-W. Park  
 A. R. Reynaga Nogales  
 P. Williamson

**COMMITTEE ON POWER BOILERS (BPV I)**

R. E. McLaughlin, *Chair*  
 E. M. Ortman, *Vice Chair*  
 U. D'Urso, *Staff Secretary*  
 D. I. Anderson  
 J. L. Arnold  
 K. K. Coleman  
 P. D. Edwards  
 J. G. Feldstein  
 S. Fincher  
 G. W. Galanes  
 T. E. Hansen  
 J. F. Henry  
 J. S. Hunter  
 M. Ishikawa  
 G. B. Komora  
 F. Massi  
 L. Moedinger  
 P. A. Molvie  
 Y. Oishi  
 D. E. Tompkins

D. E. Tuttle  
 J. Vattappilly  
 M. Wadkinson  
 R. V. Wielgoszinski  
 F. Zeller  
 H. Michael, *Delegate*  
 D. L. Berger, *Honorary Member*  
 D. N. French, *Honorary Member*  
 J. Hainsworth, *Honorary Member*  
 W. L. Lowry, *Honorary Member*  
 J. R. MacKay, *Honorary Member*  
 T. C. McGough, *Honorary Member*  
 J. T. Pillow, *Honorary Member*  
 B. W. Roberts, *Honorary Member*  
 R. D. Schueler, Jr., *Honorary Member*  
 J. M. Tanzosh, *Honorary Member*  
 R. L. Williams, *Honorary Member*  
 L. W. Yoder, *Honorary Member*

**Executive Committee (BPV I)**

E. M. Ortman, *Chair*  
 R. E. McLaughlin, *Vice Chair*  
 D. I. Anderson  
 J. L. Arnold  
 J. R. Braun  
 K. K. Coleman  
 H. Dalal

T. Dhanraj  
 U. D'Urso  
 P. F. Gilston  
 K. Hayes  
 P. Jennings  
 A. Spangenberg  
 D. E. Tompkins

**Subgroup on Design (BPV I)**

D. I. Anderson, *Chair*  
 L. S. Tsai, *Secretary*  
 P. Becker  
 D. Dewees  
 G. B. Komora  
 L. Krupp

P. A. Molvie  
 N. Ranck  
 J. Vattappilly  
 M. Wadkinson  
 J. P. Glaspie, *Contributing Member*

**Subgroup on Fabrication and Examination (BPV I)**

J. L. Arnold, *Chair*  
 P. F. Gilston, *Vice Chair*  
 P. Becker, *Secretary*  
 A. Biesecker  
 K. K. Coleman  
 S. Fincher  
 G. W. Galanes  
 T. E. Hansen

P. Jennings  
 M. Lewis  
 C. T. McDaris  
 R. E. McLaughlin  
 R. J. Newell  
 Y. Oishi  
 R. V. Wielgoszinski

**Subgroup on General Requirements and Piping (BPV I)**

E. M. Ortman, *Chair*  
 D. E. Tompkins, *Vice Chair*  
 F. Massi, *Secretary*  
 P. D. Edwards  
 T. E. Hansen  
 M. Ishikawa  
 M. Lemmons  
 R. E. McLaughlin

L. Moedinger  
 B. J. Mollitor  
 Y. Oishi  
 D. E. Tuttle  
 M. Wadkinson  
 R. V. Wielgoszinski  
 W. L. Lowry, *Contributing Member*

**Subgroup on Locomotive Boilers (BPV I)**

J. R. Braun, *Chair*  
 S. M. Butler, *Secretary*  
 A. Biesecker  
 C. Cross  
 G. W. Galanes  
 D. W. Griner

M. A. Janssen  
 S. A. Lee  
 L. Moedinger  
 G. M. Ray  
 M. W. Westland

**Subgroup on Materials (BPV I)**

K. K. Coleman, *Chair*  
 K. Hayes, *Vice Chair*  
 M. Lewis, *Secretary*  
 S. H. Bowes  
 G. W. Galanes  
 P. F. Gilston  
 J. F. Henry  
 J. S. Hunter  
 E. Liebl

F. Masuyama  
 M. Ortolani  
 D. W. Rahoi  
 J. Vattappilly  
 F. Zeller  
 B. W. Roberts, *Contributing Member*  
 J. M. Tanzosh, *Contributing Member*

**Subgroup on Solar Boilers (BPV I)**

P. Jennings, *Chair*  
 R. E. Hearne, *Secretary*  
 S. Fincher

J. S. Hunter  
 F. Massi  
 P. Swarnkar

**Task Group on Modernization (BPV I)**

D. I. Anderson, *Chair*  
 U. D'Urso, *Staff Secretary*  
 J. L. Arnold  
 D. Dewees  
 G. W. Galanes  
 J. P. Glaspie  
 T. E. Hansen

J. F. Henry  
 R. E. McLaughlin  
 P. A. Molvie  
 E. M. Ortman  
 D. E. Tuttle  
 J. Vattappilly

**Germany International Working Group (BPV I)**

A. Spangenberg, *Chair*  
 P. Chavdarov, *Secretary*  
 B. Daume  
 J. Fleischfresser  
 R. Kauer  
 D. Koelbl  
 S. Krebs  
 T. Ludwig  
 R. A. Meyers  
 H. Michael

F. Miunske  
 M. Sykora  
 R. Helmholtz, *Contributing Member*  
 J. Henrichsmeyer, *Contributing Member*  
 B. Müller, *Contributing Member*  
 P. Paluszkiewicz, *Contributing Member*  
 R. Uebel, *Contributing Member*

**India International Working Group (BPV I)**

H. Dalal, <i>Chair</i>	S. Purkait
T. Dhanraj, <i>Vice Chair</i>	M. G. Rao
K. Thanupillai, <i>Secretary</i>	U. Revisankaran
P. Brahma	G. U. Shanker
S. Chakrabarti	D. K. Shrivastava
A. Hantodkar	K. Singha
S. A. Kumar	R. Sundararaj
A. J. Patil	S. Venkataramana
A. R. Patil	

**Subgroup on Ferrous Specifications (BPV II)**

A. Appleton, <i>Chair</i>	J. Gundlach
K. M. Hottle, <i>Vice Chair</i>	D. S. Janikowski
C. Hyde, <i>Secretary</i>	S. G. Lee
B. M. Dingman	W. C. Mack
M. J. Dossourian	K. E. Orié
O. Elkadim	D. Poweleit
D. Fialkowski	E. Uptis
J. F. Grubb	J. D. Fritz, <i>Contributing Member</i>

**COMMITTEE ON MATERIALS (BPV II)**

J. Cameron, <i>Chair</i>	J. D. Fritz, <i>Contributing Member</i>
J. F. Grubb, <i>Vice Chair</i>	W. Hoffelner, <i>Contributing Member</i>
C. E. O'Brien, <i>Staff Secretary</i>	M. Katcher, <i>Contributing Member</i>
A. Appleton	R. K. Nanstad, <i>Contributing Member</i>
P. Chavdarov	M. L. Nayyar, <i>Contributing Member</i>
J. R. Foulds	D. T. Peters, <i>Contributing Member</i>
D. W. Gandy	B. W. Roberts, <i>Contributing Member</i>
J. A. Hall	J. J. Sanchez-Hanton, <i>Contributing Member</i>
J. F. Henry	R. W. Swindeman, <i>Contributing Member</i>
K. M. Hottle	J. M. Tanzosh, <i>Contributing Member</i>
M. Ishikawa	E. Uptis, <i>Contributing Member</i>
K. Kimura	R. G. Young, <i>Contributing Member</i>
F. Masuyama	T. M. Cullen, <i>Honorary Member</i>
K. E. Orié	W. D. Edsall, <i>Honorary Member</i>
D. W. Rahoí	G. C. Hsu, <i>Honorary Member</i>
W. Ren	C. E. Spaeder, Jr., <i>Honorary Member</i>
E. Shapiro	A. W. Zeuthen, <i>Honorary Member</i>
R. C. Sutherland	
F. Zeller	
O. Oldani, <i>Delegate</i>	
F. Abe, <i>Contributing Member</i>	
A. Chaudouet, <i>Contributing Member</i>	
D. B. Denis, <i>Contributing Member</i>	

**Subgroup on International Material Specifications (BPV II)**

M. Ishikawa, <i>Chair</i>	W. M. Lundy
A. R. Nywening, <i>Vice Chair</i>	F. Zeller
B. Mruk, <i>Secretary</i>	C. Zhou
A. Chaudouet	O. Oldani, <i>Delegate</i>
P. Chavdarov	H. Lorenz, <i>Contributing Member</i>
H. Chen	T. F. Miskell, <i>Contributing Member</i>
A. F. Garbolevsky	E. Uptis, <i>Contributing Member</i>
D. O. Henry	

**Subgroup on Nonferrous Alloys (BPV II)**

E. Shapiro, <i>Chair</i>	D. W. Rahoí
S. Yem, <i>Vice Chair</i>	W. Ren
J. Robertson, <i>Secretary</i>	R. C. Sutherland
R. M. Beldyk	J. Weritz
J. M. Downs	A. Williams
J. F. Grubb	R. Wright
W. MacDonald	D. B. Denis, <i>Contributing Member</i>
D. Maitra	M. Katcher, <i>Contributing Member</i>
J. A. McMaster	D. T. Peters, <i>Contributing Member</i>

**Executive Committee (BPV II)**

J. Cameron, <i>Chair</i>	M. Ishikawa
C. E. O'Brien, <i>Staff Secretary</i>	D. L. Kurlé
A. Appleton	R. W. Mikitka
G. W. Galanes	E. Shapiro
J. F. Grubb	R. C. Sutherland
J. F. Henry	

**Subgroup on Physical Properties (BPV II)**

J. F. Grubb, <i>Chair</i>	P. K. Lam
P. K. Rai, <i>Vice Chair</i>	S. Neilsen
G. Aurióles, Sr.	D. W. Rahoí
D. Chandiramani	E. Shapiro
P. Chavdarov	D. K. Verma
H. Eshraghi	S. Yem
B. F. Hantz	D. B. Denis, <i>Contributing Member</i>
R. D. Jones	

**Subgroup on External Pressure (BPV II)**

D. L. Kurlé, <i>Chair</i>	J. F. Grubb
S. Guzey, <i>Vice Chair</i>	M. H. Jawad
J. A. A. Morrow, <i>Secretary</i>	S. Krishnamurthy
E. Alexis	R. W. Mikitka
L. F. Campbell	P. K. Rai
H. Chen	M. Wadkinson
D. S. Griffin	M. Katcher, <i>Contributing Member</i>

**Subgroup on Strength, Ferrous Alloys (BPV II)**

S. W. Knowles, <i>Vice Chair</i>	M. Osterfoss
L. S. Nicol, <i>Secretary</i>	D. W. Rahoí
J. R. Foulds	S. Rosinski
G. W. Galanes	M. Ueyama
J. A. Hall	F. Zeller
J. F. Henry	F. Abe, <i>Contributing Member</i>
M. Ishikawa	A. Di Rienzo, <i>Contributing Member</i>
F. Masuyama	M. Nair, <i>Contributing Member</i>
M. Ortolani	R. G. Young, <i>Contributing Member</i>

**Subgroup on Strength of Weldments (BPV II & BPV IX)**

G. W. Galanes, <i>Chair</i>	J. Penso
K. L. Hayes, <i>Vice Chair</i>	D. W. Raho
S. H. Bowes, <i>Secretary</i>	B. W. Roberts
K. K. Coleman	W. J. Sperko
M. Denault	J. P. Swezy, Jr.
J. R. Foulds	M. Ueyama
D. W. Gandy	P. D. Flenner, <i>Contributing Member</i>
M. Ghahremani	J. J. Sanchez-Hanton, <i>Contributing Member</i>
J. F. Henry	
W. F. Newell, Jr.	

**Working Group on Materials Database (BPV II)**

W. Hoffelner, <i>Vice Chair</i>	J. L. Arnold, <i>Contributing Member</i>
C. E. O'Brien, <i>Staff Secretary</i>	D. T. Peters, <i>Contributing Member</i>
F. Abe	W. Ren, <i>Contributing Member</i>
J. R. Foulds	B. W. Roberts, <i>Contributing Member</i>
J. F. Henry	
R. C. Sutherlin	R. W. Swindeman, <i>Contributing Member</i>
D. Andrei, <i>Contributing Member</i>	

**Working Group on Creep Strength Enhanced Ferritic Steels (BPV II)**

M. Ortolani, <i>Chair</i>	J. J. Sanchez-Hanton
G. W. Galanes, <i>Vice Chair</i>	J. A. Siefert
S. H. Bowes	W. J. Sperko
K. K. Coleman	F. Zeller
J. R. Foulds	F. Abe, <i>Contributing Member</i>
J. F. Henry	G. Cumino, <i>Contributing Member</i>
M. Lang	P. D. Flenner, <i>Contributing Member</i>
S. Luke	R. W. Swindeman, <i>Contributing Member</i>
F. Masuyama	
T. Melfi	J. M. Tanzosh, <i>Contributing Member</i>
W. F. Newell, Jr.	

**Working Group on Data Analysis (BPV II)**

J. F. Grubb, <i>Chair</i>	F. Abe, <i>Contributing Member</i>
J. R. Foulds, <i>Vice Chair</i>	W. Hoffelner, <i>Contributing Member</i>
J. F. Henry	M. Katcher, <i>Contributing Member</i>
F. Masuyama	D. T. Peters, <i>Contributing Member</i>
M. Ortolani	B. W. Roberts, <i>Contributing Member</i>
W. Ren	
M. Subanovic	R. W. Swindeman, <i>Contributing Member</i>
M. J. Swindeman	

**China International Working Group (BPV II)**

S. Liu, <i>Chair</i>	Q.-J. Wang
Yong Zhang, <i>Vice Chair</i>	X. Wang
A. T. Xu, <i>Secretary</i>	F. Yang
W. Fang	G. Yang
Q. C. Feng	H.-C. Yang
S. Huo	J. Yang
F. Kong	R. Ye
H. Li	L. Yin
J. Li	H. Zhang
S. Li	X.-H. Zhang
Z. Rongcan	Yingkai Zhang
S. Tan	Q. Zhao
C. Wang	S. Zhao
J. Wang	

**COMMITTEE ON CONSTRUCTION OF NUCLEAR FACILITY COMPONENTS (BPV III)**

R. B. Keating, <i>Chair</i>	M. A. Lockwood
T. M. Adams, <i>Vice Chair</i>	K. A. Manoly
D. E. Matthews, <i>Vice Chair</i>	K. Matsunaga
K. Verderber, <i>Staff Secretary</i>	B. McGlone
A. Appleton	S. McKillop
S. Asada	J. C. Minichiello
R. W. Barnes	M. N. Mitchell
W. H. Borter	T. Nagata
M. E. Cohen	J. B. Ossmann
R. P. Deubler	S. Pellet
P. R. Donavin	E. L. Pleins
A. C. Eberhardt	S. Sham
J. V. Gardiner	W. J. Sperko
J. Grimm	C. T. Smith, <i>Contributing Member</i>
S. Hunter	W. K. Sowder, Jr., <i>Contributing Member</i>
R. M. Jessee	
R. I. Jetter	M. Zhou, <i>Contributing Member</i>
C. C. Kim	D. K. Morton, <i>Honorary Member</i>
G. H. Koo	R. F. Reedy, Sr., <i>Honorary Member</i>
V. Kostarev	

**Executive Committee (BPV III)**

R. B. Keating, <i>Chair</i>	D. E. Matthews
K. Verderber, <i>Staff Secretary</i>	S. McKillop
T. M. Adams	J. A. Munshi
P. R. Donavin	S. Sham
J. V. Gardiner	W. K. Sowder, Jr.
J. Grimm	

**Subcommittee on Design (BPV III)**

P. R. Donavin, <i>Chair</i>	S. Sham
R. P. Deubler	W. F. Weitze
M. A. Gray	G. L. Hollinger, <i>Contributing Member</i>
R. I. Jetter	
R. B. Keating	M. H. Jawad, <i>Contributing Member</i>
K. A. Manoly	W. J. O'Donnell, Sr., <i>Contributing Member</i>
D. E. Matthews	
S. McKillop	K. Wright, <i>Contributing Member</i>
M. N. Mitchell	

**Subgroup on Component Design (SC-D) (BPV III)**

D. E. Matthews, <i>Chair</i>	K. A. Manoly
P. Vock, <i>Vice Chair</i>	R. J. Masterson
S. Pellet, <i>Secretary</i>	J. C. Minichiello
T. M. Adams	T. Mitsuhashi
D. J. Ammerman	D. Murphy
G. A. Antaki	T. M. Musto
S. Asada	T. Nagata
J. F. Ball	J. R. Stinson
C. Basavaraju	G. Z. Tokarski
D. Chowdhury	J. P. Tucker
R. P. Deubler	S. Willoughby-Braun
P. Hirschberg	C. Wilson
M. Kassar	A. A. Dermenjian, <i>Contributing Member</i>
R. B. Keating	
D. Keck	I. Saito, <i>Contributing Member</i>
O.-S. Kim	K. R. Wichman, <i>Honorary Member</i>
T. R. Liszkai	

**Working Group on Core Support Structures (SG-CD) (BPV III)**

D. Keck, <i>Chair</i>	M. D. Snyder
R. Z. Ziegler, <i>Vice Chair</i>	R. Vollmer
R. Martin, <i>Secretary</i>	T. M. Wiger
G. W. Delpont	C. Wilson
L. C. Hartless	Y. Wong
T. R. Liszkai	A. Tsirigotis, <i>Alternate</i>
H. S. Mehta	J. F. Kielb, <i>Contributing Member</i>
M. Nakajima	

**Working Group on Pumps (SG-CD) (BPV III)**

D. Chowdhury, <i>Chair</i>	J. Sulley
J. V. Gregg, Jr., <i>Secretary</i>	A. G. Washburn
M. D. Eftychiou	Y. Wong
R. A. Fleming	I. H. Tseng, <i>Alternate</i>
S. Hughes	X. Di, <i>Contributing Member</i>
J. Kikushima	C. Gabhart, <i>Contributing Member</i>
K. J. Noel	R. Ladefian, <i>Contributing Member</i>

**Working Group on Design of Division 3 Containment Systems (SG-CD) (BPV III)**

D. J. Ammerman, <i>Chair</i>	D. Siromani
S. Klein, <i>Secretary</i>	X. Zhai
V. Broz	X. Zhang
D. W. Lewis	J. C. Minichiello, <i>Contributing Member</i>
A. Rigato	

**Working Group on Supports (SG-CD) (BPV III)**

J. R. Stinson, <i>Chair</i>	S. Pellet
U. S. Bandyopadhyay, <i>Secretary</i>	G. Z. Tokarski
K. Avrithi	A. Tsirigotis
F. J. Birch	L. Vandarsip
N. M. Bisceglia	P. Wiseman
R. P. Deubler	J. Huang, <i>Alternate</i>
N. M. Graham	R. J. Masterson, <i>Contributing Member</i>
Y. Matsubara	

**Working Group on HDPE Design of Components (SG-CD) (BPV III)**

T. M. Musto, <i>Chair</i>	D. P. Munson
J. B. Ossmann, <i>Secretary</i>	F. J. Schaaf, Jr.
M. Brandes	R. Stakenborghs
S. Choi	J. Wright
J. R. Hebeisen	M. T. Audrain, <i>Alternate</i>
P. Krishnaswamy	D. Burwell, <i>Contributing Member</i>
M. Kuntz	J. C. Minichiello, <i>Contributing Member</i>
K. A. Manoly	
M. Martin	

**Working Group on Valves (SG-CD) (BPV III)**

P. Vock, <i>Chair</i>	C. A. Mizer
S. Jones, <i>Secretary</i>	H. O'Brien
M. C. Buckley	J. O'Callaghan
A. Cardillo	K. E. Reid II
R. Farrell	J. Sulley
G. A. Jolly	I. H. Tseng
J. Lambin	J. P. Tucker
T. Lippucci	N. J. Hansing, <i>Alternate</i>

**Working Group on Piping (SG-CD) (BPV III)**

G. A. Antaki, <i>Chair</i>	J. F. McCabe
G. Z. Tokarski, <i>Secretary</i>	I.-K. Nam
C. Basavaraju	J. O'Callaghan
J. Catalano	K. E. Reid II
F. Claeys	N. C. Sutherland
C. M. Faidy	D. Vlaicu
R. Farrell	S. Weindorf
R. G. Gilada	C.-I. Wu
N. M. Graham	T. M. Adams, <i>Contributing Member</i>
M. A. Gray	R. J. Gurdal, <i>Contributing Member</i>
R. W. Haupt	R. B. Keating, <i>Contributing Member</i>
A. Hirano	Y. Liu, <i>Contributing Member</i>
P. Hirschberg	J. C. Minichiello, <i>Contributing Member</i>
M. Kassir	
J. Kawahata	A. N. Nguyen, <i>Contributing Member</i>
V. Kostarev	M. S. Sils, <i>Contributing Member</i>
D. Lieb	E. A. Wais, <i>Contributing Member</i>
T. B. Littleton	

**Working Group on Vessels (SG-CD) (BPV III)**

D. Murphy, <i>Chair</i>	M. C. Scott
S. Willoughby-Braun, <i>Secretary</i>	P. K. Shah
J. Arthur	C. Turylo
C. Basavaraju	D. Vlaicu
D. Keck	C. Wilson
J. I. Kim	T. Yamazaki
O.-S. Kim	R. Z. Ziegler
D. E. Matthews	B. Basu, <i>Contributing Member</i>
T. Mitsuhashi	R. B. Keating, <i>Contributing Member</i>
T. J. Schriefer	W. F. Weitze, <i>Contributing Member</i>

**Subgroup on Design Methods (SC-D) (BPV III)**

S. McKillop, <i>Chair</i>	J. I. Kim
P. R. Donavin, <i>Vice Chair</i>	W. J. O'Donnell, Sr.
J. Wen, <i>Secretary</i>	W. D. Reinhardt
K. Avrithi	P. Smith
L. Davies	S. D. Snow
R. Farrell	R. Vollmer
S. R. Gosselin	W. F. Weitze
M. A. Gray	T. M. Adams, <i>Contributing Member</i>
J. V. Gregg, Jr.	C. W. Bruny, <i>Contributing Member</i>
K. Hsu	H. T. Harrison III, <i>Contributing Member</i>
R. Kalnas	
D. Keck	K. Wright, <i>Contributing Member</i>

**Working Group on Pressure Relief (SG-CD) (BPV III)**

J. F. Ball, <i>Chair</i>	I. H. Tseng
K. R. May, <i>Vice Chair</i>	J. Yu
R. Krithivasan, <i>Secretary</i>	N. J. Hansing, <i>Alternate</i>
J. W. Dickson	J. M. Levy, <i>Alternate</i>
S. Jones	B. J. Yonsky, <i>Alternate</i>
R. Lack	S. T. French, <i>Contributing Member</i>
D. Miller	D. B. Ross, <i>Contributing Member</i>
T. Patel	S. Ruesenberg, <i>Contributing Member</i>
K. Shores	

**Working Group on Design Methodology (SG-DM) (BPV III)**

R. Farrell, *Chair*  
 R. Vollmer, *Secretary*  
 K. Avrithi  
 C. Basavaraju  
 C. M. Faidy  
 C. F. Heberling II  
 M. Kassar  
 J. I. Kim  
 T. R. Liszkai  
 K. Matsunaga  
 S. McKillop  
 B. Pellereau  
 S. Ranganath  
 W. D. Reinhardt  
 P. K. Shah  
 S. D. Snow  
 S. Wang  
 W. F. Weitze

J. Wen  
 T. M. Wiger  
 G. Banyay, *Contributing Member*  
 D. S. S. Bartran, *Contributing Member*  
 R. D. Blevins, *Contributing Member*  
 M. R. Breach, *Contributing Member*  
 C. W. Bruny, *Contributing Member*  
 D. L. Caldwell, *Contributing Member*  
 H. T. Harrison III, *Contributing Member*  
 P. Hirschberg, *Contributing Member*  
 R. B. Keating, *Contributing Member*  
 A. Walker, *Contributing Member*  
 K. Wright, *Contributing Member*

**Working Group on Environmental Fatigue Evaluation Methods (SG-DM) (BPV III)**

M. A. Gray, *Chair*  
 W. F. Weitze, *Secretary*  
 S. Asada  
 K. Avrithi  
 R. C. Cipolla  
 T. M. Damiani  
 C. M. Faidy  
 T. D. Gilman  
 S. R. Gosselin  
 Y. He  
 A. Hirano

P. Hirschberg  
 H. S. Mehta  
 J.-S. Park  
 B. Pellereau  
 G. L. Stevens  
 D. Vlaicu  
 K. Wang  
 R. Z. Ziegler  
 S. Cuvilliez, *Contributing Member*  
 K. Wright, *Contributing Member*

**Working Group on Fatigue Strength (SG-DM) (BPV III)**

P. R. Donavin, *Chair*  
 M. S. Shelton, *Secretary*  
 T. M. Damiani  
 D. W. DeJohn  
 C. M. Faidy  
 P. Gill  
 S. R. Gosselin  
 R. J. Gurdal  
 C. F. Heberling II  
 C. E. Hinnant  
 P. Hirschberg  
 K. Hsu  
 J. I. Kim

S. H. Kleinsmith  
 H. S. Mehta  
 B. Pellereau  
 S. Ranganath  
 G. L. Stevens  
 Y. Wang  
 W. F. Weitze  
 Y. Zou  
 D. Dewees, *Contributing Member*  
 S. Majumdar, *Contributing Member*  
 W. J. O'Donnell, Sr., *Contributing Member*  
 K. Wright, *Contributing Member*

**Working Group on Probabilistic Methods in Design (SG-DM) (BPV III)**

M. Golliet, *Chair*  
 R. Kalnas, *Vice Chair*  
 T. Asayama  
 K. Avrithi  
 G. Brouette  
 J. Hakii

D. O. Henry  
 A. Hirano  
 A. Martin  
 P. J. O'Regan  
 B. Pellereau  
 R. S. Hill III, *Contributing Member*

**Special Working Group on Computational Modeling for Explicit Dynamics (SG-DM) (BPV III)**

D. J. Ammerman, *Vice Chair*  
 V. Broz, *Secretary*  
 J. M. Jordan  
 S. Kuehner  
 D. Molitoris  
 W. D. Reinhardt

P. Y.-K. Shih  
 S. D. Snow  
 C.-F. Tso  
 M. C. Yaksh  
 U. Zencker

**Working Group on Allowable Stress Criteria (SG-HTR) (BPV III)**

R. Wright, *Chair*  
 M. McMurtrey, *Secretary*  
 K. Kimura  
 D. Maitra  
 R. J. McReynolds  
 M. C. Messner  
 W. Ren

R. Rupp  
 S. Sham  
 Y. Wang  
 X. Wei  
 J. R. Foulds, *Contributing Member*  
 R. W. Swindeman, *Contributing Member*

**Working Group on Analysis Methods (SG-HTR) (BPV III)**

M. C. Messner, *Chair*  
 R. W. Barnes  
 J. A. Blanco  
 P. Carter  
 M. E. Cohen  
 R. I. Jetter  
 G. H. Koo  
 H. Qian

S. Sham  
 X. Wei  
 S. X. Xu  
 T. Hassan, *Contributing Member*  
 S. Krishnamurthy, *Contributing Member*  
 M. J. Swindeman, *Contributing Member*

**Working Group on Creep-Fatigue and Negligible Creep (SG-HTR) (BPV III)**

S. Sham, *Chair*  
 Y. Wang, *Secretary*  
 M. Ando  
 F. W. Brust  
 P. Carter  
 M. E. Cohen  
 R. I. Jetter

G. H. Koo  
 M. McMurtrey  
 M. C. Messner  
 J. C. Poehler  
 H. Qian  
 X. Wei

**Working Group on High Temperature Flaw Evaluation (SG-HTR) (BPV III)**

F. W. Brust, *Chair*  
 P. Carter  
 S. Kalyanam  
 B.-L. Lyow  
 M. C. Messner  
 J. C. Poehler

H. Qian  
 P. J. Rush  
 C. J. Sallaberry  
 D. J. Shim  
 X. Wei  
 S. X. Xu

**Subgroup on General Requirements (BPV III)**

J. V. Gardiner, *Chair*  
 N. DeSantis, *Secretary*  
 V. Apostolescu  
 A. Appleton  
 S. Bell  
 J. R. Berry  
 G. Brouette  
 G. C. Deleanu  
 J. W. Highlands  
 E. V. Imbro  
 K. A. Kavanagh  
 Y.-S. Kim  
 B. McGlone

E. C. Renaud  
 T. N. Rezk  
 J. Rogers  
 D. J. Roszman  
 R. Spuhl  
 G. E. Szabatura  
 D. M. Vickery  
 J. DeKleine, *Contributing Member*  
 H. Michael, *Contributing Member*  
 C. T. Smith, *Contributing Member*  
 W. K. Sowder, Jr., *Contributing Member*

**Working Group on General Requirements (SG-GR) (BPV III)**

B. McGlone, <i>Chair</i>	K. A. Kavanagh
J. Grimm, <i>Secretary</i>	Y.-S. Kim
V. Apostolescu	D. T. Meisch
A. Appleton	R. B. Patel
S. Bell	E. C. Renaud
J. R. Berry	T. N. Rezk
G. Brouette	J. Rogers
J. Carter	D. J. Roszman
P. J. Coco	B. S. Sandhu
N. DeSantis	R. Spuhl
Y. Diaz-Castillo	J. F. Strunk
O. Elkadim	G. E. Szabatura
J. V. Gardiner	D. M. Vickery
S. M. Goodwin	J. L. Williams
J. Harris	J. DeKleine, <i>Contributing Member</i>
J. W. Highlands	S. F. Harrison, Jr., <i>Contributing Member</i>
E. V. Imbro	

**Joint ACI-ASME Committee on Concrete Components for Nuclear Service (BPV III)**

J. A. Munshi, <i>Chair</i>	N. Orbovic
J. McLean, <i>Vice Chair</i>	J. F. Strunk
J. Cassamassino, <i>Staff Secretary</i>	G. Thomas
C. J. Bang	S. Wang
L. J. Colarusso	A. Adediran, <i>Contributing Member</i>
A. C. Eberhardt	J. F. Artuso, <i>Contributing Member</i>
F. Farzam	S. Bae, <i>Contributing Member</i>
P. S. Ghosal	J.-B. Domage, <i>Contributing Member</i>
B. D. Hovis	B. B. Scott, <i>Contributing Member</i>
T. C. Inman	M. R. Senecal, <i>Contributing Member</i>
C. Jones	
O. Jovall	Z. Shang, <i>Contributing Member</i>
T. Kang	M. Sircar, <i>Contributing Member</i>
N.-H. Lee	C. T. Smith, <i>Contributing Member</i>
T. Muraki	

**Special Working Group on General Requirements Consolidation (SG-GR) (BPV III)**

J. V. Gardiner, <i>Chair</i>	R. B. Patel
J. Grimm, <i>Vice Chair</i>	E. C. Renaud
C. T. Smith, <i>Vice Chair</i>	R. Spuhl
Y. Diaz-Castillo	J. L. Williams

**Working Group on General Requirements for Graphite and Ceramic Composite Core Components and Assemblies (SG-GR) (BPV III)**

A. Appleton, <i>Chair</i>	M. N. Mitchell
W. J. Geringer, <i>Secretary</i>	E. C. Renaud
J. R. Berry	W. Windes
Y. Diaz-Castillo	

**Subgroup on Materials, Fabrication, and Examination (BPV III)**

J. Grimm, <i>Chair</i>	M. Lashley
S. Hunter, <i>Secretary</i>	D. W. Mann
W. H. Borter	T. Melfi
G. R. Cannell	I.-K. Nam
S. Cho	J. B. Ossmann
P. J. Coco	J. E. O'Sullivan
R. H. Davis	M. C. Scott
B. D. Frew	W. J. Sperko
D. W. Gandy	J. R. Stinson
S. E. Gingrich	J. F. Strunk
M. Golliet	W. Windes
L. S. Harbison	R. Wright
R. M. Jessee	S. Yee
J. Johnston, Jr.	H. Michael, <i>Delegate</i>
C. C. Kim	R. W. Barnes, <i>Contributing Member</i>
M. Kris	D. B. Denis, <i>Contributing Member</i>

**Working Group on HDPE Materials (SG-MFE) (BPV III)**

G. Brouette, <i>Chair</i>	D. P. Munson
M. A. Martin, <i>Secretary</i>	T. M. Musto
M. C. Buckley	S. Patterson
M. Golliet	S. Schuessler
J. Johnston, Jr.	R. Stakenborghs
P. Krishnaswamy	M. Troughton
M. Kuntz	J. Wright
B. Lin	B. Hauger, <i>Contributing Member</i>

**Working Group on Design (BPV III-2)**

N.-H. Lee, <i>Chair</i>	J. A. Munshi
S. Wang, <i>Vice Chair</i>	T. Muraki
M. Allam	N. Orbovic
S. Bae	J. S. Saini
L. J. Colarusso	G. Thomas
A. C. Eberhardt	A. Istar, <i>Contributing Member</i>
F. Farzam	S.-Y. Kim, <i>Contributing Member</i>
P. S. Ghosal	J. Kwon, <i>Contributing Member</i>
B. D. Hovis	B. B. Scott, <i>Contributing Member</i>
T. C. Inman	Z. Shang, <i>Contributing Member</i>
C. Jones	M. Shin, <i>Contributing Member</i>
O. Jovall	M. Sircar, <i>Contributing Member</i>

**Working Group on Materials, Fabrication, and Examination (BPV III-2)**

C. Jones, <i>Chair</i>	N.-H. Lee
A. Eberhardt, <i>Vice Chair</i>	Z. Shang
M. Allam	J. F. Strunk
C. J. Bang	I. Zivanovic
B. Birch	A. A. Aboelmagd, <i>Contributing Member</i>
J.-B. Domage	
P. S. Ghosal	J. F. Artuso, <i>Contributing Member</i>
T. Kang	B. B. Scott, <i>Contributing Member</i>

**Special Working Group on Modernization (BPV III-2)**

N. Orbovic, <i>Chair</i>	S. Wang
J. McLean, <i>Vice Chair</i>	I. Zivanovic
A. Adediran	J.-B. Domage, <i>Contributing Member</i>
O. Jovall	F. Lin, <i>Contributing Member</i>
N. Stoeva	M. A. Ugalde, <i>Contributing Member</i>
A. Varma	

**Subgroup on Containment Systems for Spent Nuclear Fuel and High-Level Radioactive Material (BPV III)**

G. J. Solovey, <i>Chair</i>	D. Siromani
D. J. Ammerman, <i>Vice Chair</i>	D. B. Spencer
S. Klein, <i>Secretary</i>	J. Wellwood
G. Bjorkman	X. J. Zhai
V. Broz	X. Zhang
D. W. Lewis	D. Dunn, <i>Alternate</i>
E. L. Pleins	W. H. Borter, <i>Contributing Member</i>
A. Rigato	N. M. Simpson, <i>Contributing Member</i>
P. Sakalaukus, Jr.	

**Subgroup on Fusion Energy Devices (BPV III)**

W. K. Sowder, Jr., <i>Chair</i>	S. Lee
D. Andrei, <i>Staff Secretary</i>	G. Li
D. J. Roszman, <i>Secretary</i>	X. Li
M. Bashir	P. Mokaria
J. P. Blanchard	T. R. Muldoon
L. C. Cadwallader	M. Porton
T. P. Davis	F. J. Schaaf, Jr.
B. R. Doshi	P. Smith
L. El-Guebaly	Y. Song
G. Holtmeier	M. Trosen
D. Johnson	C. Waldon
K. A. Kavanagh	I. J. Zatz
K. Kim	R. W. Barnes, <i>Contributing Member</i>
I. Kimihiro	

**Working Group on General Requirements (BPV III-4)**

D. J. Roszman, <i>Chair</i>	P. Mokaria
M. Ellis	W. K. Sowder, Jr.

**Working Group on In-Vessel Components (BPV III-4)**

M. Bashir, <i>Chair</i>	M. Kalsey
Y. Carin	S. T. Madabusi
T. P. Davis	

**Working Group on Magnets (BPV III-4)**

S. Lee, <i>Chair</i>	S. Kim, <i>Vice Chair</i>
----------------------	---------------------------

**Working Group on Materials (BPV III-4)**

M. Porton, <i>Chair</i>	P. Mummery
T. P. Davis	

**Working Group on Vacuum Vessels (BPV III-4)**

I. Kimihiro, <i>Chair</i>	D. Johnson
L. C. Cadwallader	Q. Shijun
B. R. Doshi	Y. Song

**Subgroup on High Temperature Reactors (BPV III)**

S. Sham, <i>Chair</i>	R. Wright
M. Ando	A. Yeshnik
N. Broom	G. L. Zeng
F. W. Brust	A. Tsirigotis, <i>Alternate</i>
P. Carter	D. S. Griffin, <i>Contributing Member</i>
M. E. Cohen	X. Li, <i>Contributing Member</i>
W. J. Geringer	S. Majumdar, <i>Contributing Member</i>
B. F. Hantz	D. L. Marriott, <i>Contributing Member</i>
M. H. Jawad	M. Morishita, <i>Contributing Member</i>
R. I. Jetter	W. O'Donnell, Sr., <i>Contributing Member</i>
K. Kimura	L. Shi, <i>Contributing Member</i>
G. H. Koo	R. W. Swindeman, <i>Contributing Member</i>
A. Mann	
M. C. Messner	
X. Wei	
W. Windes	

**Working Group on Nonmetallic Design and Materials (SG-HTR) (BPV III)**

W. Windes, <i>Chair</i>	M. G. Jenkins
W. J. Geringer, <i>Vice Chair</i>	Y. Katoh
A. Appleton	J. Lang
T. D. Burchell	M. N. Mitchell
S.-H. Chi	J. B. Ossmann
V. Chugh	A. Yeshnik
S. T. Gonczy	G. L. Zeng
K. Harris	

**Special Working Group on High Temperature Reactor Stakeholders (SG-HTR) (BPV III)**

M. E. Cohen, <i>Chair</i>	S. Sham
M. Arcaro	B. Song
R. W. Barnes	X. Wei
N. Broom	A. Yeshnik
V. Chugh	G. L. Zeng
R. A. Fleming	T. Asayama, <i>Contributing Member</i>
K. Harris	X. Li, <i>Contributing Member</i>
R. I. Jetter	M. Morishita, <i>Contributing Member</i>
Y. W. Kim	L. Shi, <i>Contributing Member</i>
G. H. Koo	G. Wu, <i>Contributing Member</i>
K. J. Noel	

**Seismic Design Steering Committee (BPV III)**

T. M. Adams, <i>Chair</i>	G. H. Koo
F. G. Abatt, <i>Secretary</i>	V. Kostarev
G. A. Antaki	A. Maekawa
C. Basavaraju	K. Matsunaga
A. Berkovsky	R. M. Pace
D. Chowdhury	D. Watkins
R. Döring	

**Argentina International Working Group (BPV III)**

J. Fernández, <i>Chair</i>	S. A. Echeverria
A. Politi, <i>Vice Chair</i>	E. P. Fresquet
O. Martinez, <i>Staff Secretary</i>	M. M. Gamizo
A. Gomez, <i>Secretary</i>	I. M. Guerreiro
A. Acrogliano	I. A. Knorr
W. Agrelo	M. F. Liendo
G. O. Anteri	D. E. Matthews
M. Anticoli	L. R. Miño
C. A. Araya	J. Monte
J. P. Balbiani	R. L. Morard
A. A. Betervide	A. E. Pastor
D. O. Bordato	E. Pizzichini
G. Bourguigne	J. L. Racamato
M. L. Cappella	H. C. Sanzi
A. Claus	G. J. Scian
R. G. Cocco	G. G. Sebastian
A. Coleff	M. E. Szarko
A. J. Dall'Osto	P. N. Torano
L. M. De Barberis	A. Turrin
D. P. Delfino	O. A. Verastegui
D. N. Dell'Erba	M. D. Vigliano
F. G. Diez	P. Yamamoto
A. Dominguez	M. Zunino

**China International Working Group (BPV III)**

J. Yan, <i>Chair</i>	C. Peiyin
W. Tang, <i>Vice Chair</i>	Z. Sun
Y. He, <i>Secretary</i>	G. Tang
L. Guo	L. Ting
Y. Jing	Y. Tu
D. Kang	Y. Wang
Y. Li	H. Wu
B. Liang	S. Xue
H. Lin	Z. Yin
S. Liu	D. Yuangang
W. Liu	G. Zhang
J. Ma	W. Zhang
K. Mao	Y. Zhong
D. E. Matthews	Z. Zhong
W. Pei	

**Germany International Working Group (BPV III)**

J. Wendt, <i>Chair</i>	H.-W. Lange
D. Koelbl, <i>Vice Chair</i>	T. Ludwig
R. Gersinska, <i>Secretary</i>	X. Pitoiset
P. R. Donavin	M. Reichert
R. Döring	G. Roos
C. G. Frantescu	J. Rudolph
A. Huber	L. Sybert
R. E. Hueggenberg	I. Tewes
C. Huttner	R. Tiete
E. Iacopetta	R. Trieglaff
M. H. Koeppen	F. Wille
C. Kuschke	S. Zickler

**India International Working Group (BPV III)**

R. N. Sen, <i>Chair</i>	A. Johori
S. B. Parkash, <i>Vice Chair</i>	D. Kulkarni
A. D. Bagdare, <i>Secretary</i>	R. Kumar
S. Aithal	D. Narain
S. Benhur	E. L. Pleins
N. M. Borwankar	V. Sehgal
M. Brijlani	S. Singh
H. Dalal	B. K. Sreedhar
S. K. Goyal	

**Korea International Working Group (BPV III)**

G. H. Koo, <i>Chair</i>	D. Kwon
O.-S. Kim, <i>Secretary</i>	B. Lee
H. Ahn	D. Lee
S. Cho	S. Lee
G.-S. Choi	S.-G. Lee
S. Choi	H. Lim
J. Y. Hong	I.-K. Nam
N.-S. Huh	C.-K. Oh
J.-K. Hwang	C.-Y. Oh
S. S. Hwang	E.-J. Oh
C. Jang	C. Park
I. I. Jeong	H. Park
S. H. Kang	J.-S. Park
J.-I. Kim	Y. S. Pyun
J.-S. Kim	T. Shin
M.-W. Kim	S. Song
S.-S. Kim	W. J. Sperko
Y.-B. Kim	J. S. Yang
Y.-S. Kim	O. Yoo

**United Kingdom International Working Group (BPV III)**

C. D. Bell, <i>Chair</i>	G. Innes
P. M. James, <i>Vice Chair</i>	S. A. Jones
C. B. Carpenter, <i>Secretary</i>	B. Pellereau
T. Bann	C. R. Schneider
M. J. Chevalier	J. W. Stairmand
M. Consonni	J. Sulley
M. J. Crathorne	J. Talamantes-Silva

**Special Working Group on Editing and Review (BPV III)**

D. E. Matthews, <i>Chair</i>	S. Hunter
R. P. Deubler	J. C. Minichiello
A. C. Eberhardt	J. F. Strunk
J. V. Gardiner	C. Wilson

**Special Working Group on HDPE Stakeholders (BPV III)**

M. Brandes, <i>Chair</i>	D. P. Munson
S. Patterson, <i>Secretary</i>	T. M. Musto
S. Choi	J. E. O'Sullivan
C. M. Faidy	V. Rohatgi
M. Golliet	F. J. Schaaf, Jr.
R. M. Jessee	R. Stakenborghs
J. Johnston, Jr.	M. Troughton
M. Kuntz	J. Wright
M. Lashley	C. Lin, <i>Alternate</i>
K. A. Manoly	D. Burwell, <i>Contributing Member</i>

**Special Working Group on Honors and Awards (BPV III)**

J. C. Minichiello, <i>Chair</i>	R. M. Jessee
A. Appleton	D. E. Matthews
R. W. Barnes	

**Special Working Group on Industry Experience for New Plants (BPV III & BPV XI)**

J. T. Lindberg, <i>Chair</i>	O.-S. Kim
J. B. Ossmann, <i>Chair</i>	K. Matsunaga
M. C. Buckley, <i>Secretary</i>	D. E. Matthews
A. Cardillo	R. E. McLaughlin
T. L. Chan	D. W. Sandusky
P. J. Hennessey	R. M. Wilson
D. O. Henry	S. M. Yee
J. Honcharik	A. Tsirigotis, <i>Alternate</i>
C. G. Kim	

**Special Working Group on International Meetings and IWG Liaisons (BPV III)**

D. E. Matthews, <i>Chair</i>	R. L. Crane
K. Verderber, <i>Staff Secretary</i>	P. R. Donavin
T. M. Adams	E. L. Pleins
R. W. Barnes	W. J. Sperko
T. D. Burchell	

**Special Working Group on New Plant Construction Issues (BPV III)**

E. L. Pleins, <i>Chair</i>	M. L. Wilson
M. C. Scott, <i>Secretary</i>	H. Xu
A. Cardillo	J. Yan
P. J. Coco	N. J. Hansing, <i>Alternate</i>
J. Honcharik	J. C. Minichiello, <i>Contributing Member</i>
O.-S. Kim	K. Verderber, <i>Contributing Member</i>
M. Kris	
D. W. Sandusky	
R. R. Stevenson	

**COMMITTEE ON HEATING BOILERS (BPV IV)**

J. A. Hall, <i>Chair</i>	P. A. Molvie
T. L. Bedeaux, <i>Vice Chair</i>	R. D. Troutt
C. R. Ramcharran, <i>Staff Secretary</i>	M. Wadkinson
L. Badziagowski	R. V. Wielgoszinski
B. Calderon	H. Michael, <i>Delegate</i>
J. P. Chicoine	D. Picart, <i>Delegate</i>
J. M. Downs	D. Nelson, <i>Alternate</i>
J. L. Kleiss	S. V. Voorhees, <i>Contributing Member</i>
J. Klug	
M. Mengon	

**Subgroup on Care and Operation of Heating Boilers (BPV IV)**

R. D. Troutt, <i>Chair</i>	J. A. Hall
C. R. Ramcharran, <i>Staff Secretary</i>	J. L. Kleiss
B. Ahee	P. A. Molvie
T. L. Bedeaux	M. Wadkinson
J. M. Downs	

**Subgroup on Cast Boilers (BPV IV)**

J. P. Chicoine, <i>Chair</i>	J. A. Hall
J. M. Downs, <i>Vice Chair</i>	J. L. Kleiss
C. R. Ramcharran, <i>Staff Secretary</i>	M. Mengon
T. L. Bedeaux	

**Subgroup on Materials (BPV IV)**

M. Wadkinson, <i>Chair</i>	L. Badziagowski
J. M. Downs, <i>Vice Chair</i>	T. L. Bedeaux
C. R. Ramcharran, <i>Staff Secretary</i>	J. A. Hall

**Subgroup on Water Heaters (BPV IV)**

L. Badziagowski, <i>Chair</i>	C. Dinic
J. L. Kleiss, <i>Vice Chair</i>	B. J. Iske
C. R. Ramcharran, <i>Staff Secretary</i>	P. A. Molvie
B. Ahee	T. E. Trant
J. P. Chicoine	R. D. Troutt

**Subgroup on Welded Boilers (BPV IV)**

T. L. Bedeaux, <i>Chair</i>	M. Mengon
J. L. Kleiss, <i>Vice Chair</i>	P. A. Molvie
C. R. Ramcharran, <i>Staff Secretary</i>	R. D. Troutt
B. Ahee	M. Wadkinson
L. Badziagowski	R. V. Wielgoszinski
B. Calderon	D. Nelson, <i>Alternate</i>
C. Dinic	

**COMMITTEE ON NONDESTRUCTIVE EXAMINATION (BPV V)**

N. A. Finney, <i>Chair</i>	L. E. Mullins
C. May, <i>Vice Chair</i>	T. L. Plasek
C. R. Ramcharran, <i>Staff Secretary</i>	P. B. Shaw
D. Bajula	C. Vorwald
J. Bennett	G. M. Gatti, <i>Delegate</i>
P. L. Brown	S. J. Akryn, <i>Contributing Member</i>
M. A. Burns	J. E. Batey, <i>Contributing Member</i>
N. Carter	A. S. Birks, <i>Contributing Member</i>
T. Clausing	N. Y. Faransso, <i>Contributing Member</i>
C. Emslander	R. W. Kruzic, <i>Contributing Member</i>
A. F. Garbolevsky	F. J. Sattler, <i>Contributing Member</i>
J. F. Halley	H. C. Graber, <i>Honorary Member</i>
P. T. Hayes	O. F. Hedden, <i>Honorary Member</i>
G. W. Hembree	J. R. MacKay, <i>Honorary Member</i>
F. B. Kovacs	T. G. McCarty, <i>Honorary Member</i>
K. Krueger	
B. D. Laite	

**Executive Committee (BPV V)**

C. May, <i>Chair</i>	J. F. Halley
N. A. Finney, <i>Vice Chair</i>	P. T. Hayes
C. R. Ramcharran, <i>Staff Secretary</i>	G. W. Hembree
N. Carter	F. B. Kovacs
C. Emslander	C. Vorwald
V. F. Godinez-Azcuaga	

**Subgroup on General Requirements/Personnel Qualifications and Inquiries (BPV V)**

C. Emslander, <i>Chair</i>	K. Krueger
D. I. Morris, <i>Vice Chair</i>	C. May
J. Bennett	C. Vorwald
N. Carter	S. J. Akryn, <i>Contributing Member</i>
T. Clausing	J. E. Batey, <i>Contributing Member</i>
N. A. Finney	N. Y. Faransso, <i>Contributing Member</i>
J. F. Halley	J. P. Swezy, Jr., <i>Contributing Member</i>
G. W. Hembree	
F. B. Kovacs	

**Subgroup on Surface Examination Methods (BPV V)**

N. Carter, <i>Chair</i>	P. B. Shaw
B. D. Laite, <i>Vice Chair</i>	C. Vorwald
P. L. Brown	C. Wassink
T. Clausing	D. M. Woodward
C. Emslander	G. M. Gatti, <i>Delegate</i>
N. Farenbaugh	S. J. Akryn, <i>Contributing Member</i>
N. A. Finney	J. E. Batey, <i>Contributing Member</i>
J. F. Halley	N. Y. Faransso, <i>Contributing Member</i>
K. Hayes	R. W. Kruzic, <i>Contributing Member</i>
G. W. Hembree	F. J. Sattler, <i>Contributing Member</i>
C. May	
L. E. Mullins	

**Subgroup on Volumetric Methods (BPV V)**

C. May, <i>Chair</i>	L. E. Mullins
J. F. Halley, <i>Vice Chair</i>	E. Peloquin
D. Adkins	T. L. Plasek
P. L. Brown	C. Vorwald
N. A. Finney	G. M. Gatti, <i>Delegate</i>
A. F. Garbolevsky	S. J. Akryn, <i>Contributing Member</i>
R. W. Hardy	J. E. Batey, <i>Contributing Member</i>
P. T. Hayes	N. Y. Faransso, <i>Contributing Member</i>
G. W. Hembree	
F. B. Kovacs	R. W. Kruzic, <i>Contributing Member</i>
K. Krueger	F. J. Sattler, <i>Contributing Member</i>

**Special Working Group on Advanced Ultrasonic Testing Techniques (BPV V)**

L. E. Mullins, <i>Chair</i>	P. T. Hayes
K. Krueger, <i>Vice Chair</i>	M. Lozev
D. Adkins	E. Peloquin
D. Bajula	M. Sens
N. A. Finney	D. Tompkins
J. L. Garner	C. Wassink
J. F. Halley	

**Working Group on Full Matrix Capture (FMC) (BPV V)**

P. T. Hayes, <i>Chair</i>	K. Hayes
E. Peloquin, <i>Vice Chair</i>	G. W. Hembree
D. Adkins	K. Krueger
D. Bajula	M. Lozev
D. Bellistri	L. E. Mullins
J. Catty	D. Richard
N. A. Finney	M. Sens
J. L. Garner	D. Tompkins
V. F. Godinez-Azcuaga	O. Volf
R. T. Grotenhuis	C. Wassink
J. F. Halley	

**Working Group on Acoustic Emissions (SG-VM) (BPV V)**

V. F. Godinez-Azcuaga, <i>Chair</i>	L. Zhang
S. R. Doctor, <i>Vice Chair</i>	J. E. Batey, <i>Contributing Member</i>
J. Catty	N. Y. Faransso, <i>Contributing Member</i>
N. F. Douglas, Jr.	
R. K. Miller	

**Working Group on Computed Tomography (BPV V)**

C. May, <i>Chair</i>	R. J. Mills
T. L. Clifford	T. L. Plasek
R. W. Hardy	C. Vorwald
G. W. Hembree	B. White
F. B. Kovacs	L. E. Mullins, <i>Contributing Member</i>

**Working Group on Radiography (SG-VM) (BPV V)**

C. Vorwald, <i>Chair</i>	C. May
D. M. Woodward, <i>Vice Chair</i>	R. J. Mills
J. Anderson	T. L. Plasek
P. L. Brown	T. Vidimos
C. Emslander	B. White
A. F. Garbolevsky	S. J. Akryn, <i>Contributing Member</i>
R. W. Hardy	J. E. Batey, <i>Contributing Member</i>
G. W. Hembree	N. Y. Faransso, <i>Contributing Member</i>
F. B. Kovacs	
B. D. Laite	R. W. Kruzic, <i>Contributing Member</i>

**Working Group on Ultrasonics (SG-VM) (BPV V)**

J. F. Halley, <i>Chair</i>	D. Tompkins
K. Krueger, <i>Vice Chair</i>	D. Van Allen
D. Adkins	J. Vinyard
D. Bajula	C. Vorwald
C. Brown	C. Wassink
C. Emslander	D. Alleyne, <i>Contributing Member</i>
N. A. Finney	J. E. Batey, <i>Contributing Member</i>
P. T. Hayes	N. Y. Faransso, <i>Contributing Member</i>
G. W. Hembree	
B. D. Laite	R. W. Kruzic, <i>Contributing Member</i>
C. May	G. M. Light, <i>Contributing Member</i>
L. E. Mullins	P. Mudge, <i>Contributing Member</i>
E. Peloquin	F. J. Sattler, <i>Contributing Member</i>
M. J. Quarry	J. Vanvelsor, <i>Contributing Member</i>

**Italy International Working Group (BPV V)**

P. L. Dinelli, <i>Chair</i>	M. A. Grimoldi
D. D. Raimander, <i>Secretary</i>	G. Luoni
M. Agostini	O. Oldani
T. Aldo	U. Papponetti
F. Bresciani	P. Pedersoli
G. Campos	A. Veroni
N. Caputo	M. Zambon
M. Colombo	V. Calo, <i>Contributing Member</i>
F. Ferrarese	G. Gobbi, <i>Contributing Member</i>
E. Ferrari	G. Pontiggia, <i>Contributing Member</i>

**COMMITTEE ON PRESSURE VESSELS (BPV VIII)**

S. C. Roberts, <i>Chair</i>	D. Srnic
M. D. Lower, <i>Vice Chair</i>	D. B. Stewart
J. Oh, <i>Staff Secretary</i>	P. L. Sturgill
S. J. Rossi, <i>Staff Secretary</i>	K. Subramanian
G. Auriolles, Sr.	D. A. Swanson
S. R. Babka	J. P. Swezy, Jr.
R. J. Basile	S. Terada
P. Chavdarov	E. Upitis
D. B. DeMichael	A. Viet
J. F. Grubb	K. Xu
B. F. Hantz	P. A. McGowan, <i>Delegate</i>
M. Kowalczyk	H. Michael, <i>Delegate</i>
D. L. Kurle	K. Oyamada, <i>Delegate</i>
R. Mahadeen	M. E. Papponetti, <i>Delegate</i>
S. A. Marks	X. Tang, <i>Delegate</i>
P. Matkovic	A. Chaudouet, <i>Contributing Member</i>
R. W. Mikitka	
B. R. Morelock	J. P. Glaspie, <i>Contributing Member</i>
T. P. Pastor	W. S. Jacobs, <i>Contributing Member</i>
D. T. Peters	K. T. Lau, <i>Contributing Member</i>
M. J. Pischke	U. R. Miller, <i>Contributing Member</i>
M. D. Rana	K. Mokhtarian, <i>Contributing Member</i>
G. B. Rawls, Jr.	
F. L. Richter	
C. D. Rodery	G. G. Karcher, <i>Honorary Member</i>
J. C. Sowinski	K. K. Tam, <i>Honorary Member</i>

**Executive Committee (BPV VIII)**

M. D. Lower, <i>Chair</i>	F. L. Richter
S. J. Rossi, <i>Staff Secretary</i>	S. C. Roberts
G. Auriolles, Sr.	J. C. Sowinski
M. Kowalczyk	K. Subramanian
S. A. Marks	A. Viet
P. Matkovic	K. Xu

**Subgroup on Design (BPV VIII)**

J. C. Sowinski, <i>Chair</i>	S. C. Roberts
C. S. Hinson, <i>Vice Chair</i>	C. D. Rodery
G. Aurioles, Sr.	T. G. Seipp
S. R. Babka	D. Srnic
O. A. Barsky	D. A. Swanson
R. J. Basile	S. Terada
D. Chandiramani	J. Vattappilly
M. Faulkner	K. Xu
B. F. Hantz	K. Oyamada, <i>Delegate</i>
C. E. Hinnant	M. E. Papponetti, <i>Delegate</i>
M. H. Jawad	W. S. Jacobs, <i>Contributing Member</i>
S. Krishnamurthy	P. K. Lam, <i>Contributing Member</i>
D. L. Kurle	K. Mokhtarian, <i>Contributing Member</i>
K. Kuscus	
M. D. Lower	T. P. Pastor, <i>Contributing Member</i>
R. W. Mikitka	S. C. Shah, <i>Contributing Member</i>
B. Millet	K. K. Tam, <i>Contributing Member</i>
M. D. Rana	E. Uptis, <i>Contributing Member</i>
G. B. Rawls, Jr.	Z. Wang, <i>Contributing Member</i>

**Subgroup on General Requirements (BPV VIII)**

F. L. Richter, <i>Chair</i>	G. B. Rawls, Jr.
M. Faulkner, <i>Vice Chair</i>	S. C. Roberts
J. Hoskinson, <i>Secretary</i>	J. C. Sowinski
N. Barkley	P. Speranza
R. J. Basile	D. Srnic
T. P. Beirne	D. B. Stewart
D. T. Davis	D. A. Swanson
D. B. DeMichael	R. Uebel
M. D. Lower	J. P. Gaspie, <i>Contributing Member</i>
T. P. Pastor	Z. Wang, <i>Contributing Member</i>
D. K. Peetz	Y. Yang, <i>Contributing Member</i>

**Task Group on Fired Heater Pressure Vessels (BPV VIII)**

J. Hoskinson, <i>Chair</i>	R. Robles
J. Bradley	J. Rust
W. Kim	P. Shanks
S. Kirk	E. Smith
D. Nelson	D. Srnic
T. P. Pastor	J. P. Swezy, Jr.

**Working Group on Design-By-Analysis (BPV VIII)**

B. F. Hantz, <i>Chair</i>	S. Krishnamurthy
T. W. Norton, <i>Secretary</i>	A. Mann
D. A. Arnett	C. Nadarajah
J. Bedoya	P. Pruetter
S. Guzey	T. G. Seipp
C. F. Heberling II	M. A. Shah
C. E. Hinnant	S. Terada
M. H. Jawad	R. G. Brown, <i>Contributing Member</i>
S. Kataoka	D. Dewees, <i>Contributing Member</i>
S. Kilambi	K. Saboda, <i>Contributing Member</i>
K. D. Kirkpatrick	

**Task Group on Subsea Applications (BPV VIII)**

M. Sarzynski, <i>Chair</i>	P. Lutkiewicz
A. J. Grohmann, <i>Vice Chair</i>	N. McKie
L. P. Antalffy	S. K. Parimi
R. C. Biel	R. H. Patil
J. Ellens	J. R. Sims
J. Hademenos	M. P. Vaclavik
J. Kaculi	R. Cordes, <i>Contributing Member</i>
K. Karpanan	S. Krishna, <i>Contributing Member</i>
F. Kirkemo	D. T. Peters, <i>Contributing Member</i>
C. Lan	

**Working Group on Elevated Temperature Design (BPV I and VIII)**

A. Mann, <i>Chair</i>	M. N. Mitchell
C. Nadarajah, <i>Secretary</i>	P. Pruetter
D. Anderson	M. J. Swindeman
D. Dewees	J. P. Gaspie, <i>Contributing Member</i>
B. F. Hantz	D. L. Marriott, <i>Contributing Member</i>
M. H. Jawad	
R. I. Jetter	N. McMurray, <i>Contributing Member</i>
S. Krishnamurthy	
T. Le	
M. C. Messner	B. J. Mollitor, <i>Contributing Member</i>

**Task Group on UG-20(f) (BPV VIII)**

S. Krishnamurthy, <i>Chair</i>	B. R. Macejko
T. L. Anderson	J. Penso
K. E. Bagnoli	M. Prager
R. P. Deubler	M. D. Rana
B. F. Hantz	

**Subgroup on Fabrication and Examination (BPV VIII)**

S. A. Marks, <i>Chair</i>	J. P. Swezy, Jr.
D. I. Morris, <i>Vice Chair</i>	E. Uptis
T. Halligan, <i>Secretary</i>	C. Violand
N. Carter	E. A. Whittle
J. Lu	K. Oyamada, <i>Delegate</i>
B. R. Morelock	W. J. Bees, <i>Contributing Member</i>
O. Mulet	L. F. Campbell, <i>Contributing Member</i>
M. J. Pischke	
M. J. Rice	J. Lee, <i>Contributing Member</i>
J. Roberts	J. Si, <i>Contributing Member</i>
C. D. Rodery	R. Uebel, <i>Contributing Member</i>
B. F. Shelley	X. Xue, <i>Contributing Member</i>
D. Smith	B. Yang, <i>Contributing Member</i>
P. L. Sturgill	

**Subgroup on Heat Transfer Equipment (BPV VIII)**

P. Matkovics, <i>Chair</i>	S. Neilsen
M. D. Clark, <i>Vice Chair</i>	E. Smith
L. Bower, <i>Secretary</i>	A. M. Voytko
G. Aurioles, Sr.	R. P. Wiberg
S. R. Babka	I. G. Campbell, <i>Contributing Member</i>
J. H. Barbee	
O. A. Barsky	G. G. Karcher, <i>Contributing Member</i>
T. Bunyarattaphantu	
A. Chaudouet	J. Pasek, <i>Contributing Member</i>
D. L. Kurle	D. Srnic, <i>Contributing Member</i>
R. Mahadeen	Z. Tong, <i>Contributing Member</i>
S. Mayeux	

**Working Group on Plate Heat Exchangers (BPV VIII)**

P. Matkovics, <i>Chair</i>	D. I. Morris
S. R. Babka	M. J. Pischke
J. F. Grubb	E. Smith
V. Gudge	D. Srnic
R. Mahadeen	S. Sullivan
S. A. Marks	

**Subgroup on High Pressure Vessels (BPV VIII)**

K. Subramanian, *Chair*  
M. Sarzynski, *Vice Chair*  
A. P. Maslowski, *Staff Secretary*  
L. P. Antalffy  
R. C. Biel  
P. N. Chaku  
L. Fridlund  
R. T. Hallman  
K. Karpanan  
J. Keltjens  
A. K. Khare  
G. M. Mital  
G. T. Nelson  
M. Parr  
D. T. Peters  
E. A. Rodriguez  
E. D. Roll  
J. R. Sims  
E. Smith  
F. W. Tatar  
S. Terada  
C. Tipple

R. Wink  
Y. Xu  
A. M. Clayton, *Contributing Member*  
R. Cordes, *Contributing Member*  
R. D. Dixon, *Contributing Member*  
Q. Dong, *Contributing Member*  
T. A. Duffey, *Contributing Member*  
D. Fuenmayor, *Contributing Member*  
R. M. Hoshman, *Contributing Member*  
Y. Huang, *Contributing Member*  
F. Kirkemo, *Contributing Member*  
R. A. Leishear, *Contributing Member*  
C. Romero, *Contributing Member*  
K.-J. Young, *Contributing Member*  
D. J. Burns, *Honorary Member*  
D. M. Fryer, *Honorary Member*  
G. J. Mraz, *Honorary Member*  
E. H. Perez, *Honorary Member*

**Subgroup on Materials (BPV VIII)**

M. Kowalczyk, *Chair*  
J. Cameron, *Vice Chair*  
S. Kilambi, *Secretary*  
P. Chavdarov  
J. F. Grubb  
D. Maitra  
D. W. Raho  
J. Robertson  
R. C. Sutherland  
E. Uptis  
K. Xu  
S. Yem

A. Di Rienzo, *Contributing Member*  
J. D. Fritz, *Contributing Member*  
M. Katcher, *Contributing Member*  
W. M. Lundy, *Contributing Member*  
J. A. McMaster, *Contributing Member*  
J. Penso, *Contributing Member*  
B. Pletcher, *Contributing Member*  
P. G. Wittenbach, *Contributing Member*  
X. Wu, *Contributing Member*

**Subgroup on Toughness (BPV VIII)**

K. Xu, *Chair*  
T. Halligan, *Vice Chair*  
N. Carter  
C. S. Hinson  
W. S. Jacobs  
S. Kilambi  
D. L. Kurle  
M. D. Rana  
F. L. Richter  
K. Subramanian

D. A. Swanson  
J. P. Swezy, Jr.  
S. Terada  
E. Uptis  
J. Vattappilly  
K. Oyamada, *Delegate*  
S. Krishnamurthy, *Contributing Member*  
K. Mokhtarian, *Contributing Member*

**Subgroup on Graphite Pressure Equipment (BPV VIII)**

A. Viet, *Chair*  
C. W. Cary, *Vice Chair*  
G. C. Becherer  
F. L. Brown  
R. J. Bulgin

J. D. Clements  
H. Lee, Jr.  
T. Rudy  
A. A. Stupica

**Argentina International Working Group (BPV VIII)**

A. Dominguez, *Chair*  
F. P. Larrosa, *Secretary*  
M. M. Acosta  
R. A. Barey  
C. Alderetes  
F. A. Andres  
L. F. Boccanera  
O. S. Bretones  
A. Burgueno  
G. Casanas  
D. H. Da Rold  
J. I. Duo  
M. Favareto

M. D. Kuhn  
L. M. Leccese  
C. Meinl  
M. A. Mendez  
J. J. Monaco  
M. A. A. Pipponzi  
D. Rizzo  
R. Robles  
J. C. Rubeo  
S. Schamun  
G. Telleria  
M. M. C. Tocco

**China International Working Group (BPV VIII)**

X. Chen, *Chair*  
B. Shou, *Vice Chair*  
Z. Fan, *Secretary*  
Y. Chen  
Z. Chen  
J. Cui  
R. Duan  
W. Guo  
B. Han  
J. Hu  
Q. Hu  
H. Hui  
D. Luo  
Y. Luo

C. Miao  
X. Qian  
L. Sun  
B. Wang  
C. Wu  
F. Xu  
F.-Z. Xuan  
Y. Yang  
K. Zhang  
Yanfeng Zhang  
Yijun Zhang  
S. Zhao  
J. Zheng  
G. Zhu

**Germany International Working Group (BPV VIII)**

P. Chavdarov, *Chair*  
M. Sykora, *Vice Chair*  
B. Daume  
A. Emrich  
J. Fleischfresser  
R. Helmholdt  
R. Kauer  
D. Koelbl  
S. Krebs

T. Ludwig  
R. A. Meyers  
H. Michael  
S. Reich  
A. Spangenberg  
G. Naumann, *Contributing Member*  
P. Paluszkiwicz, *Contributing Member*  
R. Uebel, *Contributing Member*

**India International Working Group (BPV VIII)**

D. Chandiramani, *Chair*  
D. Kulkarni, *Vice Chair*  
A. D. Dalal, *Secretary*  
P. Arulkumar  
B. Basu  
P. Gandhi  
S. K. Goyal  
V. Jayabalan  
A. Kakumanu  
V. V. P. Kumar

T. Mukherjee  
P. C. Pathak  
S. B. Patil  
D. Prabhu  
A. Sadasivam  
M. P. Shah  
R. Tiru  
V. T. Valavan  
M. Sharma, *Contributing Member*

**Italy International Working Group (BPV VIII)**

A. Teli, <i>Chair</i>	M. Guglielmetti
D. D. Raimander, <i>Secretary</i>	A. F. Magri
B. G. Alborali	P. Mantovani
P. Aliprandi	M. Millefanti
A. Avogadri	L. Moracchioli
A. Camanni	P. Pacor
M. Colombo	G. Pontiggia
P. Conti	S. Sarti
D. Cortassa	A. Veroni
P. L. Dinelli	G. Gobbi, <i>Contributing Member</i>
F. Finco	

**Special Working Group on Bolted Flanged Joints (BPV VIII)**

R. W. Mikitka, <i>Chair</i>	W. McDaniel
G. Auriolos, Sr.	M. Osterfoss
D. Bankston, Jr.	J. R. Payne
W. Brown	G. B. Rawls, Jr.
H. Chen	R. Wacker
A. Mann	

**Subgroup on Interpretations (BPV VIII)**

G. Auriolos, Sr., <i>Chair</i>	C. D. Rodery
J. Oh, <i>Staff Secretary</i>	T. G. Seipp
S. R. Babka	J. C. Sowinski
J. Cameron	D. B. Stewart
N. Carter	D. A. Swanson
C. W. Cary	J. P. Swezy, Jr.
B. F. Hantz	J. Vattappilly
M. Kowalczyk	A. Viet
D. L. Kurle	K. Xu
M. D. Lower	R. J. Basile, <i>Contributing Member</i>
A. Mann	D. B. DeMichael, <i>Contributing Member</i>
S. A. Marks	R. D. Dixon, <i>Contributing Member</i>
P. Matkovic	S. Kilambi, <i>Contributing Member</i>
G. M. Mital	R. Mahadeen, <i>Contributing Member</i>
D. I. Morris	T. P. Pastor, <i>Contributing Member</i>
D. T. Peters	P. L. Sturgill, <i>Contributing Member</i>
F. L. Richter	
S. C. Roberts	

**COMMITTEE ON WELDING, BRAZING, AND FUSING (BPV IX)**

D. A. Bowers, <i>Chair</i>	W. J. Sperko
M. J. Pischke, <i>Vice Chair</i>	P. L. Sturgill
E. Lawson, <i>Staff Secretary</i>	J. P. Swezy, Jr.
M. Bernasek	E. W. Woelfel
M. A. Boring	D. Pojatar, <i>Delegate</i>
J. G. Feldstein	A. Roza, <i>Delegate</i>
P. D. Flenner	M. Consonni, <i>Contributing Member</i>
S. E. Gingrich	S. A. Jones, <i>Contributing Member</i>
K. L. Hayes	S. Raghunathan, <i>Contributing Member</i>
R. M. Jessee	M. J. Stanko, <i>Contributing Member</i>
J. S. Lee	P. L. Van Fosson, <i>Contributing Member</i>
W. M. Lundy	R. K. Brown, Jr., <i>Honorary Member</i>
S. A. Marks	M. L. Carpenter, <i>Honorary Member</i>
T. Melfi	B. R. Newmark, <i>Honorary Member</i>
W. F. Newell, Jr.	S. D. Reynolds, Jr., <i>Honorary Member</i>
D. K. Peetz	
E. G. Reichelt	
M. J. Rice	
M. B. Sims	

**Subgroup on Brazing (BPV IX)**

S. A. Marks, <i>Chair</i>	A. R. Nywening
E. W. Beckman	M. J. Pischke
A. F. Garbolevsky	J. P. Swezy, Jr.
N. Mohr	

**Subgroup on General Requirements (BPV IX)**

P. L. Sturgill, <i>Chair</i>	D. K. Peetz
N. Carter, <i>Vice Chair</i>	H. B. Porter
S. A. Marks, <i>Secretary</i>	J. P. Swezy, Jr.
J. P. Bell	E. W. Woelfel
D. A. Bowers	E. Molina, <i>Delegate</i>
P. Gilston	E. W. Beckman, <i>Contributing Member</i>
M. Heinrichs	B. R. Newmark, <i>Honorary Member</i>
A. Howard	
R. M. Jessee	

**Subgroup on Materials (BPV IX)**

M. Bernasek, <i>Chair</i>	M. J. Pischke
T. Anderson	A. Roza
E. Cutlip	C. E. Sainz
M. Denault	P. L. Sturgill
S. E. Gingrich	C. Zafir
L. S. Harbison	V. G. V. Giunto, <i>Delegate</i>
M. James	D. J. Kotecki, <i>Contributing Member</i>
R. M. Jessee	B. Krueger, <i>Contributing Member</i>
T. Melfi	W. J. Sperko, <i>Contributing Member</i>
S. D. Nelson	M. J. Stanko, <i>Contributing Member</i>

**Subgroup on Plastic Fusing (BPV IX)**

E. W. Woelfel, <i>Chair</i>	E. G. Reichelt
D. Burwell	M. J. Rice
K. L. Hayes	S. Schuessler
R. M. Jessee	M. Troughton
J. Johnston, Jr.	C. Violand
J. E. O'Sullivan	J. Wright

**Subgroup on Strength of Weldments (BPV II and IX)**

G. W. Galanes, <i>Chair</i>	J. Penso
K. L. Hayes, <i>Vice Chair</i>	D. W. Rahoi
S. H. Bowes, <i>Secretary</i>	B. Roberts
K. K. Coleman	W. J. Sperko
M. Denault	J. P. Swezy, Jr.
J. R. Foulds	M. Ueyama
D. W. Gandy	A. A. Amiri, <i>Contributing Member</i>
M. Ghahremani	P. D. Flenner, <i>Contributing Member</i>
J. Henry	J. J. Sanchez-Hanton, <i>Contributing Member</i>
W. F. Newell, Jr.	

**Subgroup on Welding Qualifications (BPV IX)**

M. J. Rice, <i>Chair</i>	B. R. Newton
J. S. Lee, <i>Vice Chair</i>	E. G. Reichelt
K. L. Hayes, <i>Secretary</i>	M. B. Sims
M. Bernasek	W. J. Sperko
M. A. Boring	S. A. Sprague
D. A. Bowers	P. L. Sturgill
R. Campbell	J. P. Swezy, Jr.
R. B. Corbit	C. Violand
P. D. Flenner	A. D. Wilson
L. S. Harbison	D. Chandiramani, <i>Contributing Member</i>
M. Heinrichs	M. Consonni, <i>Contributing Member</i>
W. M. Lundy	M. Dehghan, <i>Contributing Member</i>
D. W. Mann	T. C. Wiesner, <i>Contributing Member</i>
T. Melfi	
W. F. Newell, Jr.	

**COMMITTEE ON FIBER-REINFORCED PLASTIC PRESSURE VESSELS (BPV X)**

B. Linnemann, <i>Chair</i>	L. E. Hunt
B. F. Shelley, <i>Vice Chair</i>	D. L. Keeler
P. D. Stumpf, <i>Staff Secretary</i>	D. H. McCauley
A. L. Beckwith	N. L. Newhouse
F. L. Brown	G. Ramirez
J. L. Bustillos	J. R. Richter
B. R. Colley	S. L. Wagner
T. W. Cowley	D. O. Yancey, Jr.
I. L. Dinovo	P. H. Ziehl
D. Eisberg	D. H. Hodgkinson, <i>Contributing Member</i>
M. R. Gorman	
B. Hebb	

**Argentina International Working Group (BPV IX)**

A. Burgueno, <i>Chair</i>	J. A. Herrera
E. Lawson, <i>Staff Secretary</i>	M. D. Kuhn
B. Bardott	M. A. Mendez
L. F. Boccanera	A. E. Pastor
M. Favareto	G. Telleria
C. A. Garibotti	M. M. C. Tocco

**COMMITTEE ON NUCLEAR INSERVICE INSPECTION (BPV XI)**

R. W. Swayne, <i>Chair</i>	N. A. Palm
S. D. Kulat, <i>Vice Chair</i>	G. C. Park
D. W. Lamond, <i>Vice Chair</i>	A. T. Roberts III
D. Miro-Quesada, <i>Staff Secretary</i>	D. A. Scarth
J. F. Ball	F. J. Schaaf, Jr.
W. H. Bamford	S. Takaya
J. M. Boughman	D. Vetter
C. Brown	T. V. Vo
S. B. Brown	D. E. Waskey
T. L. Chan	J. G. Weicks
R. C. Cipolla	M. Weis
D. R. Cordes	Y.-K. Chung, <i>Delegate</i>
H. Do	C. Ye, <i>Delegate</i>
E. V. Farrell, Jr.	M. L. Benson, <i>Alternate</i>
M. J. Ferlisi	J. K. Loy, <i>Alternate</i>
P. D. Fisher	R. O. McGill, <i>Alternate</i>
T. J. Griesbach	D. J. Shim, <i>Alternate</i>
J. Hakii	A. Udyawar, <i>Alternate</i>
M. L. Hall	E. B. Gerlach, <i>Contributing Member</i>
D. O. Henry	B. R. Newton, <i>Contributing Member</i>
W. C. Holston	C. D. Cowfer, <i>Honorary Member</i>
J. T. Lindberg	D. D. Davis, <i>Honorary Member</i>
G. A. Lofthus	R. E. Gimple, <i>Honorary Member</i>
H. Malikowski	F. E. Gregor, <i>Honorary Member</i>
S. L. McCracken	O. F. Hedden, <i>Honorary Member</i>
S. A. Norman	R. D. Kerr, <i>Honorary Member</i>
C. A. Nove	P. C. Riccardella, <i>Honorary Member</i>
T. Nuoffer	R. A. West, <i>Honorary Member</i>
J. Nygaard	C. J. Wirtz, <i>Honorary Member</i>
J. E. O'Sullivan	R. A. Yonekawa, <i>Honorary Member</i>

**Germany International Working Group (BPV IX)**

P. Chavdarov, <i>Chair</i>	S. Krebs
A. Spangenberg, <i>Vice Chair</i>	T. Ludwig
E. Lawson, <i>Staff Secretary</i>	G. Naumann
P. Thiebo, <i>Secretary</i>	A. Roza
J. Daldrup	K.-G. Toelle
B. Daume	S. Wegener
J. Fleischfresser	F. Wodke
E. Floer	R. Helmholdt

**Italy International Working Group (BPV IX)**

D. D. Raimander, <i>Chair</i>	L. Moracchioli
M. Bernasek	P. Pacor
A. Camanni	G. Pontiggia
P. L. Dinelli	P. Siboni
F. Ferrarese	A. Volpi
M. Mandina	V. Calo, <i>Contributing Member</i>
A. S. Monastra	G. Gobbi, <i>Contributing Member</i>

**Spain International Working Group (BPV IX)**

F. J. Q. Pandelo, <i>Chair</i>	F. Manas
F. L. Villabrille, <i>Vice Chair</i>	B. B. Miguel
E. Lawson, <i>Staff Secretary</i>	A. D. G. Munoz
F. R. Hermida, <i>Secretary</i>	A. B. Pascual
C. A. Celimendiz	S. Sevil
M. A. F. Garcia	G. Gobbi, <i>Contributing Member</i>
R. G. Garcia	

**Executive Committee (BPV XI)**

S. D. Kulat, <i>Chair</i>	S. L. McCracken
R. W. Swayne, <i>Vice Chair</i>	C. A. Nove
D. Miro-Quesada, <i>Staff Secretary</i>	T. Nuoffer
W. H. Bamford	N. A. Palm
M. J. Ferlisi	G. C. Park
D. W. Lamond	A. T. Roberts III
J. T. Lindberg	M. L. Benson, <i>Alternate</i>

**Argentina International Working Group (BPV XI)**

F. M. Schroeter, <i>Chair</i>	R. J. Lopez
O. Martinez, <i>Staff Secretary</i>	M. Magliocchi
D. A. Cipolla	L. R. Miño
A. Claus	J. Monte
D. Costa	M. D. Pereda
D. P. Delfino	A. Politi
D. N. Dell'Erba	C. G. Real
A. Dominguez	F. J. Schaaf, Jr.
S. A. Echeverria	G. J. Scian
E. P. Fresquet	M. J. Solari
M. M. Gamizo	P. N. Torano
I. M. Guerreiro	P. Yamamoto
F. Llorente	

**Task Group on Inspectability (BPV XI)**

J. T. Lindberg, <i>Chair</i>	G. A. Lofthus
E. Henry, <i>Secretary</i>	S. Matsumoto
A. Cardillo	D. E. Matthews
D. R. Cordes	P. J. O'Regan
M. J. Ferlisi	J. B. Ossmann
P. Gionta	S. A. Sabo
D. O. Henry	P. Sullivan
J. Honcharik	C. Thomas
R. Klein	J. Tucker
C. Latiolais	

**Task Group on ISI of Spent Nuclear Fuel Storage and Transportation Containment Systems (BPV XI)****China International Working Group (BPV XI)**

J. H. Liu, <i>Chair</i>	S. Shuo
Y. Nie, <i>Vice Chair</i>	Y. Sixin
C. Ye, <i>Vice Chair</i>	Y. X. Sun
M. W. Zhou, <i>Secretary</i>	G. X. Tang
J. F. Cai	Q. Wang
H. Chen	Q. W. Wang
H. D. Chen	Z. S. Wang
Y. Cheng	L. Xing
Y. B. Guo	F. Xu
Y. Hongqi	S. X. Xu
D. R. Horn	Q. Yin
Y. Hou	K. Zhang
S. X. Lin	Y. Zhe
W. N. Pei	Z. M. Zhong
L. Shiwei	

K. Hunter, <i>Chair</i>	M. Liu
M. Orihuela, <i>Secretary</i>	K. Mauskar
D. J. Ammerman	R. M. Meyer
W. H. Borter	B. L. Montgomery
J. Broussard	R. M. Pace
S. Brown	E. L. Pleins
C. R. Bryan	M. A. Richter
T. Carraher	B. Sarno
S. Corcoran	R. Sindelar
D. Dunn	M. Staley
N. Fales	J. Wellwood
R. C. Folley	X. J. Zhai
G. Grant	P.-S. Lam, <i>Alternate</i>
B. Gutherman	G. White, <i>Alternate</i>
M. W. Joseph	J. Wise, <i>Alternate</i>
M. Keene	H. Smith, <i>Contributing Member</i>

**German International Working Group (BPV XI)**

R. Döring, <i>Chair</i>	N. Legl
R. Trieglaff, <i>Vice Chair</i>	T. Ludwig
R. Piel, <i>Secretary</i>	X. Pitoiset
A. Casse	M. Reichert
S. Dugan	L. Sybertz
C. G. Fratescu	I. Tewes
M. Hagenbruch	R. Tiete
E. Iacopetta	J. Wendt
S. D. Kulat	S. Zickler
H.-W. Lange	

**Subgroup on Evaluation Standards (SG-ES) (BPV XI)**

W. H. Bamford, <i>Chair</i>	R. O. McGill
N. A. Palm, <i>Secretary</i>	H. S. Mehta
M. Brumovsky	K. Miyazaki
H. D. Chung	R. M. Pace
R. C. Cipolla	J. C. Poehler
C. M. Faigy	S. Ranganath
M. M. Farooq	D. A. Scarth
B. R. Ganta	D. J. Shim
T. J. Griesbach	G. L. Stevens
K. Hasegawa	A. Udyawar
K. Hojo	T. V. Vo
D. N. Hopkins	G. M. Wilkowski
D. R. Lee	S. X. Xu
Y. S. Li	M. L. Benson, <i>Alternate</i>

**India International Working Group (BPV XI)**

S. B. Parkash, <i>Chair</i>	N. Palm
D. Narain, <i>Vice Chair</i>	D. Rawal
K. K. Rai, <i>Secretary</i>	R. Sahai
Z. M. Mansuri	R. K. Sharma
M. R. Nadgouda	

**Task Group on Evaluation of Beyond Design Basis Events (SG-ES) (BPV XI)**

R. M. Pace, <i>Chair</i>	M. Hayashi
S. X. Xu, <i>Secretary</i>	K. Hojo
F. G. Abatt	S. A. Kleinsmith
G. A. Antaki	H. S. Mehta
P. R. Donavin	T. V. Vo
R. G. Gilada	G. M. Wilkowski
T. J. Griesbach	T. Weaver, <i>Contributing Member</i>

**Special Working Group on Editing and Review (BPV XI)**

R. W. Swayne, <i>Chair</i>	K. R. Rao
M. Orihuela	

**Working Group on Flaw Evaluation (SG-ES) (BPV XI)**

R. C. Cipolla, <i>Chair</i>	C. Liu
S. X. Xu, <i>Secretary</i>	M. Liu
W. H. Bamford	H. S. Mehta
M. L. Benson	G. A. A. Miessi
M. Brumovsky	K. Miyazaki
H. D. Chung	S. Noronha
M. A. Erickson	R. K. Qashu
C. M. Faidy	S. Ranganath
M. M. Farooq	P. J. Rush
B. R. Ganta	D. A. Scarth
R. G. Gilada	W. L. Server
F. D. Hayes	D. J. Shim
P. H. Hoang	S. Smith
K. Hojo	M. Uddin
D. N. Hopkins	A. Udyawar
S. Kalyanam	T. V. Vo
Y. Kim	K. Wang
V. Lacroix	B. Wasiluk
D. R. Lee	G. M. Wilkowski
Y. S. Li	

**Working Group on Pipe Flaw Evaluation (SG-ES) (BPV XI)**

D. A. Scarth, <i>Chair</i>	S. Kalyanam
G. M. Wilkowski, <i>Secretary</i>	K. Kashima
K. Azuma	V. Lacroix
M. L. Benson	Y. S. Li
M. Brumovsky	R. O. McGill
F. W. Brust	H. S. Mehta
H. D. Chung	G. A. A. Miessi
R. C. Cipolla	K. Miyazaki
N. G. Cofie	S. H. Pellet
C. M. Faidy	P. J. Rush
M. M. Farooq	C. J. Sallaberry
B. R. Ganta	W. L. Server
S. R. Gosselin	D. J. Shim
C. E. Guzman-Leong	S. Smith
K. Hasegawa	M. F. Uddin
P. H. Hoang	A. Udyawar
K. Hojo	T. V. Vo
D. N. Hopkins	K. Wang
E. J. Houston	B. Wasiluk
R. Janowiak	S. X. Xu

**Working Group on Flaw Evaluation Reference Curves (BPV XI)**

G. L. Stevens, <i>Chair</i>	A. Jenks
A. Udyawar, <i>Secretary</i>	V. Lacroix
W. H. Bamford	H. S. Mehta
M. L. Benson	K. Miyazaki
F. W. Brust	B. Pellereau
R. C. Cipolla	S. Ranganath
M. M. Farooq	D. A. Scarth
A. E. Freed	D. J. Shim
P. Gill	S. Smith
K. Hasegawa	T. V. Vo
K. Hojo	S. X. Xu
R. Janowiak	

**Task Group on Code Case N-513 (WG-PFE) (BPV XI)**

R. O. McGill, <i>Chair</i>	S. M. Parker
E. J. Houston, <i>Secretary</i>	D. Rudland
G. A. Antaki	P. J. Rush
R. C. Cipolla	D. A. Scarth
M. M. Farooq	S. X. Xu
R. Janowiak	

**Working Group on Operating Plant Criteria (SG-ES) (BPV XI)**

N. A. Palm, <i>Chair</i>	H. Kobayashi
A. E. Freed, <i>Secretary</i>	H. S. Mehta
K. R. Baker	A. D. Odell
W. H. Bamford	R. M. Pace
M. Brumovsky	J. C. Poehler
M. A. Erickson	S. Ranganath
T. J. Griesbach	W. L. Server
M. Hayashi	C. A. Tomes
R. Janowiak	A. Udyawar
M. Kirk	T. V. Vo
S. A. Kleinsmith	H. Q. Xu

**Task Group on Evaluation Procedures for Degraded Buried Pipe (WG-PFE) (BPV XI)**

R. O. McGill, <i>Chair</i>	M. Kassir
S. X. Xu, <i>Secretary</i>	M. Moenssens
F. G. Abatt	D. P. Munson
G. A. Antaki	R. M. Pace
R. C. Cipolla	S. H. Pellet
R. G. Gilada	D. Rudland
K. Hasegawa	P. J. Rush
K. M. Hoffman	D. A. Scarth
R. Janowiak	

**Task Group on Flaw Evaluation for HDPE Pipe (WG-PFE) (BPV XI)**

P. J. Rush, <i>Chair</i>	D. J. Shim
P. Krishnaswamy	M. Troughton
M. Moenssens	J. Wright
D. P. Munson	S. X. Xu
D. A. Scarth	

**Task Group on Appendix L (WG-OPC) (BPV XI)**

N. Glunt, <i>Chair</i>	C.-S. Oh
R. M. Pace, <i>Secretary</i>	H. Park
A. E. Freed	S. Ranganath
M. A. Gray	D. J. Shim
T. J. Griesbach	S. Smith
H. Nam	G. L. Stevens
A. Nana	A. Udyawar
A. D. Odell	

**Subgroup on Nondestructive Examination (SG-NDE) (BPV XI)**

J. T. Lindberg, <i>Chair</i>	J. Harrison
D. R. Cordes, <i>Secretary</i>	D. O. Henry
M. Briley	G. A. Lofthus
C. Brown	S. A. Sabo
T. L. Chan	F. J. Schaaf, Jr.
T. Cinson	R. V. Swain
S. E. Cumblidge	C. A. Nove, <i>Alternate</i>
K. J. Hacker	

**Working Group on Personnel Qualification and Surface Visual and Eddy Current Examination (SG-NDE) (BPV XI)**

C. Brown, <i>Chair</i>	D. O. Henry
T. Cinson, <i>Secretary</i>	J. T. Lindberg
J. E. Aycock	C. Shinsky
J. Bennett	R. Tedder
S. E. Cumblidge	T. Thulien
A. Diaz	J. T. Timm
N. Farenbaugh	

**Working Group on Procedure Qualification and Volumetric Examination (SG-NDE) (BPV XI)**

G. A. Lofthus, <i>Chair</i>	D. A. Kull
J. Harrison, <i>Secretary</i>	C. Latiolais
M. Briley	C. A. Nove
A. Bushmire	S. A. Sabo
D. R. Cordes	R. V. Swain
S. R. Doctor	D. Van Allen
K. J. Hacker	D. K. Zimmerman
W. A. Jensen	B. Lin, <i>Alternate</i>

**Subgroup on Repair/Replacement Activities (SG-RRA) (BPV XI)**

S. L. McCracken, <i>Chair</i>	B. R. Newton
E. V. Farrell, Jr., <i>Secretary</i>	S. A. Norman
J. F. Ball	J. E. O'Sullivan
M. Brandes	G. C. Park
S. B. Brown	R. R. Stevenson
R. Clow	R. W. Swayne
P. D. Fisher	D. J. Tilly
M. L. Hall	D. E. Waskey
W. C. Holston	J. G. Weicks
J. Honcharik	B. Lin, <i>Alternate</i>
A. B. Meichler	J. K. Loy, <i>Alternate</i>

**Working Group on Welding and Special Repair Processes (SG-RRA) (BPV XI)**

J. G. Weicks, <i>Chair</i>	M. Kris
D. Barborak	S. E. Marlette
S. J. Findlan	S. L. McCracken
P. D. Fisher	B. R. Newton
R. C. Folley	J. E. O'Sullivan
M. L. Hall	D. J. Tilly
W. C. Holston	D. E. Waskey
J. Honcharik	J. K. Loy, <i>Alternate</i>
C. C. Kim	

**Task Group on Temper Bead Welding (BPV XI)**

S. J. Findlan, <i>Chair</i>	J. E. O'Sullivan
D. Barborak	A. Patel
M. L. Hall	J. Tatman
S. L. McCracken	D. J. Tilly
N. Mohr	D. E. Waskey
B. R. Newton	J. G. Weicks
G. Olson	

**Task Group on Weld Overlay (BPV XI)**

S. L. McCracken, <i>Chair</i>	B. R. Newton
D. Barborak	G. Olson
S. J. Findlan	A. Patel
M. L. Hall	P. Raynaud
W. C. Holston	D. W. Sandusky
S. Hunter	D. E. Waskey
C. Lohse	J. G. Weicks
S. E. Marlette	

**Working Group on Non-Metals Repair/Replacement Activities (SG-RRA) (BPV XI)**

J. E. O'Sullivan, <i>Chair</i>	M. P. Marohl
S. Schuessler, <i>Secretary</i>	T. M. Musto
M. Brandes	S. Patterson
D. R. Dechene	A. Pridmore
J. Johnston, Jr.	F. J. Schaaf, Jr.
B. Lin	R. Stakenborghs

**Task Group on HDPE Piping for Low Safety Significance Systems (WG-NMRA) (BPV XI)**

M. Brandes, <i>Chair</i>	T. M. Musto
J. E. O'Sullivan, <i>Secretary</i>	F. J. Schaaf, Jr.
M. Golliet	S. Schuessler
B. Lin	R. Stakenborghs

**Task Group on Repair by Carbon Fiber Composites (WGN-MRR) (BPV XI)**

J. E. O'Sullivan, <i>Chair</i>	R. P. Ojdrovic
S. F. Arnold	A. Pridmore
S. W. Choi	P. Raynaud
D. R. Dechene	S. Rios
M. Golliet	C. W. Rowley
L. S. Gordon	J. Sealey
M. Kuntz	R. Stakenborghs
H. Lu	N. Stoeva
M. P. Marohl	M. F. Uddin
L. Nadeau	J. Wen
C. A. Nove	B. Davenport, <i>Alternate</i>

**Working Group on Design and Programs (SG-RRA) (BPV XI)**

S. B. Brown, <i>Chair</i>	B. Lin
A. B. Meichler, <i>Secretary</i>	H. Malikowski
O. Bhatti	G. C. Park
R. Clow	M. A. Pyne
R. R. Croft	R. R. Stevenson
E. V. Farrell, Jr.	R. W. Swayne

**Task Group on Repair and Replacement Optimization (WG-D&P) (BPV XI)**

S. L. McCracken, <i>Chair</i>	D. Jacobs
T. Basso	H. Malikowski
R. Clow	T. Nuoffer
K. Dietrich	G. C. Park
E. V. Farrell, Jr.	A. Patel
R. C. Folley	R. R. Stevenson
M. L. Hall	R. G. Weicks
W. C. Holston	

**Subgroup on Water-Cooled Systems (SG-WCS) (BPV XI)**

M. J. Ferlisi, <i>Chair</i>	S. D. Kulat
J. Nygaard, <i>Secretary</i>	D. W. Lamond
J. M. Boughman	T. Nomura
S. B. Brown	T. Nuoffer
S. T. Chesworth	M. A. Pyne
H. Q. Do	H. M. Stephens, Jr.
K. W. Hall	R. Thames
P. J. Hennessey	M. Weis
K. M. Hoffman	M. J. Homiack, <i>Alternate</i>
A. E. Keyser	

**Task Group on High Strength Nickel Alloys Issues (SG-WCS) (BPV XI)**

H. Malikowski, <i>Chair</i>	S. E. Marlette
K. Dietrich, <i>Secretary</i>	B. L. Montgomery
W. H. Bamford	G. C. Park
T. Cinson	W. Sims
P. R. Donavin	D. E. Waskey
K. M. Hoffman	C. Wax
H. Kobayashi	K. A. Whitney
C. Lohse	

**Working Group on Containment (SG-WCS) (BPV XI)**

M. J. Ferlisi, <i>Chair</i>	J. A. Munshi
R. Thames, <i>Secretary</i>	M. Sircar
P. S. Ghosal	P. C. Smith
H. T. Hill	S. Walden
A. E. Keyser	M. Weis
B. Lehman	S. G. Brown, <i>Alternate</i>
P. Leininger	

**Working Group on Inspection of Systems and Components (SG-WCS) (BPV XI)**

H. Q. Do, <i>Chair</i>	J. Howard
M. Weis, <i>Secretary</i>	A. Keller
R. W. Blyde	S. D. Kulat
K. Caver	E. Lantz
C. Cueto-Felgueroso	A. Maekawa
M. J. Ferlisi	T. Nomura
M. L. Garcia Heras	J. C. Nygaard
K. W. Hall	S. Orita
K. M. Hoffman	

**Working Group on Pressure Testing (SG-WCS) (BPV XI)**

J. M. Boughman, <i>Chair</i>	D. W. Lamond
S. A. Norman, <i>Secretary</i>	J. K. McClanahan
T. Anselmi	T. P. McClure
B. Casey	B. L. Montgomery
Y.-K. Chung	M. Moenssens
M. J. Homiack	R. A. Nettles
A. E. Keyser	C. Thomas

**Working Group on Risk-Informed Activities (SG-WCS) (BPV XI)**

M. A. Pyne, <i>Chair</i>	S. D. Kulat
S. T. Chesworth, <i>Secretary</i>	D. W. Lamond
G. Brouette	G. J. Navratil
C. Cueto-Felgueroso	P. J. O'Regan
R. Haessler	N. A. Palm
J. Hakii	D. Vetter
K. W. Hall	J. C. Younger
M. J. Homiack	

**Working Group on General Requirements (BPV XI)**

T. Nuoffer, <i>Chair</i>	A. T. Roberts III
J. Mayo, <i>Secretary</i>	S. R. Scott
J. F. Ball	D. Vetter
T. L. Chan	S. E. Woolf
P. J. Hennessey	M. T. Audrain, <i>Alternate</i>
K. A. Kavanagh	R. S. Spencer, <i>Alternate</i>
T. N. Rezk	

**Subgroup on Reliability and Integrity Management Program (SG-RIM) (BPV XI)**

A. T. Roberts III, <i>Chair</i>	P. J. Hennessey
D. Vetter, <i>Secretary</i>	D. M. Jones
T. Anselmi	D. R. Lee
N. Broom	T. Lupold
V. Chugh	M. Orihuela
S. R. Doctor	F. J. Schaaf, Jr.
J. D. Fletcher	H. M. Stephens, Jr.
J. T. Fong	R. W. Swayne
J. Grimm	S. Takaya
K. Harris	R. Vayda

**Working Group on MANDE (BPV XI)**

H. M. Stephens, Jr., <i>Chair</i>	J. T. Fong
S. R. Doctor, <i>Vice Chair</i>	D. O. Henry
M. Turnbow, <i>Secretary</i>	T. Lupold
T. Anselmi	L. E. Mullins
N. A. Finney	M. Orihuela

**JSME/ASME Joint Task Group for System-Based Code (SWG-RIM) (BPV XI)**

S. Takaya, <i>Chair</i>	D. R. Lee
T. Asayama	H. Machida
S. R. Doctor	T. Muraki
K. Dozaki	A. T. Roberts III
J. T. Fong	F. J. Schaaf, Jr.
J. Hakii	R. Vayda
K. Harris	D. Watanabe
M. Hayashi	M. Morishita, <i>Contributing Member</i>
Y. Kamishima	

**COMMITTEE ON TRANSPORT TANKS (BPV XII)**

N. J. Paulick, <i>Chair</i>	T. A. Rogers
M. D. Rana, <i>Vice Chair</i>	R. C. Sallash
J. Oh, <i>Staff Secretary</i>	M. Shah
A. N. Antoniou	S. Staniszewski
P. Chilukuri	A. P. Varghese
W. L. Garfield	Y. Doron, <i>Contributing Member</i>
M. Pitts	R. Meyers, <i>Contributing Member</i>
J. Roberts	M. R. Ward, <i>Contributing Member</i>

**Executive Committee (BPV XII)**

M. D. Rana, <i>Chair</i>	T. A. Rogers
N. J. Paulick, <i>Vice Chair</i>	R. C. Sallash
J. Oh, <i>Staff Secretary</i>	S. Staniszewski
M. Pitts	A. P. Varghese

**Subgroup on Design and Materials (BPV XII)**

R. C. Sallash, *Chair*  
 D. K. Chandiramani  
 P. Chilukuri  
 Y. Doron  
 S. L. McWilliams  
 N. J. Paulick  
 M. D. Rana  
 T. A. Rogers  
 M. Shah  
 S. Staniszewski  
 A. P. Varghese

K. Xu  
 A. T. Duggleby, *Contributing Member*  
 R. D. Hayworth, *Contributing Member*  
 G. G. Karcher, *Contributing Member*  
 B. E. Spencer, *Contributing Member*  
 M. R. Ward, *Contributing Member*  
 J. Zheng, *Contributing Member*

**Subgroup on Fabrication, Inspection, and Continued Service (BPV XII)**

M. Pitts, *Chair*  
 P. Chilukuri  
 Y. Doron  
 M. Koprivnak  
 P. Miller  
 O. Mulet  
 J. Roberts

T. A. Rogers  
 R. C. Sallash  
 L. Selensky  
 S. Staniszewski  
 R. D. Hayworth  
 G. McRae, *Contributing Member*

**Subgroup on General Requirements (BPV XII)**

S. Staniszewski, *Chair*  
 B. F. Pittel, *Secretary*  
 A. N. Antoniou  
 Y. Doron  
 H. Ebben III  
 J. L. Freiler  
 W. L. Garfield  
 O. Mulet  
 M. Pitts  
 R. C. Sallash

L. Selensky  
 P. Chilukuri, *Contributing Member*  
 T. J. Hitchcock, *Contributing Member*  
 S. L. McWilliams, *Contributing Member*  
 T. A. Rogers, *Contributing Member*  
 D. G. Shelton, *Contributing Member*  
 M. R. Ward, *Contributing Member*

**Subgroup on Nonmandatory Appendices (BPV XII)**

T. A. Rogers, *Chair*  
 S. Staniszewski, *Secretary*  
 P. Chilukuri  
 N. J. Paulick

M. Pitts  
 R. C. Sallash  
 D. G. Shelton  
 Y. Doron, *Contributing Member*

**COMMITTEE ON OVERPRESSURE PROTECTION (BPV XIII)**

D. B. DeMichael, *Chair*  
 D. Miller, *Vice Chair*  
 C. E. O'Brien, *Staff Secretary*  
 J. F. Ball  
 J. Burgess  
 B. Calderon  
 J. W. Dickson  
 A. Donaldson  
 S. F. Harrison, Jr.  
 B. K. Nutter  
 T. Patel  
 M. Poehlmann  
 T. R. Tarbay  
 D. E. Tompkins  
 Z. Wang  
 J. A. West  
 A. Wilson  
 H. Aguilar, *Contributing Member*  
 R. W. Barnes, *Contributing Member*

R. D. Danzy, *Contributing Member*  
 M. Elias, *Contributing Member*  
 D. Felix, *Contributing Member*  
 A. Frigerio, *Contributing Member*  
 J. P. Glaspie, *Contributing Member*  
 A. Hassan, *Contributing Member*  
 P. K. Lam, *Contributing Member*  
 J. M. Levy, *Contributing Member*  
 M. Mengon, *Contributing Member*  
 J. Mize, *Contributing Member*  
 M. Mullavey, *Contributing Member*  
 S. K. Parimi, *Contributing Member*  
 R. Raman, *Contributing Member*  
 M. Reddy, *Contributing Member*  
 S. Ruesenberg, *Contributing Member*  
 K. Shores, *Contributing Member*  
 D. E. Tezzo, *Contributing Member*

**Executive Committee (BPV XIII)**

D. Miller, *Chair*  
 D. B. DeMichael, *Vice Chair*  
 C. E. O'Brien, *Staff Secretary*  
 J. F. Ball

A. Donaldson  
 B. K. Nutter  
 J. A. West

**Subgroup on Design and Materials (BPV XIII)**

D. Miller, *Chair*  
 T. Patel, *Vice Chair*  
 B. Mruk, *Secretary*  
 C. E. Bear  
 A. Biesecker  
 W. E. Chapin  
 J. L. Freiler  
 B. Joergensen  
 V. Kalyanasundaram  
 B. J. Mollitor  
 A. Swearingin

T. R. Tarbay  
 J. A. West  
 A. Williams  
 D. J. Azukas, *Contributing Member*  
 R. D. Danzy, *Contributing Member*  
 A. Hassan, *Contributing Member*  
 R. Miyata, *Contributing Member*  
 M. Mullavey, *Contributing Member*  
 S. K. Parimi, *Contributing Member*  
 G. Ramirez, *Contributing Member*  
 K. Shores, *Contributing Member*

**Subgroup on General Requirements (BPV XIII)**

A. Donaldson, *Chair*  
 B. F. Pittel, *Vice Chair*  
 J. M. Levy, *Secretary*  
 D. J. Azukas  
 J. F. Ball  
 M. Z. Brown  
 J. Burgess  
 D. B. DeMichael  
 M. Elias  
 S. T. French  
 J. Gillham  
 R. Klimas, Jr.  
 Z. E. Kumana  
 P. K. Lam  
 K. R. May  
 J. Mize  
 L. Moedinger  
 M. Mullavey  
 M. Poehlmann  
 K. Shores  
 D. E. Tezzo  
 D. E. Tompkins  
 J. F. White  
 B. Calderon, *Contributing Member*  
 P. Chavdarov, *Contributing Member*

T. M. Fabiani, *Contributing Member*  
 J. L. Freiler, *Contributing Member*  
 J. P. Glaspie, *Contributing Member*  
 G. D. Goodson, *Contributing Member*  
 C. Haldiman, *Contributing Member*  
 J. Horne, *Contributing Member*  
 B. Joergensen, *Contributing Member*  
 C. Lasarte, *Contributing Member*  
 D. Mainiero-Cessna, *Contributing Member*  
 M. Mengon, *Contributing Member*  
 D. E. Miller, *Contributing Member*  
 R. Miyata, *Contributing Member*  
 B. Mruk, *Contributing Member*  
 R. Raman, *Contributing Member*  
 M. Reddy, *Contributing Member*  
 S. Ruesenberg, *Contributing Member*  
 R. Sadowski, *Contributing Member*  
 A. Swearingin, *Contributing Member*  
 A. P. Varghese, *Contributing Member*

**Subgroup on Nuclear (BPV XIII)**

J. F. Ball, *Chair*  
 K. R. May, *Vice Chair*  
 R. Krithivasan, *Secretary*  
 J. W. Dickson  
 S. Jones  
 R. Lack  
 D. Miller  
 T. Patel

K. Shores  
 I. H. Tseng  
 J. Yu  
 N. J. Hansing, *Alternate*  
 J. M. Levy, *Alternate*  
 B. J. Yonsky, *Alternate*  
 S. T. French, *Contributing Member*  
 D. B. Ross, *Contributing Member*

**Subgroup on Testing (BPV XIII)**

B. K. Nutter, <i>Chair</i>	J. R. Thomas, Jr.
T. P. Beirne, <i>Vice Chair</i>	Z. Wang
J. W. Dickson, <i>Secretary</i>	A. Wilson
B. Calderon	D. Nelson, <i>Alternate</i>
V. Chicola III	J. Cockerham, <i>Contributing Member</i>
B. Engman	J. Mize, <i>Contributing Member</i>
R. J. Garnett	M. Mullavey, <i>Contributing Member</i>
R. Houk	R. Raman, <i>Contributing Member</i>
R. Lack	S. Ruesenberg, <i>Contributing Member</i>
M. Mengon	K. Shores, <i>Contributing Member</i>
C. Sharpe	
A. Strecker	

**ISO TAG to ISO TC 185 Safety Devices for Protection Against Excessive Pressure (BPV XIII)**

D. Miller, <i>Chair</i>	B. K. Nutter
C. E. O'Brien, <i>Staff Secretary</i>	T. Patel
J. F. Ball	J. R. Thomas, Jr.
T. J. Bevilacqua	J. A. West
D. B. DeMichael	J. F. White
J. W. Dickson	

**COMMITTEE ON BOILER AND PRESSURE VESSEL CONFORMITY ASSESSMENT (CBPVCA)**

R. V. Wielgoszinski, <i>Chair</i>	T. P. Beirne, <i>Alternate</i>
G. Scribner, <i>Vice Chair</i>	M. Blankinship, <i>Alternate</i>
P. Murray, <i>Staff Secretary</i>	J. W. Dickson, <i>Alternate</i>
J. P. Chicoine	J. M. Downs, <i>Alternate</i>
P. D. Edwards	B. J. Hackett, <i>Alternate</i>
T. E. Hansen	W. Hibdon, <i>Alternate</i>
B. L. Krasiun	Y.-S. Kim, <i>Alternate</i>
P. F. Martin	B. Morelock, <i>Alternate</i>
L. E. McDonald	M. Poehlmann, <i>Alternate</i>
D. Miller	R. Rockwood, <i>Alternate</i>
I. Powell	B. C. Turczynski, <i>Alternate</i>
L. Skarin	D. E. Tuttle, <i>Alternate</i>
R. Uebel	S. V. Voorhees, <i>Alternate</i>
E. A. Whittle	D. Cheetham, <i>Contributing Member</i>
P. Williams	A. J. Spencer, <i>Honorary Member</i>

**COMMITTEE ON NUCLEAR CERTIFICATION (CNC)**

R. R. Stevenson, <i>Chair</i>	E. A. Whittle
J. DeKleine, <i>Vice Chair</i>	T. Aldo, <i>Alternate</i>
Z. McLucas, <i>Staff Secretary</i>	M. Blankinship, <i>Alternate</i>
J. F. Ball	P. J. Coco, <i>Alternate</i>
G. Claffey	N. DeSantis, <i>Alternate</i>
G. Gobbi	C. Dinic, <i>Alternate</i>
S. M. Goodwin	P. D. Edwards, <i>Alternate</i>
J. W. Highlands	T. B. Franchuk, <i>Alternate</i>
K. A. Kavanagh	K. M. Hottle, <i>Alternate</i>
J. C. Krane	P. Krane, <i>Alternate</i>
M. A. Lockwood	D. Nenstiel, <i>Alternate</i>
T. McGee	L. Ponce, <i>Alternate</i>
E. L. Pleins	P. F. Prescott, <i>Alternate</i>
T. E. Quaka	S. V. Voorhees, <i>Alternate</i>
T. N. Rezk	M. Wilson, <i>Alternate</i>
G. E. Szabatura	S. Yang, <i>Alternate</i>
C. Turylo	S. F. Harrison, Jr., <i>Contributing Member</i>
D. M. Vickery	

# ORGANIZATION OF SECTION III

## 1 GENERAL

Section III consists of Division 1, Division 2, Division 3, and Division 5. These Divisions are broken down into Subsections and are designated by capital letters preceded by the letter “N” for Division 1, by the letter “C” for Division 2, by the letter “W” for Division 3, and by the letter “H” for Division 5. Each Subsection is published separately, with the exception of those listed for Divisions 2, 3, and 5.

- Subsection NCA — General Requirements for Division 1 and Division 2
- Appendices
- Division 1
  - Subsection NB — Class 1 Components
  - Subsection NCD — Class 2 and Class 3 Components\*
  - Subsection NE — Class MC Components
  - Subsection NF — Supports
  - Subsection NG — Core Support Structures
- Division 2 — Code for Concrete Containments
  - Subsection CC — Concrete Containments
- Division 3 — Containment Systems for Transportation and Storage of Spent Nuclear Fuel and High-Level Radioactive Material
  - Subsection WA — General Requirements for Division 3
  - Subsection WB — Class TC Transportation Containments
  - Subsection WC — Class SC Storage Containments
  - Subsection WD — Class ISS Internal Support Structures
- Division 5 — High Temperature Reactors
  - Subsection HA — General Requirements
    - Subpart A — Metallic Materials
    - Subpart B — Graphite Materials
    - Subpart C — Composite Materials
  - Subsection HB — Class A Metallic Pressure Boundary Components
    - Subpart A — Low Temperature Service
    - Subpart B — Elevated Temperature Service
  - Subsection HC — Class B Metallic Pressure Boundary Components
    - Subpart A — Low Temperature Service
    - Subpart B — Elevated Temperature Service
  - Subsection HF — Class A and B Metallic Supports
    - Subpart A — Low Temperature Service
  - Subsection HG — Class SM Metallic Core Support Structures
    - Subpart A — Low Temperature Service
    - Subpart B — Elevated Temperature Service
  - Subsection HH — Class SN Nonmetallic Core Components
    - Subpart A — Graphite Materials
    - Subpart B — Composite Materials

## 2 SUBSECTIONS

Subsections are divided into Articles, subarticles, paragraphs, and, where necessary, subparagraphs and subsubparagraphs.

---

\* In the 2021 Edition, Subsections NC and ND have been incorporated into one publication, Subsection NCD (BPVC.III.1.NCD), Class 2 and Class 3 Components.

### 3 ARTICLES

Articles are designated by the applicable letters indicated above for the 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, in accordance with the following general scheme:

Article Number	Title
1000	Introduction or Scope
2000	Material
3000	Design
4000	Fabrication and Installation
5000	Examination
6000	Testing
7000	Overpressure Protection
8000	Nameplates, Stamping With Certification Mark, and Reports

The numbering of Articles and the material contained in the Articles may not, however, be consecutive. Due to the fact that the complete outline may cover phases not applicable to a particular Subsection or Article, the rules have been prepared with some gaps in the numbering.

### 4 SUBARTICLES

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

### 5 SUBSUBARTICLES

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.

### 6 PARAGRAPHS

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

### 7 SUBPARAGRAPHS

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).

### 8 SUBSUBPARAGRAPHS

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).

### 9 REFERENCES

References used within Section III generally fall into one of the following four categories:

(a) *References to Other Portions of Section III.* When a reference is made to another Article, subarticle, or paragraph, all numbers subsidiary to that reference shall be included. For example, reference to Article NB-3000 includes all material in Article NB-3000; reference to NB-3100 includes all material in subarticle NB-3100; reference to NB-3110 includes all paragraphs, NB-3111 through NB-3113.

(b) *References to Other Sections.* Other Sections referred to in Section III are the following:

(1) *Section II, Materials.* When a requirement for a material, or for the examination or testing of a material, is to be in accordance with a specification such as SA-105, SA-370, or SB-160, the reference is to material specifications in Section II. These references begin with the letter "S."

(2) *Section V, Nondestructive Examination.* Section V references begin with the letter “T” and relate to the nondestructive examination of material or welds.

(3) *Section IX, Welding and Brazing Qualifications.* Section IX references begin with the letter “Q” and relate to welding and brazing requirements.

(4) *Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components.* When a reference is made to inservice inspection, the rules of Section XI shall apply.

(c) *Reference to Specifications and Standards Other Than Published in Code Sections*

(1) Specifications for examination methods and acceptance standards to be used in connection with them are published by the American Society for Testing and Materials (ASTM). At the time of publication of Section III, some such specifications were not included in Section II of this Code. A reference to ASTM E94 refers to the specification so designated by and published by ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428.

(2) Dimensional standards covering products such as valves, flanges, and fittings are sponsored and published by The American Society of Mechanical Engineers and approved by the American National Standards Institute. \*\* When a product is to conform to such a standard, for example ASME B16.5, the standard is approved by the American National Standards Institute. The applicable year of issue is that suffixed to its numerical designation in Table NCA-7100-1, for example ASME B16.5-2003. Standards published by The American Society of Mechanical Engineers are available from ASME (<https://www.asme.org/>).

(3) Dimensional and other types of standards covering products such as valves, flanges, and fittings are also published by the Manufacturers Standardization Society of the Valve and Fittings Industry and are known as Standard Practices. When a product is required by these rules to conform to a Standard Practice, for example MSS SP-100, the Standard Practice referred to is published by the Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS), 127 Park Street, NE, Vienna, VA 22180. The applicable year of issue of such a Standard Practice is that suffixed to its numerical designation in Table NCA-7100-1, for example MSS SP-58-2009.

(4) Specifications for welding and brazing materials are published by the American Welding Society (AWS), 8669 NW 36 Street, No. 130, Miami, FL 33166. Specifications of this type are incorporated in Section II and are identified by the AWS designation with the prefix “SF,” for example SFA-5.1.

(5) Standards applicable to the design and construction of tanks and flanges are published by the American Petroleum Institute and have designations such as API-605. When documents so designated are referred to in Section III, for example API-605-1988, they are standards published by the American Petroleum Institute and are listed in Table NCA-7100-1.

(d) *References to Appendices.* Section III uses two types of appendices that are designated as either Section III Appendices or Subsection Appendices. Either of these appendices is further designated as either Mandatory or Nonmandatory for use. Mandatory Appendices are referred to in the Section III rules and contain requirements that must be followed in construction. Nonmandatory Appendices provide additional information or guidance when using Section III.

(1) Section III Appendices are contained in a separate book titled “Appendices.” These appendices have the potential for multiple subsection applicability. Mandatory Appendices are designated by a Roman numeral followed, when appropriate, by Arabic numerals to indicate various articles, subarticles, and paragraphs of the appendix, such as II-1500 or XIII-1210. Nonmandatory Appendices are designated by a capital letter followed, when appropriate, by Arabic numerals to indicate various articles, subarticles, and paragraphs of the appendix, such as D-1200 or Y-1440.

(2) Subsection Appendices are specifically applicable to just one subsection and are contained within that subsection. Subsection-specific mandatory and nonmandatory appendices are numbered in the same manner as Section III Appendices, but with a subsection identifier (e.g., NF, NH, D2, etc.) preceding either the Roman numeral or the capital letter for a unique designation. For example, NF-II-1100 or NF-A-1200 would be part of a Subsection NF mandatory or nonmandatory appendix, respectively. For Subsection CC, D2-IV-1120 or D2-D-1330 would be part of a Subsection CC mandatory or nonmandatory appendix, respectively.

(3) It is the intent of this Section that the information provided in both Mandatory and Nonmandatory Appendices may be used to meet the rules of any Division or Subsection. In case of conflict between Appendix rules and Division/Subsection rules, the requirements contained in the Division/Subsection shall govern. Additional guidance on Appendix usage is provided in the front matter of Section III Appendices.

---

\*\* The American National Standards Institute (ANSI) was formerly known as the American Standards Association. Standards approved by the Association were designated by the prefix “ASA” followed by the number of the standard and the year of publication. More recently, the American National Standards Institute was known as the United States of America Standards Institute. Standards were designated by the prefix “USAS” followed by the number of the standard and the year of publication. While the letters of the prefix have changed with the name of the organization, the numbers of the standards have remained unchanged.

## SUMMARY OF CHANGES

Errata to the BPV Code may be posted on the ASME website to provide corrections to incorrectly published items, or to correct typographical or grammatical errors in the BPV Code. Such Errata shall be used on the date posted.

Information regarding Special Notices and Errata is published by ASME at <http://go.asme.org/BPVCerrata>.

Changes given below are identified on the pages by a margin note, **(21)**, placed next to the affected area.

<i>Page</i>	<i>Location</i>	<i>Change</i>
xxv	List of Sections	(1) Listing for Section III updated (2) Section XIII added (3) Code Case information updated
xxvii	Foreword	(1) Subparagraph (k) added and subsequent subparagraph redesignated (2) Second footnote revised (3) Last paragraph added
xxx	Submittal of Technical Inquiries to the Boiler and Pressure Vessel Standards Committees	Paragraphs 1(a)(3)(-b), 2(b), and 5(a)(3) revised
xxxiii	Personnel	Updated
liv	Organization of Section III	(1) In para. 1, Division 1 listing updated (2) In para. 9(c)(3), "MSS SP-89-2003" corrected by errata to "MSS SP-58-2009"
4	Article HAA-3000	(1) HAA-3100 added (2) In HAA-3252(a)(1) and HAA-3252(a)(2), cross-reference to NCA updated
6	Article HAA-8000	(1) In first and second paragraphs, first sentence revised (2) HAA-8200, HAA-8300, and Table HAA-8110-1 added
12	HAB-1150	In fifth paragraph, second sentence revised
17	HAB-3240	First sentence revised
17	HAB-3255	First sentence revised
25	HAB-4110	In subpara. (a), first sentence, penultimate line revised
25	HAB-4130	(1) HAB-4131, HAB-4134.2(b), HAB-4134.2(c), HAB-4134.4, HAB-4134.6, HAB-4134.7, and HAB-4134.18(b) revised (2) HAB-4133 added
29	HAB-4551.3	Subparagraph (a) revised
30	HAB-4553.3	Revised
30	HAB-4555.2	Subparagraphs (a), (b), and (c) revised
30	HAB-4555.3	Subparagraph (c)(1) revised
33	HAB-4559.1	Subparagraphs (d) and (e) revised
34	HAB-5125	Revised in its entirety

<i>Page</i>	<i>Location</i>	<i>Change</i>
35	HAB-5220	(1) In first paragraph, cross-reference updated (2) New subpara. (i) added and subsequent subparagraphs redesignated
35	HAB-5230	Subparagraphs (b) and (c) revised
36	HAB-5256	Added
38	Article HAB-7000	(1) In HAB-7100, second sentence added (2) Table HAB-7100-1 editorially revised
39	HAB-8161	In subpara. (b), last sentence revised
40	HAB-8180	Restructured and revised to include HAB-8181 and HAB-8182
40	HAB-8420	Second sentence revised
46	Article HBA-7000	Added
50	HBB-2160	(1) In subparas. (a) and (b), cross-reference to NCA updated (2) Subparagraph (d)(4) added
53	HBB-3111.1	Cross-reference to NCA updated
53	HBB-3112	Cross-reference to NCA updated
54	HBB-3113.2	Cross-reference to NCA updated
55	HBB-3114	Cross-references to NCA updated
55	HBB-3134	Cross-reference to NCA updated
57	HBB-3211	In endnote 1, cross-references to NCA updated (see Endnotes)
66	Figure HBB-3221-1	Revised
68	HBB-3224	In subpara. (b) nomenclature, definition of $B$ , cross-reference to NCA updated
68	HBB-3225	(1) In subpara. (a), cross-reference to NCA updated (2) In subpara. (c) nomenclature, definition of $B_r$ , cross-reference to NCA updated
75	HBB-3241	In subpara. (a), cross-reference to NCA updated
76	HBB-3250	Cross-references to NCA updated
80	HBB-3364	Cross-reference to NCA updated
82	HBB-3421.11	Cross-reference to NCA updated
82	HBB-3421.12	Cross-reference to NCA updated
83	HBB-3524	Cross-reference to NCA updated
84	HBB-3622.2	Cross-reference to NCA updated
86	HBB-3660	In subpara. (b), cross-reference to NCA updated
87	HBB-3671.7	In subpara. (c), cross-reference to NCA updated
93	HBB-6112	Subparagraph (b) revised
98	HBB-7110	In subpara. (a), cross-reference to NCA updated
99	HBB-7800	Added
168	HBB-T-1210	Cross-reference to NCA updated

<i>Page</i>	<i>Location</i>	<i>Change</i>
171	HBB-T-1330	(1) In HBB-T-1331, subparas. (c) and (d) revised, subpara. (g) deleted, and subsequent subpara. redesignated and revised (2) HBB-T-1333 deleted
172	Figure HBB-T-1332-1	Title revised
176	Figure HBB-T-1420-1A	Within graph, "Cycle Strain Range" corrected by errata to "Cycle Strain Rate"
178	Figure HBB-T-1420-1B	Within graph, "Cycle Strain Range" corrected by errata to "Cycle Strain Rate"
183	Figure HBB-T-1420-1E	Revised in its entirety
186	HBB-T-1432	(1) In subpara. (c), paragraph below first group of nomenclature revised (2) In subpara. (c), second group of nomenclature revised (3) In subpara. (g), fourth sentence, cross-references updated
187	Figure HBB-T-1432-1	Revised
188	HBB-T-1433	In subpara. (a), Step 4 and Step 5(b) revised
193	HBB-T-1510	Subparagraph (g) revised
194	HBB-T-1714	Cross-reference to NCA updated
199	HBB-T-1800	Revised in its entirety, including figures
293	HCA-1110	In subpara. (b), last sentence added
295	HCB-1110	(1) In subpara. (b), last sentence added (2) In subparas. (j)(1) and (j)(2), cross-references to NCA updated
298	HCB-3115	In subparas. (a) and (b), cross-references to NCA updated
299	HCB-3310	In first paragraph, cross-reference to NCA updated
307	HCB-7100	In subpara. (a), cross-reference to NCA updated
344	HFA-1110	In subparas. (f) and (g)(3), cross-references to NCA updated
348	HGB-1111	In second paragraph, cross-reference to NCA updated
350	HGB-2160	In subpara. (a), cross-reference to NCA updated
351	HGB-3112	In subparas. (b) and (c), cross-reference to NCA updated
352	HGB-3113.2	Cross-reference to NCA updated
352	HGB-3114	Cross-references to NCA updated
356	HGB-3214	Cross-reference to NCA updated
361	HGB-3224	In subpara. (b) nomenclature and last paragraph, cross-references to NCA updated
362	HGB-3225	In subpara. (a) and subpara. (c) nomenclature, cross-reference to NCA updated
365	HGB-3241	Cross-reference to NCA updated
365	HGB-3250	Cross-references to NCA updated
377	HGB-II-1110	In second paragraph, cross-reference to NCA updated
421	HHA-3130	(1) Definitions of $K_{Ic}$ and $\sigma_m$ added (2) Definition of $V_m$ revised

<i>Page</i>	<i>Location</i>	<i>Change</i>
426	HHA-3217	(1) Subparagraphs (c), (d), and (e) revised (2) In subpara. (g)(4) nomenclature, definition of $V_m$ revised
447	Form MDS-2	Title editorially revised
528	Table HHB-II-2000-1	For line 27, subpara. (a) corrected by errata
546	HHB-B-1100	In second paragraph, first sentence revised

**NOTE:** Section III, Subsections NC and ND have been merged to create Subsection NCD. Consequently, cross-references to NC, ND, or NC/ND have been updated to reflect Subsection NCD.

**LIST OF CHANGES IN RECORD NUMBER ORDER**

**DELETED**

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

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

## Subparagraph Breakdowns/Nested Lists Hierarchy

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

## Footnotes

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

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

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

## Cross-References

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

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

# SUBSECTION HA GENERAL REQUIREMENTS

---

## SUBPART A METALLIC MATERIALS

### ARTICLE HAA-1000 INTRODUCTION

#### HAA-1100 GENERAL

##### HAA-1110 SCOPE

The rules of this [Subsection HA, Subpart A](#) constitute the general requirements associated with metallic components used in the construction of high temperature reactor systems and their supporting systems.

(a) The rules of [Subsection HA, Subpart A](#) are contained in Divisions 1 and 2, Subsection NCA, except for those paragraphs or subparagraphs (with numbered headers) replaced by corresponding numbered HAA paragraphs or subparagraphs in this Subpart or new numbered HAA paragraphs or subparagraphs added to this Subpart.

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

(c) Division 1, Class 1 requirements are applicable to Division 5 construction but shall be referred to as Division 5, Class A.

(d) Division 1, Class CS requirements are applicable to Division 5 construction but shall be referred to as Division 5, Class SM.

(e) Division 1, Class 2 requirements are applicable to Division 5 construction but shall be referred to as Division 5, Class B.

(f) Division 1, Class 3 and Class MC requirements are not applicable to Division 5 construction.

(g) References to Appendices are to the Section III Appendices, unless otherwise identified.

#### HAA-1120 DEFINITIONS

Definitions of key terms used in this Division for metallic components are included in [Article HAA-9000](#). The definitions in [Article HAA-9000](#) shall prevail should a conflict exist with definitions found in Division 1 or in other documents referenced in this Division. Unless defined in [Article HAA-9000](#), the definitions of Divisions 1 and 2, Article NCA-9000 shall apply.

#### HAA-1130 LIMITS OF THESE RULES

(a) The rules of this Division for metallic materials provide requirements for new construction and include consideration of mechanical and thermal stresses due to cyclic operation and high temperature creep. They do not cover deterioration that may occur in service as a result of radiation effects, corrosion, erosion, thermal embrittlement, or instability of the material. These effects shall be taken into account with a view to realizing the design or the specified life of the components and supports. The changes in properties of materials subjected to neutron radiation may be checked periodically by means of material surveillance programs.

(b) The rules are not intended to be applicable to valve operators, controllers, position indicators, pump impellers, pump drivers, or other accessories and devices, unless they are pressure-retaining parts or act as core support structures or supports. If such items are in a support load path, the provisions of [HFA-1100](#) apply.