ASME BPVC.III.4-2023

SECTION III

Rules for Construction of Nuclear Facility Components

2023 ASME Boiler and Pressure Vessel Code

An International Code

Division 4

Fusion Energy Devices

ASME

SETTING THE STANDARD

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

2023 ASME Boiler & Pressure Vessel Code

2023 Edition July 1, 2023

III

RULES FOR CONSTRUCTION OF NUCLEAR FACILITY COMPONENTS

Division 4

Fusion Energy Devices

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, 2023

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 ensure that individuals from competent and concerned interests had an opportunity to participate. The proposed code or standard was made available for public review and comment, which provided 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 does ASME 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 representatives or persons 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

Library of Congress Catalog Card Number: 56-3934

Adopted by the Council of The American Society of Mechanical Engineers, 1914; latest edition 2023.

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

TABLE OF CONTENTS

Figures

Table

LIST OF SECTIONS

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 4 — Fusion Energy Devices
- 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 Reactor Facility 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 Reactor Facilities

XII Rules for Construction and Continued Service of Transport Tanks

XIII Rules for Overpressure Protection

FOREWORD*

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 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

* 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.

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.

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

January 1, 2023

TECHNICAL OVERSIGHT MANAGEMENT COMMITTEE (TOMC)

R. E. McLaughlin, *Chair*
N. A. Finney, *Vice Chair*
S. J. Rossi, *Staff Secretary*
G. Aurioles, Sr.
R. W. Barnes
T. L. Bedeaux
C. Brown
D. B. DeMichael
R. P. Deubler
J. G. Feldstein
G. W. Galanes
J. A. Hall
T. E. Hansen
G. W. Hembree
R. B. Keating
B. Linnemann
W. M. Lundy
D. I. Morris
T. P. Pastor
M. D. Rana
S. C. Roberts
F. J. Schaaf, Jr.
G. Scribner
W. J. Sperko
D. Srnic
R. W. Swayne
J. Vattappilly
M. Wadkinson
B. K. Nutter, *Ex-Officio Member*
M. J. Pischke, *Ex-Officio Member*
J. F. Henry, *Honorary Member*

Subgroup on Research and Development (TOMC)

S. C. Roberts, *Chair*
S. J. Rossi, *Staff Secretary*
R. W. Barnes
N. A. Finney
W. Hoffelner
R. B. Keating
R. E. McLaughlin
T. P. Pastor
D. Andrei, *Contributing Member*

Subgroup on Strategic Initiatives (TOMC)

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

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

S. C. Roberts, *Chair*
P. J. Coco
N. A. Finney
S. A. Marks
R. Rockwood
C. Stevens
M. Tannenbaum
J. Cameron, *Alternate*
A. Byk, *Contributing Member*
J. Pang, *Contributing Member*
S. J. Rossi, *Contributing Member*
C. A. Sanna, *Contributing Member*

Special Working Group on High Temperature Technology (TOMC)

D. Dewees, *Chair*
F. W. Brust
T. D. Burchell
P. R. Donavin
B. F. Hantz
R. I. Jetter
P. Smith

ADMINISTRATIVE COMMITTEE

R. E. McLaughlin, *Chair*
N. A. Finney, *Vice Chair*
S. J. Rossi, *Staff Secretary*
J. Cameron
R. B. Keating
B. Linnemann
B. K. Nutter
M. J. Pischke
M. D. Rana
S. C. Roberts
R. R. Stevenson
R. W. Swayne
M. Wadkinson

MARINE CONFERENCE GROUP

J. Oh, *Staff Secretary*
J. G. Hungerbuhler, Jr.
G. Nair
H. N. Patel
N. Prokopuk
J. D. Reynolds

CONFERENCE COMMITTEE

R. D. Troutt — Texas, *Chair*
J. T. Amato — Ohio, *Secretary*
W. Anderson — Mississippi
R. Becker — Colorado
T. D. Boggs — Missouri
R. A. Boillard — Indiana
D. P. Brockerville — Newfoundland and Labrador, Canada
R. J. Bunte — Iowa
J. H. Burpee — Maine
M. Carlson — Washington
T. G. Clark — Oregon
B. J. Crawford — Georgia
E. L. Creaser — New Brunswick, Canada
J. J. Dacanay — Hawaii
R. DeLury — Manitoba, Canada
A. Denham — Michigan
C. Dinic — Ontario, Canada
D. A. Ehler — Nova Scotia, Canada
S. D. Frazier — Washington
T. J. Granneman II — Oklahoma
S. Harder — Arizona
M. L. Jordan — Kentucky
R. Kamboj — British Columbia, Canada
E. Kawa — Massachusetts
A. Khssassi — Quebec, Canada
D. Kinney — North Carolina
K. S. Lane — Alaska
J. LeSage, Jr. — Louisiana
A. M. Lorimor — South Dakota
M. Mailman — Northwest Territories, Canada
W. McGivney — City of New York, New York
S. F. Noonan — Maryland
C. L. O'Guin — Tennessee
B. S. Oliver — New Hampshire
J. L. Oliver — Nevada
P. B. Polick — Illinois
J. F. Porcella — West Virginia
B. Ricks — Montana
W. J. Ross — Pennsylvania
M. H. Sansone — New York
T. S. Seime — North Dakota
C. S. Selinger — Saskatchewan, Canada
J. E. Sharier — Ohio
R. Spiker — North Carolina
D. Srnic — Alberta, Canada
D. J. Stenrose — Michigan
R. J. Stimson II — Kansas
R. K. Sturm — Utah
D. K. Sullivan — Arkansas
J. Taveras — Rhode Island
G. Teel — California
D. M. Warburton — Florida
M. Washington — New Jersey
E. Wiggins — Alabama

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
J. G. Feldstein
S. Fincher
G. W. Galanes
T. E. Hansen
J. S. Hunter
M. Ishikawa
M. Lemmons
L. Moedinger
Y. Oishi
M. Ortolani
A. Spangenberg
D. E. Tompkins
D. E. Tuttle
J. Vattappilly
M. Wadkinson
R. V. Wielgoszinski
F. Zeller
H. Michael, *Delegate*
D. L. Berger, *Honorary Member*
P. D. Edwards, *Honorary Member*
D. N. French, *Honorary Member*
J. Hainsworth, *Honorary Member*
J. F. Henry, *Honorary Member*
W. L. Lowry, *Honorary Member*
J. R. MacKay, *Honorary Member*
P. A. Molvie, *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
M. Wadkinson

Subgroup on Design (BPV I)

D. I. Anderson, *Chair*
L. S. Tsai, *Secretary*
P. Becker
L. Krupp
C. T. McDaris
N. S. Ranck
J. Vattappilly
M. Wadkinson
D. Dewees, *Contributing Member*
J. P. Glaspie, *Contributing Member*

Subgroup on Fabrication and Examination (BPV I)

J. L. Arnold, *Chair*
P. F. Gilston, *Vice Chair*
P. Becker, *Secretary*
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)

D. E. Tompkins, *Chair*
M. Wadkinson, *Vice Chair*
M. Lemmons, *Secretary*
R. Antoniuk
T. E. Hansen
M. Ishikawa
R. E. McLaughlin
L. Moedinger
B. J. Mollitor
Y. Oishi
E. M. Ortman
D. E. Tuttle
J. Vattappilly
R. V. Wielgoszinski
W. L. Lowry, *Contributing Member*

Subgroup on Locomotive Boilers (BPV I)

J. R. Braun, *Chair*
S. M. Butler, *Secretary*
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. S. Hunter
E. Liebl
F. Masuyama
L. S. Nicol
M. Ortolani
D. W. Rahoi
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
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
R. E. McLaughlin
E. M. Ortman
D. E. Tuttle
J. Vattappilly

Germany International Working Group (BPV I)

A. Spangenberg, *Chair*
P. Chavdarov, *Secretary*
B. Daume
J. Fleischfresser
C. Jaekel
R. Kauer
D. Koelbl
S. Krebs
T. Ludwig
R. A. Meyers
H. Michael
F. Miunske
M. Sykora
R. Helmholdt, *Contributing Member*
J. Henrichsmeyer, *Contributing Member*
B. Müller, *Contributing Member*

India International Working Group (BPV I)

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

COMMITTEE ON MATERIALS (BPV II)

J. Cameron, *Chair*
G. W. Galanes, *Vice Chair*
C. E. Rodrigues, *Staff Secretary*
A. Appleton
P. Chavdarov
K. K. Coleman
D. W. Gandy
J. F. Grubb
J. A. Hall
D. O. Henry
K. M. Hottle
M. Ishikawa
K. Kimura
M. Kowalczyk
D. L. Kurle
F. Masuyama
S. Neilsen
L. S. Nicol
M. Ortolani
D. W. Rahoi
W. Ren
E. Shapiro
R. C. Sutherlin
F. Zeller
O. Oldani, *Delegate*
A. Chaudouet, *Contributing Member*
J. D. Fritz, *Contributing Member*
W. Hoffelner, *Contributing Member*
K. E. Orie, *Contributing Member*
D. T. Peters, *Contributing Member*
B. W. Roberts, *Contributing Member*
J. M. Tanzosh, *Contributing Member*
E. Upitis, *Contributing Member*
R. G. Young, *Contributing Member*

Executive Committee (BPV II)

J. Cameron, *Chair*
C. E. Rodrigues, *Staff Secretary*
A. Appleton
K. K. Coleman
G. W. Galanes
J. F. Grubb
S. Guzey
W. Hoffelner
M. Ishikawa
M. Ortolani
P. K. Rai
J. Robertson
E. Shapiro

Subgroup on External Pressure (BPV II)

S. Guzey, *Chair*
E. Alexis, *Vice Chair*
J. A. A. Morrow, *Secretary*
L. F. Campbell
H. Chen
D. S. Griffin
J. F. Grubb
M. H. Jawad
S. Krishnamurthy
D. L. Kurle
R. W. Mikitka
P. K. Rai
M. Wadkinson

Subgroup on Ferrous Specifications (BPV II)

A. Appleton, *Chair*
K. M. Hottle, *Vice Chair*
C. Hyde, *Secretary*
D. Amire-Brahimi
G. Cuccio
O. Elkadim
D. Fialkowski
J. F. Grubb
D. S. Janikowski
Y.-J. Kim
S. G. Lee
W. C. Mack
J. Nickel
K. E. Orie
D. Poweleit
E. Upitis
L. Watzke
J. D. Fritz, *Contributing Member*
C. Meloy, *Contributing Member*

Subgroup on International Material Specifications (BPV II)

M. Ishikawa, *Chair*
P. Chavdarov, *Vice Chair*
A. Chaudouet
H. Chen
A. F. Garbolevsky
D. O. Henry
W. M. Lundy
F. Zeller
C. Zhou
O. Oldani, *Delegate*
H. Lorenz, *Contributing Member*
T. F. Miskell, *Contributing Member*
E. Upitis, *Contributing Member*

Subgroup on Nonferrous Alloys (BPV II)

E. Shapiro, *Chair*
W. MacDonald, *Vice Chair*
J. Robertson, *Secretary*
R. M. Beldyk
J. M. Downs
J. F. Grubb
J. A. Hall
D. Maitra
J. A. McMaster
D. W. Rahoi
W. Ren
R. C. Sutherlin
R. Wright
S. Yem
D. B. Denis, *Contributing Member*
D. T. Peters, *Contributing Member*

Subgroup on Physical Properties (BPV II)

P. K. Rai, *Chair*
S. Neilsen, *Vice Chair*
G. Aurioles, Sr.
D. Chandiramani
P. Chavdarov
H. Eshraghi
J. F. Grubb
B. F. Hantz
R. D. Jones
P. K. Lam
D. W. Rahoi
E. Shapiro
D. K. Verma
S. Yem
D. B. Denis, *Contributing Member*

Subgroup on Strength, Ferrous Alloys (BPV II)

M. Ortolani, *Chair*
L. S. Nicol, *Secretary*
G. W. Galanes
J. A. Hall
M. Ishikawa
S. W. Knowles
F. Masuyama
M. Osterfoss
D. W. Rahoi
S. Rosinski
M. Ueyama
F. Zeller
F. Abe, *Contributing Member*
R. G. Young, *Contributing Member*

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

K. K. Coleman, *Chair*
K. L. Hayes, *Vice Chair*
S. H. Bowes, *Secretary*
M. Denault
G. W. Galanes
D. W. Gandy
M. Ghahremani
W. F. Newell, Jr.
J. Penso
D. W. Rahoi
W. J. Sperko
J. P. Swezy, Jr.
M. Ueyama
P. D. Flenner, *Contributing Member*
B. W. Roberts, *Contributing Member*

Working Group on Materials Database (BPV II)

W. Hoffelner, *Chair*
C. E. Rodrigues, *Staff Secretary*
F. Abe
W. MacDonald
R. C. Sutherlin
D. Andrei, *Contributing Member*
J. L. Arnold, *Contributing Member*
J. Cameron, *Contributing Member*
J. F. Grubb, *Contributing Member*
D. T. Peters, *Contributing Member*
W. Ren, *Contributing Member*
B. W. Roberts, *Contributing Member*
E. Shapiro, *Contributing Member*

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

M. Ortolani, *Chair*
G. W. Galanes, *Vice Chair*
P. Becker, *Secretary*
S. H. Bowes
K. K. Coleman
K. Kimura
M. Lang
S. Luke
F. Masuyama
T. Melfi
W. F. Newell, Jr.
J. J. Sanchez-Hanton
J. A. Siefert
W. J. Sperko
F. Zeller
F. Abe, *Contributing Member*
P. D. Flenner, *Contributing Member*
J. M. Tanzosh, *Contributing Member*

Working Group on Data Analysis (BPV II)

J. F. Grubb, *Chair*
W. Ren, *Vice Chair*
K. Kimura
F. Masuyama
S. Neilsen
M. Ortolani
M. J. Swindeman
F. Abe, *Contributing Member*
W. Hoffelner, *Contributing Member*
W. C. Mack, *Contributing Member*
D. T. Peters, *Contributing Member*
B. W. Roberts, *Contributing Member*

China International Working Group (BPV II)

T. Xu, *Secretary*
W. Cai
W. Fang
Q. C. Feng
S. Huo
F. Kong
H. Leng
Hli Li
Hongbin Li
J. Li
S. Liu
Z. Rongcan
S. Tan
C. Wang
Jinguang Wang
Jiongxiang Wang
Q.-J. Wang
X. Wang
H.-C. Yang
J. Yang
L. Yin
H. Zhang
X.-H. Zhang
Y. Zhang

COMMITTEE ON CONSTRUCTION OF NUCLEAR FACILITY COMPONENTS (BPV III)

R. B. Keating, *Chair*
T. M. Adams, *Vice Chair*
D. E. Matthews, *Vice Chair*
A. Maslowski, *Staff Secretary*
A. Appleton
S. Asada
R. W. Barnes
W. H. Borter
M. E. Cohen
R. P. Deubler
P. R. Donavin
A. C. Eberhardt
J. V. Gardiner
J. Grimm
S. Hunter
R. M. Jessee
R. I. Jetter
C. C. Kim
G. H. Koo
D. W. Lewis
M. A. Lockwood
K. A. Manoly
K. Matsunaga
B. McGlone
S. McKillop
J. McLean
J. C. Minichiello
M. N. Mitchell
T. Nagata
J. B. Ossmann
S. Pellet
E. L. Pleins
T.-L. Sham
W. J. Sperko
W. Windes
C. Basavaraju, *Alternate*
C. T. Smith, *Contributing Member*
W. K. Sowder, Jr., *Contributing Member*
M. Zhou, *Contributing Member*
E. B. Branch, *Honorary Member*
G. D. Cooper, *Honorary Member*
D. F. Landers, *Honorary Member*
C. Pieper, *Honorary Member*

Executive Committee (BPV III)

R. B. Keating, *Chair*
A. Maslowski, *Secretary*
T. M. Adams
P. R. Donavin
J. V. Gardiner
J. Grimm
D. W. Lewis
K. A. Manoly
D. E. Matthews
S. McKillop
J. McLean
T.-L. Sham
W. K. Sowder, Jr.
K. A. Kavanagh, *Alternate*

Argentina International Working Group (BPV III)

M. F. Liendo, *Chair*
J. Fernández, *Vice Chair*
O. Martinez, *Staff Secretary*
O. A. Verastegui, *Secretary*
E. H. Aldaz
G. O. Anteri
A. P. Antipasti
D. O. Bordato
G. Bourguigne
M. Brusa
A. Claus
R. G. Cocco
A. J. Dall'Osto
J. I. Duo
M. M. Gamizo
I. M. Guerreiro
I. A. Knorr
D. E. Matthews
A. E. Pastor
M. Rivero
M. D. Vigliano
P. Yamamoto
M. Zunino

China International Working Group (BPV III)

Y. Wang, *Chair*
H. Yu, *Secretary*
L. Feng
J. Gu
L. Guo
C. Jiang
D. Kang
Y. Li
H. Lin
S. Liu
W. Liu
J. Ma
K. Mao
D. E. Matthews
J. Ming
W. Pei
C. Peiyin
Z. Sun
G. Tang
L. Ting
F. Wu
C. Yang
P. Yang
W. Yang
H. Yin
D. Yuangang
G. Zhang
D. Zhao
Z. Zhong
Q. Zhou
H. Zhu

Germany International Working Group (BPV III)

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

India International Working Group (BPV III)

R. N. Sen, *Chair*
S. B. Parkash, *Vice Chair*
A. D. Bagdare, *Secretary*
S. Aithal
S. Benhur
N. M. Borwankar
M. Brijlani
H. Dalal
S. K. Goyal
A. Johori
A. P. Kishore
D. Kulkarni
R. Kumar
S. Kumar
M. Lakshminarasimhan
T. Mukherjee
D. Narain
A. D. Paranjpe
J. R. Patel
E. L. Pleins
T. J. P. Rao
V. Sehgal
S. Singh
B. K. Sreedhar

Korea International Working Group (BPV III)

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

Seismic Design Steering Committee (BPV III)

T. M. Adams, *Chair*
F. G. Abatt, *Secretary*
G. A. Antaki
C. Basavaraju
D. Chowdhury
R. Döring
G. H. Koo
A. Maekawa
K. Matsunaga
J. McLean
R. M. Pace
D. Watkins

Task Group on Alternate Requirements (BPV III)

J. Wen, *Chair*
R. R. Romano, *Secretary*
P. J. Coco
P. R. Donavin
J. V. Gardiner
J. Grimm
R. S. Hill III
M. Kris
M. A. Lockwood
D. E. Matthews
S. McKillop
B. P. Nolan
J. B. Ossmann
E. C. Renaud
M. A. Richter
I. H. Tseng
Y. Wang

United Kingdom International Working Group (BPV III)

C. D. Bell, *Chair*
P. M. James, *Vice Chair*
C. B. Carpenter, *Secretary*
T. M. Adams
T. Bann
M. J. Chevalier
A. J. Cole-Baker
M. Consonni
M. J. Crathorne
G. Innes
S. A. Jones
B. Pellereau
C. R. Schneider
J. W. Stairmand
J. Sulley
J. Talamantes-Silva
A. J. Holt, *Contributing Member*

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

J. B. Ossmann, *Chair*
A. Maslowski, *Staff Secretary*
M. C. Buckley, *Secretary*
M. Arcaro
A. Cardillo
P. J. Coco
K. Harris
J. Honcharik
M. Kris
R. E. McLaughlin
E. L. Pleins
D. W. Sandusky
M. C. Scott
R. R. Stevenson
H. Xu
J. Yan
J. C. Minichiello, *Contributing Member*

Special Working Group on Editing and Review (BPV III)

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

Special Working Group on HDPE Stakeholders (BPV III)

S. Patterson, *Secretary*
S. Choi
C. M. Faidy
M. Golliet
R. M. Jessee
J. Johnston, Jr.
M. Kuntz
M. Lashley
K. A. Manoly
D. P. Munson
T. M. Musto
J. E. O'Sullivan
V. Rohatgi
F. J. Schaaf, Jr.
R. Stakenborghs
M. Troughton
B. Lin, *Alternate*

Special Working Group on Honors and Awards (BPV III)

J. C. Minichiello, *Chair*
A. Appleton
R. W. Barnes
R. M. Jessee
D. E. Matthews

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

D. E. Matthews, *Chair*
A. Maslowski, *Staff Secretary*
T. M. Adams
R. W. Barnes
P. R. Donavin
E. L. Pleins
W. J. Sperko

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

J. McLean, *Chair*
L. J. Colarusso, *Vice Chair*
J. Cassamassino, *Staff Secretary*
A. Dinizulu, *Staff Secretary*
C. J. Bang
A. C. Eberhardt
B. D. Hovis
T. C. Inman
C. Jones
T. Kang
N.-H. Lee
J. A. Munshi
T. Muraki
J. S. Saini
J. F. Strunk
G. Thomas
A. Varma
S. Wang
A. Istar, *Alternate*
A. Adediran, *Contributing Member*
S. Bae, *Contributing Member*
J.-B. Domage, *Contributing Member*
P. S. Ghosal, *Contributing Member*
B. B. Scott, *Contributing Member*
M. R. Senecal, *Contributing Member*
Z. Shang, *Contributing Member*
M. Sircar, *Contributing Member*
C. T. Smith, *Contributing Member*

Special Working Group on Modernization (BPV III-2)

S. Wang, *Chair*
J. McLean, *Vice Chair*
A. Adediran
S. Malushte
J. S. Saini
A. Varma
F. Lin, *Contributing Member*
J. A. Pires, *Contributing Member*
I. Zivanovic, *Contributing Member*

Task Group on Steel-Concrete Composite Containments (BPV III-2)

A. Varma, *Chair*
S. Malushte
J. McLean
J. A. Pires
J. S. Saini

Working Group on Design (BPV III-2)

N.-H. Lee, *Chair*
S. Wang, *Vice Chair*
M. Allam
S. Bae
L. J. Colarusso
A. C. Eberhardt
B. D. Hovis
T. C. Inman
C. Jones
J. A. Munshi
T. Muraki
J. S. Saini
G. Thomas
A. Istar, *Alternate*
P. S. Ghosal, *Contributing Member*
S.-Y. Kim, *Contributing Member*
J. Kwon, *Contributing Member*
S. E. Ohler-Schmitz, *Contributing Member*
B. B. Scott, *Contributing Member*
Z. Shang, *Contributing Member*
M. Shin, *Contributing Member*
M. Sircar, *Contributing Member*

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

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

Subcommittee on Design (BPV III)

P. R. Donavin, *Chair*
S. McKillop, *Vice Chair*
R. P. Deubler
M. A. Gray
R. I. Jetter
R. B. Keating
J.-I. Kim
K. A. Manoly
D. E. Matthews
M. N. Mitchell
B. Pellereau
T.-L. Sham
W. F. Weitze
C. Basavaraju, *Alternate*
G. L. Hollinger, *Contributing Member*
M. H. Jawad, *Contributing Member*
W. J. O'Donnell, Sr., *Contributing Member*
K. Wright, *Contributing Member*

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

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

Task Group to Improve Section III/XI Interface (SG-CD) (BPV III)

P. Vock, *Chair*
E. Henry, *Secretary*
G. A. Antaki
A. Cardillo
D. Chowdhury
J. Honcharik
J. Hurst
J. Lambin
C. A. Nove
T. Nuoffer
J. B. Ossmann
A. T. Roberts III
J. Sciulli
A. Udyawar
S. Willoughby-Braun

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

D. Keck, *Chair*
R. Z. Ziegler, *Vice Chair*
R. Martin, *Secretary*
G. W. Delport
L. C. Hartless
T. R. Liszkai
M. Nakajima
M. D. Snyder
R. Vollmer
T. M. Wiger
C. Wilson
Y. Wong
H. S. Mehta, *Contributing Member*

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

D. J. Ammerman, *Chair*
S. Klein, *Secretary*
G. Bjorkman
V. Broz
D. W. Lewis
J. M. Piotter
A. Rigato
P. Sakalaukus, Jr.
D. Siromani
R. Sypulski
X. Zhai
X. Zhang
C. R. Sydnor, *Alternate*
J. C. Minichiello, *Contributing Member*

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

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

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

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

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

K. R. May, *Chair*
R. Krithivasan, *Secretary*
M. Brown
J. W. Dickson
S. Jones
R. Lack
D. Miller
T. Patel
K. Shores
I. H. Tseng
B. J. Yonsky
Y. Wong, *Alternate*
J. Yu, *Alternate*
S. T. French, *Contributing Member*
D. B. Ross, *Contributing Member*
S. Ruesenberg, *Contributing Member*

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

D. Chowdhury, *Chair*
J. V. Gregg, Jr., *Secretary*
B. Busse
M. D. Eftychiou
R. A. Fleming
K. J. Noel
J. Sulley
K. B. Wilson
Y. Wong
I. H. Tseng, *Alternate*
X. Di, *Contributing Member*
C. Gabhart, *Contributing Member*
R. Ladefian, *Contributing Member*

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

N. A. Costanzo, *Chair*
U. S. Bandyopadhyay, *Secretary*
K. Avrithi
N. M. Bisceglia
R. P. Deubler
N. M. Graham
Y. Matsubara
S. Pellet
G. Thomas
G. Z. Tokarski
L. Vandersip
P. Wiseman
R. J. Masterson, *Contributing Member*
J. R. Stinson, *Contributing Member*

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

P. Vock, *Chair*
S. Jones, *Secretary*
M. C. Buckley
A. Cardillo
G. A. Jolly
J. Lambin
T. Lippucci
C. A. Mizer
H. O'Brien
J. O'Callaghan
M. Rain
K. E. Reid II
J. Sulley
I. H. Tseng
J. P. Tucker
Y. Wong, *Alternate*

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

D. Murphy, *Chair*
S. Willoughby-Braun, *Secretary*
J. J. Arthur
C. Basavaraju
M. Brijlani
L. Constantinescu
J. I. Kim
O.-S. Kim
D. E. Matthews
T. Mitsuhashi
T. J. Schriefer
M. C. Scott
P. K. Shah
D. Vlaicu
C. Wilson
R. Z. Ziegler
R. J. Huang, *Alternate*
B. Basu, *Contributing Member*
R. B. Keating, *Contributing Member*
W. F. Weitze, *Contributing Member*

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

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

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

G. Bjorkman, *Chair*
D. J. Ammerman, *Vice Chair*
V. Broz, *Secretary*
S. Kuehner
D. Molitoris
W. D. Reinhardt
D. Siromani
C.-F. Tso
M. C. Yaksh
U. Zencker
X. Zhang
Y. Wong, *Contributing Member*

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

B. Pellereau, *Chair*
R. Vollmer, *Secretary*
K. Avrithi
C. Basavaraju
F. Berkepile
C. M. Faidy
Y. Gao
M. Kassar
J. I. Kim
T. R. Liszkai
D. Lytle
K. Matsunaga
S. McKillop
S. Ranganath
W. D. Reinhardt
P. K. Shah
S. Wang
W. F. Weitze
J. Wen
T. M. Wiger
K. Hsu, *Alternate*
G. Banyay, *Contributing Member*
D. 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*
C. F. Heberling II, *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
A. Hirano
P. Hirschberg
K. Hsu
J.-S. Park
B. Pellereau
D. Vlaicu
K. Wang
R. Z. Ziegler
S. Cuvilliez, *Contributing Member*
T. D. Gilman, *Contributing Member*
S. R. Gosselin, *Contributing Member*
Y. He, *Contributing Member*
H. S. Mehta, *Contributing Member*
K. Wright, *Contributing Member*

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

P. R. Donavin, *Chair*
M. S. Shelton, *Secretary*
R. S. Bass
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
B. Pellereau
S. Ranganath
Y. Wang
W. F. Weitze
Y. Zou
S. Majumdar, *Contributing Member*
H. S. Mehta, *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*
K. Avrithi
G. Brouette
J. Hakii
D. O. Henry
A. Hirano
K. A. Manoly
P. J. O'Regan
B. Pellereau
M. Yagodich
R. S. Hill III, *Contributing Member*

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

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

Subgroup on Fusion Energy Devices (BPV III)

W. K. Sowder, Jr., *Chair*
A. Maslowski, *Staff Secretary*
M. Ellis, *Secretary*
M. Bashir
J. P. Blanchard
T. P. Davis
B. R. Doshi
L. El-Guebaly
G. Holtmeier
D. Johnson
I. Kimihiro
C. J. Lammi
S. Lawler
P. Mokaria
D. J. Roszman
F. J. Schaaf, Jr.
P. Smith
Y. Song
C. Vangaasbeek
I. J. Zatz
R. W. Barnes, *Contributing Member*

Special Working Group on Fusion Stakeholders (BPV III-4)

T. P. Davis, *Chair*
R. W. Barnes
V. Chugh
S. S. Desai
F. Deschamps
M. Hua
S. Lawler
S. C. Middleburgh
R. J. Pearson
W. K. Sowder, Jr.
D. A. Sutherland
N. Young
J. Zimmermann

Working Group on General Requirements (BPV III-4)

D. J. Roszman, *Chair*
M. Ellis
P. Mokaria
W. K. Sowder, Jr.

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

M. Bashir, *Chair*
Y. Carin
T. P. Davis
M. Kalsey
S. T. Madabusi

Working Group on Magnets (BPV III-4)

W. K. Sowder, Jr., *Chair*
D. S. Bartran

Working Group on Materials (BPV III-4)

M. Porton, *Chair*
T. P. Davis
P. Mummery

Working Group on Vacuum Vessels (BPV III-4)

I. Kimihiro, *Chair*
L. C. Cadwallader
B. R. Doshi
D. Johnson
Q. Shijun
Y. Song

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

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

J. V. Gardiner, *Chair*
J. Grimm, *Vice Chair*
G. C. Deleanu
A. C. Eberhardt
E. C. Renaud
J. L. Williams
C. T. Smith, *Contributing Member*

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

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

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

W. J. Geringer, *Chair*
A. Appleton
J. R. Berry
C. Cruz
Y. Diaz-Castillo
J. Lang
M. N. Mitchell
J. Potgieter
E. C. Renaud
R. Spuhl
W. Windes
B. Lin, *Alternate*

Subgroup on High Temperature Reactors (BPV III)

T.-L. Sham, *Chair*
Y. Wang, *Secretary*
M. Ando
N. Broom
F. W. Brust
P. Carter
M. E. Cohen
W. J. Geringer
B. F. Hantz
M. H. Jawad
W. T. Jessup
R. I. Jetter
K. Kimura
G. H. Koo
A. Mann
M. C. Messner
X. Wei
W. Windes
R. Wright
G. L. Zeng
D. S. Griffin, *Contributing Member*
X. Li, *Contributing Member*
W. O'Donnell, Sr., *Contributing Member*
L. Shi, *Contributing Member*
R. W. Swindeman, *Contributing Member*

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

M. E. Cohen, *Chair*
M. C. Albert
M. Arcaro
R. W. Barnes
N. Broom
R. Christensen
V. Chugh
W. Corwin
G. C. Deleanu
R. A. Fleming
K. Harris
R. I. Jetter
Y. W. Kim
G. H. Koo
N. J. McTiernan
T. Nguyen
K. J. Noel
T.-L. Sham
B. Song
X. Wei
G. L. Zeng
T. Asayama, *Contributing Member*
X. Li, *Contributing Member*
L. Shi, *Contributing Member*
G. Wu, *Contributing Member*

Task Group on Division 5 AM Components (SG-HTR) (BPV III)

R. Wright, *Chair*
R. Bass, *Secretary*
M. C. Albert
R. W. Barnes
F. W. Brust
Z. Feng
S. Lawler
X. Lou
M. McMurtrey
M. C. Messner
T. Patterson
E. C. Renaud
D. Rudland
T.-L. Sham
I. J. Van Rooyen
X. Wei

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

R. Wright, *Chair*
M. McMurtrey, *Secretary*
R. Bass
K. Kimura
D. Maitra
R. J. McReynolds
M. C. Messner
J. C. Poehler
W. Ren
T.-L. Sham
Y. Wang
X. Wei
M. Yoo, *Alternate*
R. W. Swindeman, *Contributing Member*

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

M. C. Messner, *Chair*
H. Mahajan, *Secretary*
R. W. Barnes
J. A. Blanco
P. Carter
W. T. Jessup
R. I. Jetter
G. H. Koo
H. Qian
T. Riordan
T.-L. Sham
X. Wei
S. X. Xu
J. Young
M. R. Breach, *Contributing Member*
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)

Y. Wang, *Chair*
M. Ando
P. Carter
M. E. Cohen
J. I. Duo
R. I. Jetter
G. H. Koo
H. Mahajan
M. McMurtrey
M. C. Messner
T. Nguyen
J. C. Poehler
H. Qian
R. Rajasekaran
T.-L. Sham
X. Wei
J. Young
M. Yoo, *Alternate*

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

C. J. Sallaberry, *Chair*
F. W. Brust
P. Carter
S. Kalyanam
B.-L. Lyow
M. C. Messner
J. C. Poehler
H. Qian
D. A. Scarth
D. J. Shim
A. Udyawar
X. Wei
S. X. Xu
M. Yoo, *Alternate*

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

W. Windes, *Chair*
W. J. Geringer, *Vice Chair*
J. Potgieter, *Secretary*
G. Beirnaert
C. Chen
A. N. Chereskin
V. Chugh
C. Contescu
N. Gallego
S. T. Gonczy
K. Harris
M. G. Jenkins
J. Lang
M. P. Metcalfe
M. N. Mitchell
J. Parks
T.-L. Sham
A. Tzelepi
G. L. Zeng
M. Yoo, *Alternate*
A. Appleton, *Contributing Member*
R. W. Barnes, *Contributing Member*
A. A. Campbell, *Contributing Member*
S.-H. Chi, *Contributing Member*
Y. Katoh, *Contributing Member*
A. Mack, *Contributing Member*
J. B. Ossmann, *Contributing Member*

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

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

Task Group on Advanced Manufacturing (BPV III)

D. W. Mann, *Chair*
D. W. Gandy, *Secretary*
R. Bass
D. Chowdhury
P. J. Coco
B. D. Frew
J. Grimm
A. L. Hiser, Jr.
J. Lambin
T. Lippucci
K. Matsunaga
T. Melfi
E. C. Renaud
W. J. Sperko
J. F. Strunk
J. Sulley
S. Tate
S. Wolbert
H. Xu
D. W. Pratt, *Alternate*
S. Malik, *Contibuting Member*

Joint Working Group on HDPE (SG-MFE) (BPV III)

M. Brandes, *Chair*
T. M. Musto, *Chair*
J. B. Ossmannn, *Secretary*
G. Brouette
M. C. Buckley
S. Choi
M. Golliet
J. Hebeisen
J. Johnston, Jr.
P. Krishnaswamy
M. Kuntz
B. Lin
K. Manoly
D. P. Munson
J. O'Sullivan
V. Rohatgi
F. Schaaf, Jr.
S. Schuessler
R. Stakenborghs
M. Troughton
P. Vibien
J. Wright
T. Adams, *Contributing Member*

COMMITTEE ON HEATING BOILERS (BPV IV)

M. Wadkinson, *Chair*
J. L. Kleiss, *Vice Chair*
C. R. Ramcharran, *Staff Secretary*
B. Ahee
L. Badziagowski
T. L. Bedeaux
B. Calderon
J. P. Chicoine
C. Dinic
J. M. Downs
J. A. Hall
M. Mengon
D. Nelson
H. Michael, *Delegate*
D. Picart, *Delegate*
P. A. Molvie, *Contributing Member*

Executive Committee (BPV IV)

M. Wadkinson, *Chair*
C. R. Ramcharran, *Staff Secretary*
L. Badziagowski
T. L. Bedeaux
J. P. Chicoine
J. A. Hall
J. L. Kleiss

Subgroup on Cast Boilers (BPV IV)

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

Subgroup on Materials (BPV IV)

J. A. Hall, *Chair*
J. M. Downs, *Vice Chair*
C. R. Ramcharran, *Staff Secretary*
L. Badziagowski
T. L. Bedeaux
Y. Teng
M. Wadkinson

Subgroup on Water Heaters (BPV IV)

J. L. Kleiss, *Chair*
L. Badziagowski, *Vice Chair*
C. R. Ramcharran, *Staff Secretary*
B. Ahee
J. P. Chicoine
C. Dinic
B. J. Iske
M. Mengon
Y. Teng
T. E. Trant
P. A. Molvie, *Contributing Member*

Subgroup on Welded Boilers (BPV IV)

T. L. Bedeaux, *Chair*
C. R. Ramcharran, *Staff Secretary*
B. Ahee
L. Badziagowski
B. Calderon
J. P. Chicoine
C. Dinic
J. L. Kleiss
M. Mengon
M. Wadkinson
M. J. Melita, *Alternate*
D. Nelson, *Alternate*
P. A. Molvie, *Contributing Member*

Europe International Working Group (BPV IV)

L. Badziagowski, *Chair*
D. Picart, *Vice Chair*
R. Lozny
E. Van Bruggen
G. Vicchi
A. Alessandrini, *Alternate*

COMMITTEE ON NONDESTRUCTIVE EXAMINATION (BPV V)

N. A. Finney, *Chair*
C. May, *Vice Chair*
C. R. Ramcharran, *Staff Secretary*
D. Bajula
P. L. Brown
M. A. Burns
N. Carter
T. Clausing
C. Emslander
A. F. Garbolevsky
P. T. Hayes
G. W. Hembree
F. B. Kovacs
K. Krueger
B. D. Laite
P. B. Shaw
C. Vorwald
S. J. Akrin, *Contributing Member*
J. E. Batey, *Contributing Member*
A. S. Birks, *Contributing Member*
N. Y. Faransso, *Contributing Member*
J. F. Halley, *Contributing Member*
R. W. Kruzic, *Contributing Member*
L. E. Mullins, *Contributing Member*
F. J. Sattler, *Contributing Member*
H. C. Graber, *Honorary Member*
T. G. McCarty, *Honorary Member*

Executive Committee (BPV V)

C. May, *Chair*
N. A. Finney, *Vice Chair*
C. R. Ramcharran, *Staff Secretary*
N. Carter
V. F. Godinez-Azcuaga
P. T. Hayes
G. W. Hembree
F. B. Kovacs
K. Krueger
E. Peloquin
C. Vorwald

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

C. Vorwald, *Chair*
D. Bajula
N. Carter
P. Chavdarov
T. Clausing
C. Emslander
N. A. Finney
G. W. Hembree
F. B. Kovacs
K. Krueger
C. May
S. J. Akrin, *Contributing Member*
N. Y. Faransso, *Contributing Member*
J. F. Halley, *Contributing Member*
D. I. Morris, *Contributing Member*
J. P. Swezy, Jr., *Contributing Member*

Project Team on Assisted Analysis (BPV V)

K. Hayes, *Chair*
J. Aldrin
J. Chen
N. A. Finney
V. F. Godinez-Azcuaga
C. Hansen
G. W. Hembree
R. S. F. Orozco
E. Peloquin
T. Thulien

Subgroup on Volumetric Methods (BPV V)

C. May, *Chair*
P. T. Hayes, *Vice Chair*
D. Adkins
P. L. Brown
N. A. Finney
A. F. Garbolevsky
R. W. Hardy
G. W. Hembree
F. B. Kovacs
K. Krueger
E. Peloquin
C. Vorwald
S. J. Akrin, *Contributing Member*
N. Y. Faransso, *Contributing Member*
J. F. Halley, *Contributing Member*
R. W. Kruzic, *Contributing Member*
L. E. Mullins, *Contributing Member*
F. J. Sattler, *Contributing Member*

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

C. Vorwald, *Chair*
D. M. Woodward, *Vice Chair*
J. Anderson
P. L. Brown
C. Emslander
A. F. Garbolevsky
R. W. Hardy
G. W. Hembree
F. B. Kovacs
B. D. Laite
T. R. Lerohl
C. May
R. J. Mills
J. F. Molinaro
T. Vidimos
B. White
S. J. Akrin, *Contributing Member*
T. L. Clifford, *Contributing Member*
N. Y. Faransso, *Contributing Member*
R. W. Kruzic, *Contributing Member*

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

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

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

V. F. Godinez-Azcuaga, *Chair*
J. Catty, *Vice Chair*
S. R. Doctor
N. F. Douglas, Jr.
R. K. Miller
N. Y. Faransso, *Contributing Member*

Working Group on Full Matrix Capture (SG-VM) (BPV V)

E. Peloquin, *Chair*
C. Wassink, *Vice Chair*
D. Bajula
D. Bellistri
J. Catty
N. A. Finney
J. L. Garner
R. T. Grotenhuis
P. T. Hayes
G. W. Hembree
K. Krueger
M. Lozev
R. Nogueira
D. Richard
M. Sens
D. Tompkins
J. F. Halley, *Contributing Member*
L. E. Mullins, *Contributing Member*

Subgroup on Inservice Examination Methods and Techniques (BPV V)

P. T. Hayes, *Chair*
E. Peloquin, *Vice Chair*
M. A. Burns
M. Carlson
N. A. Finney
V. F. Godinez-Azcuaga
G. W. Hembree
K. Krueger
C. May
D. D. Raimander
C. Vorwald

Subgroup on Surface Examination Methods (BPV V)

N. Carter, *Chair*
B. D. Laite, *Vice Chair*
R. M. Beldyk
P. L. Brown
T. Clausing
C. Emslander
N. Farenbaugh
N. A. Finney
A. F. Garbolevsky
K. Hayes
G. W. Hembree
C. May
P. B. Shaw
R. Tedder
C. Vorwald
C. Wassink
D. M. Woodward
S. J. Akrin, *Contributing Member*
N. Y. Faransso, *Contributing Member*
J. F. Halley, *Contributing Member*
R. W. Kruzic, *Contributing Member*
L. E. Mullins, *Contributing Member*
F. J. Sattler, *Contributing Member*

Germany International Working Group (BPV V)

P. Chavdarov, *Chair*
C. Kringe, *Vice Chair*
H.-P. Schmitz, *Secretary*
K.-H. Gischler
D. Kaiser
S. Mann
V. Reusch

India International Working Group (BPV V)

P. Kumar, *Chair*
A. V. Bhagwat
J. Chahwala
S. Jobanputra
D. Joshi
G. R. Joshi
A. Relekar
V. J. Sonawane
D. B. Tanpure

Italy International Working Group (BPV V)

D. D. Raimander, *Chair*
O. Oldani, *Vice Chair*
C. R. Ramcharran, *Staff Secretary*
P. Campli, *Secretary*
M. Agostini
T. Aldo
F. Bresciani
N. Caputo
M. Colombo
P. L. Dinelli
F. Ferrarese
E. Ferrari
M. A. Grimoldi
G. Luoni
U. Papponetti
P. Pedersoli
A. Veroni
M. Zambon
V. Calo, *Contributing Member*
G. Gobbi, *Contributing Member*
A. Gusmaroli, *Contributing Member*
G. Pontiggia, *Contributing Member*

COMMITTEE ON PRESSURE VESSELS (BPV VIII)

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

Executive Committee (BPV VIII)

M. D. Lower, *Chair*
S. J. Rossi, *Staff Secretary*
G. Aurioles, Sr.
C. W. Cary
J. Hoskinson
M. Kowalczyk
S. A. Marks
P. Matkovics
S. C. Roberts
J. C. Sowinski
K. Subramanian
K. Xu

Subgroup on Design (BPV VIII)

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

Working Group on Design-by-Analysis (BPV VIII)

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

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

A. Mann, *Chair*
C. Nadarajah, *Secretary*
D. Anderson
D. Dewees
B. F. Hantz
M. H. Jawad
R. I. Jetter
S. Krishnamurthy
T. Le
M. C. Messner
M. N. Mitchell
P. Prueter
M. J. Swindeman
J. P. Glaspie, *Contributing Member*
N. McMurray, *Contributing Member*
B. J. Mollitor, *Contributing Member*

Subgroup on Fabrication and Examination (BPV VIII)

S. A. Marks, *Chair*
D. I. Morris, *Vice Chair*
T. Halligan, *Secretary*
N. Carter
J. Lu
B. R. Morelock
O. Mulet
M. J. Pischke
M. J. Rice
J. Roberts
C. D. Rodery
B. F. Shelley
D. Smith
P. L. Sturgill
J. P. Swezy, Jr.
E. Upitis
C. Violand
K. Oyamada, *Delegate*
W. J. Bees, *Contributing Member*
L. F. Campbell, *Contributing Member*
R. Uebel, *Contributing Member*

Subgroup on General Requirements (BPV VIII)

J. Hoskinson, *Chair*
M. Faulkner, *Vice Chair*
N. Barkley
R. J. Basile
T. P. Beirne
D. B. DeMichael
M. D. Lower
T. P. Pastor
I. Powell
G. B. Rawls, Jr.
F. L. Richter
S. C. Roberts
J. Rust
J. C. Sowinski
P. Speranza
D. Srnic
D. B. Stewart
D. A. Swanson
J. P. Glaspie, *Contributing Member*
Y. Yang, *Contributing Member*

Task Group on Fired Heater Pressure Vessels (BPV VIII)

J. Hoskinson, *Chair*
W. Kim
S. Kirk
D. Nelson
T. P. Pastor
R. Robles
J. Rust
P. Shanks
E. Smith
D. Srnic

Task Group on Subsea Applications (BPV VIII)

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

Subgroup on Heat Transfer Equipment (BPV VIII)

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

Working Group on Plate Heat Exchangers (BPV VIII)

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

Subgroup on High Pressure Vessels (BPV VIII)

K. Subramanian, *Chair*
M. Sarzynski, *Vice Chair*
A. Dinizulu, *Staff Secretary*
L. P. Antalffy
J. Barlow
R. C. Biel
P. N. Chaku
L. Fridlund
D. Fuenmayor
J. Gibson
R. T. Hallman
K. Karpanan
J. Keltjens
A. K. Khare
G. T. Nelson
D. T. Peters
E. D. Roll
J. R. Sims
E. Smith
F. W. Tatar
S. Terada
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*
R. M. Hoshman, *Contributing Member*
F. Kirkemo, *Contributing Member*
R. A. Leishear, *Contributing Member*
G. M. Mital, *Contributing Member*
M. Parr, *Contributing Member*
M. D. Rana, *Contributing Member*
C. Romero, *Contributing Member*
C. Tipple, *Contributing Member*
K.-J. Young, *Contributing Member*
D. J. Burns, *Honorary Member*
G. J. Mraz, *Honorary Member*

Subgroup on Materials (BPV VIII)

M. Kowalczyk, *Chair*
P. Chavdarov, *Vice Chair*
S. Kilambi, *Secretary*
J. Cameron
J. F. Grubb
D. Maitra
D. W. Rahoi
J. Robertson
R. C. Sutherlin
E. Upitis
K. Xu
S. Yem
A. Di Rienzo, *Contributing Member*
J. D. Fritz, *Contributing Member*
M. Katcher, *Contributing Member*
W. M. Lundy, *Contributing Member*
J. Penso, *Contributing Member*

Subgroup on Toughness (BPV VIII)

K. Xu, *Chair*
T. Halligan, *Vice Chair*
T. Finn
C. S. Hinson
S. Kilambi
D. L. Kurle
T. Newman
J. Qu
M. D. Rana
F. L. Richter
K. Subramanian
D. A. Swanson
J. P. Swezy, Jr.
S. Terada
E. Upitis
J. Vattappilly
K. Oyamada, *Delegate*
L. Dong, *Contributing Member*
S. Krishnamurthy, *Contributing Member*
K. Mokhtarian, *Contributing Member*

Subgroup on Graphite Pressure Equipment (BPV VIII)

C. W. Cary, *Chair*
A. Viet, *Vice Chair*
G. C. Becherer
F. L. Brown
R. J. Bulgin
J. D. Clements
H. Lee, Jr.
S. Mehrez
T. Rudy
A. A. Stupica

Argentina International Working Group (BPV VIII)

A. Dominguez, *Chair*
R. Robles, *Vice Chair*
G. Glissenti, *Secretary*
M. M. Acosta
R. A. Barey
C. Alderetes
F. A. Andres
A. Antipasti
D. A. Bardelli
L. F. Boccanera
O. S. Bretones
A. Burgueno
G. Casanas
D. H. Da Rold
D. A. Del Teglia
J. I. Duo
M. Favareto
M. D. Kuhn
F. P. Larrosa
L. M. Leccese
C. Meinl
M. A. Mendez
J. J. Monaco
C. Parente
M. A. A. Pipponzi
L. C. Rigoli
A. Rivas
D. Rizzo
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
J. Cui
R. Duan
J.-G. Gong
B. Han
J. Hu
Q. Hu
H. Hui
K. Li
D. Luo
Y. Luo
C. Miao
L. Sun
C. Wu
J. Xiaobin
F. Xu
G. Xu
F. Yang
Y. Yang
Y. Yuan
Yanfeng Zhang
Yijun Zhang
S. Zhao
J. Zheng
G. Zhu

Germany International Working Group (BPV VIII)

R. Kauer, *Chair*
M. Sykora, *Vice Chair*
A. Aloui
P. Chavdarov
A. Emrich
J. Fleischfresser
C. Jaekel
D. Koelbl
S. Krebs
T. Ludwig
R. A. Meyers
H. Michael
S. Reich
A. Spangenberg
C. Stobbe
G. Naumann, *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
U. Ganesan
S. K. Goyal
V. Jayabalan
V. K. Joshi
A. Kakumanu
V. V. P. Kumar
T. Mukherjee
P. C. Pathak
D. Prabhu
A. Sadasivam
M. P. Shah
R. Tiru
V. T. Valavan
M. Sharma, *Contributing Member*

Italy International Working Group (BPV VIII)

A. Teli, *Chair*
M. Millefanti, *Vice Chair*
P. Campli, *Secretary*
B. G. Alborali
P. Aliprandi
A. Avogadri
A. Camanni
N. Caputo
M. Colombo
P. Conti
D. Cortassa
P. L. Dinelli
F. Finco
M. Guglielmetti
A. F. Magri
P. Mantovani
L. Moracchioli
P. Pacor
S. Sarti
V. Calo, *Contributing Member*
G. Gobbi, *Contributing Member*
A. Gusmaroli, *Contributing Member*
G. Pontiggia, *Contributing Member*
D. D. Raimander, *Contributing Member*

Special Working Group on Bolted Flanged Joints (BPV VIII)

W. Brown, *Chair*
M. Osterfoss, *Vice Chair*
G. Aurioles, Sr.
D. Bankston, Jr.
H. Bouzid
A. Chaudouet
H. Chen
D. Francis
H. Lejeune
A. Mann
W. McDaniel
R. W. Mikitka
D. Nash
M. Ruffin
R. Wacker
E. Jamalyaria, *Contributing Member*
J. R. Payne, *Contributing Member*
G. Van Zyl, *Contributing Member*
J. Veiga, *Contributing Member*

Subgroup on Interpretations (BPV VIII)

G. Aurioles, Sr., *Chair*
J. Oh, *Staff Secretary*
S. R. Babka
J. Cameron
C. W. Cary
B. F. Hantz
M. Kowalczyk
D. L. Kurle
M. D. Lower
S. A. Marks
P. Matkovics
D. I. Morris
D. T. Peters
F. L. Richter
S. C. Roberts
C. D. Rodery
T. G. Seipp
J. C. Sowinski
D. B. Stewart
K. Subramanian
D. A. Swanson
J. P. Swezy, Jr.
J. Vattappilly
A. Viet
K. Xu
R. J. Basile, *Contributing Member*
D. B. DeMichael, *Contributing Member*
R. D. Dixon, *Contributing Member*
S. Kilambi, *Contributing Member*
R. Mahadeen, *Contributing Member*
T. P. Pastor, *Contributing Member*
P. L. Sturgill, *Contributing Member*

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

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

Subgroup on Brazing (BPV IX)

S. A. Marks, *Chair*
E. W. Beckman
A. F. Garbolevsky
N. Mohr
M. J. Pischke
P. L. Sturgill
J. P. Swezy, Jr.

Subgroup on General Requirements (BPV IX)

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

Subgroup on Materials (BPV IX)

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

Subgroup on Plastic Fusing (BPV IX)

K. L. Hayes, *Chair*
R. M. Jessee
J. Johnston, Jr.
J. E. O'Sullivan
E. G. Reichelt
M. J. Rice
S. Schuessler
M. Troughton
C. Violand
E. W. Woelfel
J. Wright

Subgroup on Welding Qualifications (BPV IX)

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

Argentina International Working Group (BPV IX)

A. Burgueno, *Chair*
A. R. G. Frinchaboy, *Vice Chair*
R. Rahaman, *Staff Secretary*
M. D. Kuhn, *Secretary*
B. Bardott
L. F. Boccanera
P. J. Cabot
J. Caprarulo
M. Favareto
J. A. Gandola
C. A. Garibotti
J. A. Herrera
M. A. Mendez
A. E. Pastor
G. Telleria
M. M. C. Tocco

Germany International Working Group (BPV IX)

A. Roza, *Chair*
A. Spangenberg, *Vice Chair*
R. Rahaman, *Staff Secretary*
P. Chavadarov
B. Daume
J. Fleischfresser
P. Khwaja
S. Krebs
T. Ludwig
S. Wegener
F. Wodke
J. Daldrup, *Contributing Member*
E. Floer, *Contributing Member*
R. Helmholdt, *Contributing Member*
G. Naumann, *Contributing Member*
K.-G. Toelle, *Contributing Member*

Italy International Working Group (BPV IX)

D. D. Raimander, *Chair*
F. Ferrarese, *Vice Chair*
R. Rahaman, *Staff Secretary*
M. Bernasek
A. Camanni
P. L. Dinelli
M. Mandina
A. S. Monastra
L. Moracchioli
P. Pacor
P. Siboni
V. Calo, *Contributing Member*
G. Gobbi, *Contributing Member*
A. Gusmaroli, *Contributing Member*
G. Pontiggia, *Contributing Member*

Spain International Working Group (BPV IX)

F. J. Q. Pandelo, *Chair*
F. L. Villabrille, *Vice Chair*
R. Rahaman, *Staff Secretary*
F. R. Hermida, *Secretary*
C. A. Celimendiz
M. A. F. Garcia
R. G. Garcia
F. Manas
B. B. Miguel
A. D. G. Munoz
A. B. Pascual
S. Sevil
G. Gobbi, *Contributing Member*

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

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

COMMITTEE ON NUCLEAR INSERVICE INSPECTION (BPV XI)

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

Executive Committee (BPV XI)

D. W. Lamond, *Chair*
R. W. Swayne, *Vice Chair*
D. Miro-Quesada, *Staff Secretary*
M. L. Benson
M. J. Ferlisi
S. D. Kulat
J. T. Lindberg
S. L. McCracken
T. Nuoffer
N. A. Palm
G. C. Park
A. T. Roberts III
B. L. Lin, *Alternate*

Argentina International Working Group (BPV XI)

O. Martinez, *Staff Secretary*
A. Claus
I. M. Guerreiro
L. R. Miño
F. J. Schaaf, Jr.
F. M. Schroeter
P. Yamamoto

China International Working Group (BPV XI)

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

Germany International Working Group (BPV XI)

R. Döring, *Chair*
M. Hagenbruch, *Vice Chair*
R. Piel, *Secretary*
A. Casse
C. G. Frantescu
E. Iacopetta
S. D. Kulat
H.-W. Lange
N. Legl
T. Ludwig
X. Pitoiset
M. Reichert
L. Sybertz
I. Tewes
R. Tiete
J. Wendt

India International Working Group (BPV XI)

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

Special Working Group on Editing and Review (BPV XI)

R. W. Swayne, *Chair*
R. C. Cipolla
D. O. Henry
M. Orihuela
D. A. Scarth

Task Group on Inspectability (BPV XI)

J. T. Lindberg, *Chair*
E. Henry, *Secretary*
A. Bushmire
A. Cardillo
K. Caver
D. R. Cordes
P. Gionta
D. O. Henry
J. Honcharik
C. Latiolais
G. A. Lofthus
S. Matsumoto
D. E. Matthews
P. J. O'Regan
J. B. Ossmann
C. Thomas

Working Group on Spent Nuclear Fuel Storage and Transportation Containment Systems (BPV XI)

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

Task Group on Mitigation and Repair of Spent Nuclear Fuel Canisters (WG-SNFS & TCS) (BPV XI)

J. Tatman, *Chair*
D. J. Ammerman
J. Broussard
C. R. Bryan
G. R. Cannell
K. Dietrich
D. Dunn
N. Fales
R. C. Folley
D. Jacobs
N. Klymyshyn
M. Kris
M. Liu
K. Mauskar
S. L. McCracken
M. Orihuela
M. Richter
K. E. Ross
B. Sarno
R. Sindelar
J. Wellwood
A. Williams

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

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

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

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

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

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

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

A. Udyawar, *Chair*
D. A. Scarth, *Secretary*
W. H. Bamford
M. L. Benson
F. W. Brust
R. C. Cipolla
M. M. Farooq
A. E. Freed
P. Gill
K. Hasegawa
K. Hojo
V. Lacroix
K. Miyazaki
B. Pellereau
S. Ranganath
D. J. Shim
S. Smith
M. Uddin
T. V. Vo
G. White
S. X. Xu
H. S. Mehta, *Contributing Member*

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

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

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

N. Glunt, *Chair*
R. M. Pace, *Secretary*
J. I. Duo
A. E. Freed
M. A. Gray
T. J. Griesbach
H. Nam
A. Nana
A. D. Odell
C.-S. Oh
H. Park
S. Ranganath
A. Scott
D. J. Shim
S. Smith
A. Udyawar
T. V. Vo

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

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

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

R. O. McGill, *Chair*
S. M. Parker, *Secretary*
G. A. Antaki
R. C. Cipolla
M. M. Farooq
K. Gresh
E. J. Houston
R. Janowiak
S. H. Pellet
D. Rudland
D. A. Scarth
S. X. Xu

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

R. O. McGill, *Chair*
S. X. Xu, *Secretary*
F. G. Abatt
G. A. Antaki
R. C. Cipolla
R. G. Gilada
K. Hasegawa
K. M. Hoffman
R. Janowiak
M. Kassar
M. Moenssens
D. P. Munson
R. M. Pace
S. H. Pellet
D. Rudland
D. A. Scarth

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

S. Kalyanam, *Chair*
P. Krishnaswamy
M. Moenssens
D. P. Munson
D. A. Scarth
D. J. Shim
M. Troughton
J. Wright
S. X. Xu

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

J. T. Lindberg, *Chair*
D. O. Henry, *Vice Chair*
T. Cinson, *Secretary*
M. Briley
C. Brown
A. Bushmire
T. L. Chan
D. R. Cordes
S. E. Cumblidge
K. J. Hacker
J. Harrison
D. A. Kull
C. Latiolais
F. J. Schaaf, Jr.
R. V. Swain
C. A. Nove, *Alternate*

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

C. Brown, *Chair*
M. Orihuela, *Secretary*
J. Bennett
T. Cinson
S. E. Cumblidge
A. Diaz
N. Farenbaugh
D. O. Henry
J. T. Lindberg
C. Shinsky
R. Tedder
T. Thulien
J. T. Timm

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

J. Harrison, *Chair*
D. A. Kull, *Secretary*
M. Briley
A. Bushmire
D. R. Cordes
K. J. Hacker
R. E. Jacob
W. A. Jensen
C. Latiolais
C. A. Nove
D. R. Slivon
R. V. Swain
D. Van Allen
J. Williams
B. Lin, *Alternate*

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

A. T. Roberts III, *Chair*
D. Vetter, *Secretary*
T. Anselmi
M. T. Audrain
N. Broom
F. W. Brust
V. Chugh
S. R. Doctor
J. D. Fletcher
J. T. Fong
R. Grantom
K. Harris
P. J. Hennessey
S. Kalyanam
D. R. Lee
R. J. McReynolds
R. Meyer
M. Orihuela
C. J. Sallaberry
F. J. Schaaf, Jr.
H. M. Stephens, Jr.
R. W. Swayne
S. Takaya
R. Vayda

Working Group on MANDE (SG-RIM) (BPV XI)

H. M. Stephens, Jr., *Chair*
S. R. Doctor, *Vice Chair*
M. Turnbow, *Secretary*
T. Anselmi
M. T. Audrain
N. A. Finney
J. T. Fong
D. O. Henry
R. J. McReynolds
R. Meyer
M. Orihuela
K. Yamada

Task Group on Nonmetallic Component Degradation and Failure Monitoring (SG-RIM) (BPV XI)

M. P. Metcalfe, *Chair*
A. Tzelepi, *Secretary*
M. T. Audrain
G. Beirnaert
C. Chen
W. J. Geringer
K. Harris
J. Lang
J. Potgieter

ASME/JSME Joint Working Group on RIM Processes and System-Based Code (SG-RIM) (BPV XI)

S. Takaya, *Chair*
R. J. McReynolds, *Vice Chair*
M. T. Audrain
K. Dozaki
J. T. Fong
J. Hakii
K. Harris
M. Hayashi
S. Kalyanam
D. R. Lee
H. Machida
R. Meyer
T. Muraki
S. Okajima
A. T. Roberts III
C. J. Sallaberry
F. J. Schaaf, Jr.
R. Vayda
D. Watanabe
H. Yada
K. Yamada
T. Asayama, *Contributing Member*

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

S. L. McCracken, *Chair*
E. V. Farrell, Jr., *Secretary*
J. F. Ball
M. Brandes
S. B. Brown
R. Clow
S. J. Findlan
M. L. Hall
J. Honcharik
A. B. Meichler
L. A. Melder
S. A. Norman
G. T. Olson
J. E. O'Sullivan
G. C. Park
R. R. Stevenson
R. W. Swayne
D. J. Tilly
J. G. Weicks
B. Lin, *Alternate*

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

S. B. Brown, *Chair*
R. A. Patel, *Secretary*
O. Bhatty
R. Clow
R. R. Croft
E. V. Farrell, Jr.
K. Harris
B. Lin
H. Malikowski
A. B. Meichler
G. C. Park
M. A. Pyne
R. R. Stevenson
K. Sullivan
R. W. Swayne

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

S. L. McCracken, *Chair*
S. J. Findlan, *Secretary*
T. Basso
R. Clow
K. Dietrich
E. V. Farrell, Jr.
M. J. Ferlisi
R. C. Folley
M. L. Hall
D. Jacobs
H. Malikowski
T. Nuoffer
G. C. Park
A. Patel
R. R. Stevenson
J. G. Weicks

Working Group on Nonmetals Repair/Replacement Activities (SG-RRA) (BPV XI)

J. E. O'Sullivan, *Chair*
S. Schuessler, *Secretary*
M. Brandes
D. R. Dechene
M. Golliet
J. Johnston, Jr.
B. Lin
T. M. Musto
A. Pridmore
F. J. Schaaf, Jr.
R. Stakenborghs
P. Vibien
M. P. Marohl, *Contributing Member*

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

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

Task Group on Repair by Carbon Fiber Composites (WG-NMRRA) (BPV XI)

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

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

J. G. Weicks, *Chair*
G. T. Olson, *Secretary*
D. Barborak
S. J. Findlan
R. C. Folley
M. L. Hall
J. Honcharik
D. Jacobs
M. Kris
S. E. Marlette
S. L. McCracken
L. A. Melder
J. E. O'Sullivan
D. J. Tilly

Task Group on Temper Bead Welding (WG-W&SRP) (BPV XI)

S. J. Findlan, *Chair*
D. Barborak
R. C. Folley
J. Graham
M. L. Hall
D. Jacobs
H. Kobayashi
S. L. McCracken
N. Mohr
G. T. Olson
J. E. O'Sullivan
A. Patel
J. Tatman
J. G. Weicks

Task Group on Weld Overlay (WG-W&SRP)(BPV XI)

S. L. McCracken, *Chair*
S. Hunter, *Secretary*
D. Barborak
S. J. Findlan
J. Graham
M. L. Hall
D. Jacobs
C. Lohse
S. E. Marlette
G. T. Olson
A. Patel
D. W. Sandusky
D. E. Waskey
J. G. Weicks

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

M. J. Ferlisi, *Chair*
J. Nygaard, *Secretary*
J. M. Boughman
S. T. Chesworth
J. Collins
H. Q. Do
K. W. Hall
P. J. Hennessey
A. E. Keyser
S. D. Kulat
D. W. Lamond
T. Nomura
T. Nuoffer
M. A. Pyne
H. M. Stephens, Jr.
R. Thames
M. Weis
I. A. Anchondo-Lopez, *Alternate*

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

H. Malikowski, *Chair*
C. Waskey, *Secretary*
E. Blackard
T. Cinson
J. Collins
K. Dietrich
P. R. Donavin
H. Kobayashi
S. E. Marlette
G. C. Park
C. Wax
G. White
K. A. Whitney

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

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

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

H. Q. Do, *Chair*
M. Weis, *Secretary*
I. A. Anchondo-Lopez
R. W. Blyde
K. Caver
C. Cueto-Felgueroso
M. J. Ferlisi
M. L. Garcia Heras
K. W. Hall
J. Howard
A. Keller
S. D. Kulat
E. Lantz
A. Maekawa
T. Nomura
J. C. Nygaard
S. Orita
A. W. Wilkens

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

J. M. Boughman, *Chair*
S. A. Norman, *Secretary*
T. Anselmi
M. J. Homiack
A. E. Keyser
D. W. Lamond
M. Moenssens
R. A. Nettles
C. Thomas
K. Whitney

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

M. A. Pyne, *Chair*
S. T. Chesworth, *Secretary*
G. Brouette
C. Cueto-Felgueroso
R. Haessler
J. Hakii
K. W. Hall
M. J. Homiack
S. D. Kulat
D. W. Lamond
E. Lantz
P. J. O'Regan
N. A. Palm
D. Vetter

Working Group on General Requirements (BPV XI)

T. Nuoffer, *Chair*
J. Mayo, *Secretary*
J. F. Ball
T. L. Chan
P. J. Hennessey
K. A. Kavanagh
G. Ramaraj
T. N. Rezk
A. T. Roberts III
S. R. Scott
D. Vetter
S. E. Woolf
B. Harris, *Alternate*
R. S. Spencer, *Alternate*

COMMITTEE ON TRANSPORT TANKS (BPV XII)

N. J. Paulick, *Chair*
M. D. Rana, *Vice Chair*
J. Oh, *Staff Secretary*
A. N. Antoniou
K. W. A. Cheng
P. Chilukuri
W. L. Garfield
P. Miller
M. Pitts
J. Roberts
T. A. Rogers
R. C. Sallash
M. Shah
S. Staniszewski
A. P. Varghese
R. Meyers, *Contributing Member*

Executive Committee (BPV XII)

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

Subgroup on Design and Materials (BPV XII)

R. C. Sallash, *Chair*
D. K. Chandiramani
K. W. A. Cheng
P. Chilukuri
S. L. McWilliams
N. J. Paulick
M. D. Rana
T. J. Rishel
T. A. Rogers
M. Shah
S. Staniszewski
A. P. Varghese
K. Xu
Y. Doron, *Contributing Member*
A. T. Duggleby, *Contributing Member*
R. D. Hayworth, *Contributing Member*
B. E. Spencer, *Contributing Member*
J. Zheng, *Contributing Member*

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

M. Pitts, *Chair*
K. W. A. Cheng
P. Chilukuri
M. Koprivnak
P. Miller
O. Mulet
T. J. Rishel
J. Roberts
T. A. Rogers
R. C. Sallash
S. Staniszewski
Y. Doron, *Contributing Member*
R. D. Hayworth, *Contributing Member*
G. McRae, *Contributing Member*

Subgroup on General Requirements (BPV XII)

S. Staniszewski, *Chair*
A. N. Antoniou
P. Chilukuri
H. Ebben III
J. L. Freiler
W. L. Garfield
O. Mulet
B. F. Pittel
M. Pitts
R. C. Sallash
Y. Doron, *Contributing Member*
T. J. Hitchcock, *Contributing Member*
S. L. McWilliams, *Contributing Member*
T. A. Rogers, *Contributing Member*
D. G. Shelton, *Contributing Member*

Subgroup on Nonmandatory Appendices (BPV XII)

T. A. Rogers, *Chair*
S. Staniszewski, *Secretary*
P. Chilukuri
N. J. Paulick
M. Pitts
T. J. Rishel
R. C. Sallash
D. G. Shelton
D. D. Brusewitz, *Contributing Member*
Y. Doron, *Contributing Member*

COMMITTEE ON OVERPRESSURE PROTECTION (BPV XIII)

B. K. Nutter, *Chair*
A. Donaldson, *Vice Chair*
C. E. Rodrigues, *Staff Secretary*
J. F. Ball
J. Burgess
B. Calderon
D. B. DeMichael
J. W. Dickson
J. M. Levy
D. Miller
T. Patel
B. F. Pittel
T. R. Tarbay
D. E. Tompkins
Z. Wang
J. A. West
B. Engman, *Alternate*
H. Aguilar, *Contributing Member*
R. W. Barnes, *Contributing Member*
R. D. Danzy, *Contributing Member*
A. Frigerio, *Contributing Member*
J. P. Glaspie, *Contributing Member*
S. F. Harrison, Jr., *Contributing Member*
A. Hassan, *Contributing Member*
P. K. Lam, *Contributing Member*
M. Mengon, *Contributing Member*
J. Mize, *Contributing Member*
M. Mullavey, *Contributing Member*
S. K. Parimi, *Contributing Member*
J. Phillips, *Contributing Member*
M. Reddy, *Contributing Member*
S. Ruesenberg, *Contributing Member*
K. Shores, *Contributing Member*
D. E. Tezzo, *Contributing Member*
A. Wilson, *Contributing Member*

Executive Committee (BPV XIII)

A. Donaldson, *Chair*
B. K. Nutter, *Vice Chair*
C. E. Rodrigues, *Staff Secretary*
J. F. Ball
D. B. DeMichael
K. R. May
D. Miller

Subgroup on Design and Materials (BPV XIII)

D. Miller, *Chair*
T. Patel, *Vice Chair*
T. K. Acharya
C. E. Beair
W. E. Chapin
J. L. Freiler
B. Joergensen
V. Kalyanasundaram
R. Krithivasan
B. J. Mollitor
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*
R. Antoniuk
D. J. Azukas
J. F. Ball
J. Burgess
D. B. DeMichael
S. T. French
J. Grace
C. Haldiman
J. Horne
R. Klimas, Jr.
Z. E. Kumana
P. K. Lam
D. Mainiero-Cessna
K. R. May
J. Mize
L. Moedinger
M. Mullavey
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*
B. Joergensen, *Contributing Member*
C. Lasarte, *Contributing Member*
M. Mengon, *Contributing Member*
D. E. Miller, *Contributing Member*
R. Miyata, *Contributing Member*
B. Mruk, *Contributing Member*
J. Phillips, *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)

K. R. May, *Chair*
J. F. Ball, *Vice Chair*
R. Krithivasan, *Secretary*
M. Brown
J. W. Dickson
S. Jones
R. Lack
D. Miller
T. Patel
K. Shores
I. H. Tseng
B. J. Yonsky
J. M. Levy, *Alternate*
Y. Wong, *Alternate*
J. Yu, *Alternate*
S. T. French, *Contributing Member*
D. B. Ross, *Contributing Member*

Subgroup on Testing (BPV XIII)

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

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

D. Miller, *Chair*
C. E. Rodrigues, *Staff Secretary*
J. F. Ball
T. J. Bevilacqua
D. B. DeMichael
J. W. Dickson
B. K. Nutter
T. Patel
J. R. Thomas, Jr.
D. Tuttle
J. A. West
J. F. White

COMMITTEE ON BOILER AND PRESSURE VESSEL CONFORMITY ASSESSMENT (CBPVCA)

R. V. Wielgoszinski, *Chair*
G. Scribner, *Vice Chair*
G. Moino, *Staff Secretary*
M. Blankinship
J. P. Chicoine
T. E. Hansen
W. Hibdon
B. L. Krasiun
L. E. McDonald
N. Murugappan
I. Powell
D. E. Tuttle
E. A. Whittle
P. Williams
T. P. Beirne, *Alternate*
N. Caputo, *Alternate*
P. Chavdarov, *Alternate*
J. M. Downs, *Alternate*
P. D. Edwards, *Alternate*
Y.-S. Kim, *Alternate*
B. Morelock, *Alternate*
M. Prefumo, *Alternate*
R. Rockwood, *Alternate*
K. Roewe, *Alternate*
B. C. Turczynski, *Alternate*
J. Yu, *Alternate*
D. Cheetham, *Contributing Member*
A. J. Spencer, *Honorary Member*

COMMITTEE ON NUCLEAR CERTIFICATION (CNC)

R. R. Stevenson, *Chair*
M. A. Lockwood, *Vice Chair*
S. Khan, *Staff Secretary*
A. Appleton
J. F. Ball
G. Claffey
N. DeSantis
C. Dinic
G. Gobbi
J. W. Highlands
K. A. Kavanagh
J. C. Krane
T. McGee
E. L. Pleins
T. E. Quaka
T. N. Rezk
D. M. Vickery
E. A. Whittle
T. Aldo, *Alternate*
M. Blankinship, *Alternate*
G. Brouette, *Alternate*
M. Burke, *Alternate*
P. J. Coco, *Alternate*
Y. Diaz-Castillo, *Alternate*
P. D. Edwards, *Alternate*
J. Grimm, *Alternate*
K. M. Hottle, *Alternate*
P. Krane, *Alternate*
S. J. Montano, *Alternate*
I. Olson, *Alternate*
L. Ponce, *Alternate*
M. Wilson, *Alternate*
S. Yang, *Alternate*
S. F. Harrison, Jr., *Contributing Member*

CORRESPONDENCE WITH THE COMMITTEE

General

ASME codes and standards are developed and maintained by committees with the intent to represent the consensus of concerned interests. Users of ASME codes and standards may correspond with the committees to propose revisions or cases, report errata, or request interpretations. Correspondence for this Section of the ASME Boiler and Pressure Vessel Code (BPVC) should be sent to the staff secretary noted on the Section's committee web page, accessible at https://go.asme.org/CSCommittees.

NOTE: See ASME BPVC Section II, Part D for guidelines on requesting approval of new materials. See Section II, Part C for guidelines on requesting approval of new welding and brazing materials ("consumables").

Revisions and Errata

The committee processes revisions to this Code on a continuous basis to incorporate changes that appear necessary or desirable as demonstrated by the experience gained from the application of the Code. Approved revisions will be published in the next edition of the Code.

In addition, the committee may post errata and Special Notices at http://go.asme.org/BPVCerrata. Errata and Special Notices become effective on the date posted. Users can register on the committee web page to receive e-mail notifications of posted errata and Special Notices.

This Code is always open for comment, and the committee welcomes proposals for revisions. Such proposals should be as specific as possible, citing the paragraph number(s), the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent background information and supporting documentation.

Cases

(a) The most common applications for cases are

(1) to permit early implementation of a revision based on an urgent need

(2) to provide alternative requirements

(3) to allow users to gain experience with alternative or potential additional requirements prior to incorporation directly into the Code

(4) to permit use of a new material or process

(b) Users are cautioned that not all jurisdictions or owners automatically accept cases. Cases 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.

(c) The committee will consider proposed cases concerning the following topics only:

(1) equipment to be marked with the ASME Single Certification Mark, or

(2) equipment to be constructed as a repair/replacement activity under the requirements of Section XI

(d) A proposed case shall be written as a question and reply in the same format as existing cases. The proposal shall also include the following information:

(1) a statement of need and background information

(2) the urgency of the case (e.g., the case concerns a project that is underway or imminent)

(3) the Code Section and the paragraph, figure, or table number(s) to which the proposed case applies

(4) the edition(s) of the Code to which the proposed case applies

(e) A case is effective for use when the public review process has been completed and it is approved by the cognizant supervisory board. Cases that have been approved will appear in the next edition or supplement of the Code Cases books, "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 until the next edition of the 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. The status of any case is available at http://go.asme.org/BPVCCDatabase. An index of the complete list of Boiler and Pressure Vessel Code Cases and Nuclear Code Cases is available at http://go.asme.org/BPVCC.

Interpretations

(a) Interpretations clarify existing Code requirements and are written as a question and reply. Interpretations do not introduce new requirements. If a revision to resolve conflicting or incorrect wording is required to support the interpretation, the committee will issue an intent interpretation in parallel with a revision to the Code.

(b) Upon request, the committee will render an interpretation of any requirement of the Code. An interpretation can be rendered only in response to a request submitted through the online Interpretation Submittal Form at http://go.asme.org/InterpretationRequest. Upon submitting the form, the inquirer will receive an automatic e-mail confirming receipt.

(c) ASME does not act as a consultant for specific engineering problems or for the general application or understanding of the Code requirements. If, based on the information submitted, it is the opinion of the committee that the inquirer should seek assistance, the request will be returned with the recommendation that such assistance be obtained. Inquirers may track the status of their requests at http://go.asme.org/Interpretations.

(d) ASME procedures provide for reconsideration of any interpretation when or if additional information that might affect an interpretation is available. Further, persons aggrieved by an interpretation may appeal to the cognizant ASME committee or subcommittee. ASME does not "approve," "certify," "rate," or "endorse" any item, construction, proprietary device, or activity.

(e) Interpretations are published in the ASME Interpretations Database at http://go.asme.org/Interpretations as they are issued.

Committee Meetings

The ASME BPVC committees regularly hold meetings that are open to the public. Persons wishing to attend any meeting should contact the secretary of the applicable committee. Information on future committee meetings can be found at http://go.asme.org/BCW.

INTRODUCTION TO SECTION III, DIVISION 4

There is an ongoing effort within the ASME Boiler and Pressure Vessel Committee on Construction of Nuclear Facility Components (Section III) to develop rules for the construction of fusion energy devices. The Standards Committee of Section III, Division 4 and its Subgroup on Fusion Energy Devices are developing these new fusion Code rules. These rules cover fusion-energy-related components such as vacuum vessels, cryostats, and magnet structures and the interactions of these components. Related support structures, including metallic and nonmetallic materials; containment or confinement structures; and in-vessel components such as blankets, divertors, shield fusion-system piping, vessels, valves, pumps, and supports, are also covered. The rules include requirements for materials, design, fabrication, testing, examination, inspection, certification, and stamping.

ORGANIZATION OF SECTION III

1 GENERAL

Section III consists of Division 1, Division 2, Division 3, Division 4, 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, by the letter "F" for Division 4, and by the letter "H" for Division 5. Each Subsection is published separately, with the exception of those listed for Divisions 2, 3, 4, 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 4 — Fusion Energy Devices
  - Subsection FA — Fusion Energy Device Facilities
  - Subsection FB — Pressure Boundary Components
- 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.

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.

* 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.

(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.

CROSS-REFERENCING IN THE ASME BPVC

Paragraphs within the ASME BPVC may include subparagraph breakdowns, i.e., nested lists. The following is a guide to the designation and cross-referencing of subparagraph breakdowns:

(a) *Hierarchy of Subparagraph Breakdowns*

(1) First-level breakdowns are designated as (a), (b), (c), etc.

(2) Second-level breakdowns are designated as (1), (2), (3), etc.

(3) Third-level breakdowns are designated as (-a), (-b), (-c), etc.

(4) Fourth-level breakdowns are designated as (-1), (-2), (-3), etc.

(5) Fifth-level breakdowns are designated as (+a), (+b), (+c), etc.

(6) Sixth-level breakdowns are designated as (+1), (+2), etc.

(b) *Cross-References to Subparagraph Breakdowns.* Cross-references within an alphanumerically designated paragraph (e.g., PG-1, UIG-56.1, NCD-3223) do not include the alphanumerical designator of that paragraph. The crossreferences to subparagraph breakdowns follow the hierarchy of the designators under which the breakdown appears. The following examples show the format:

(1) If X.1(c)(1)(-a) is referenced in X.1(c)(1), it will be referenced as (-a).

(2) If X.1(c)(1)(-a) is referenced in X.1(c)(2), it will be referenced as (1)(-a).

(3) If X.1(c)(1)(-a) is referenced in X.1(e)(1), it will be referenced as (c)(1)(-a).

(4) If X.1(c)(1)(-a) is referenced in X.2(c)(2), it will be referenced as X.1(c)(1)(-a).

SUBSECTION FA
FUSION ENERGY DEVICE FACILITIES

SUBPART FAA
GENERAL REQUIREMENTS

ARTICLE FAA-1000
INTRODUCTION

FAA-1100 GENERAL

FAA-1110 SCOPE

The rules of Subsection FA, Subpart FAA constitute the general requirements for fusion components used in the construction of fusion devices and their supporting systems. Only those fusion components that are serving a pressure boundary function or a structural integrity function (see FAA-2120), or both, are covered by these rules. Items that are specifically excluded are electrical components and superconducting strand. Subpart FAA documents rules for construction that are not adequately addressed within existing Divisions of Section III or other existing codes and standards used in the nuclear industry.

(a) The general requirements of Division 4 are provided in Subsection NCA, except for those paragraphs or subparagraphs (with number headers) replaced by corresponding numbered FAA paragraphs or subparagraphs or new numbered FAA paragraphs or subparagraphs.

(b) Section III, Division 1 terminology might differ from that in Division 4 (e.g., Class 1 and Class 2 versus Class A and Class B), but the application and use of Division 1 rules are identical for Division 4 construction except where otherwise noted.

FAA-1120 DEFINITIONS

Definitions of key terms specific to Division 4 are included in Article FAA-9000 or noted within the applicable text. The definitions in Article FAA-9000 shall prevail should a conflict exist with definitions found in Subsection NCA or in other documents referenced in Division 4. Unless a term is defined in Article FAA-9000, the definition in Article NCA-9000 shall apply.

FAA-1140 TEMPERATURE LIMITS

The rules of Subpart FAA shall not be used for items that are to be subjected to metal temperatures that exceed the temperature limit in the Design Specification.

FAA-1150 LIMITS OF THESE RULES

The rules of Division 4 for fusion components provide requirements for new construction and include consideration of mechanical and thermal stresses due to cyclic operation and high-temperature creep in tokamaks and similar fusion technologies (see FAA-1300 for further detail). These rules currently do not evaluate different issues of concern for non-tokamak fusion systems or fusion systems using fuels other than tritium. These rules address the thermal and radiation effects on materials produced during the fusion activity. The rules do not explicitly address issues such as degradation of properties because of service conditions or environment. The rules do address the degradation of yield and ultimate tensile strengths due to long-time elevated temperature service. However, issues on environmental effects are highlighted in the Code, and it is the responsibility of the Owner and the Facility Operator to demonstrate to the jurisdictional regulatory body that these additional issues are adequately addressed by the design. Additional environmental testing to support Section III Appendices, Nonmandatory Appendix W is strongly encouraged.

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

The rules of Division 4 do not apply to instruments or permanently sealed, fluid-filled tubing systems furnished with instruments, but they do apply to instrument, control, and sampling piping specified in a Design Specification.

FAA-1300 FUSION TECHNOLOGIES

Subsection FA provides the rules for construction of nuclear fusion devices and their supporting systems. Nuclear fusion and nuclear fission are reactions in which energy is released from high-powered atomic bonds between the particles within a nucleus. The fundamental difference between these two processes is that fission is the splitting of an atom into two or more smaller ones, whereas fusion is the fusing of two or more smaller atoms into a larger one.

Nuclear fission is a technology that has been in use since the 1950s. Figure FAA-1300-1 illustrates a typical light water fission system. There is potential for new developments in nuclear energy technology to enhance nuclear energy's role in a sustainable-energy future.

Nuclear fusion is a process in which light nuclei, usually deuterium and tritium, collide and join together to form a heavier nucleus. When this happens, a considerable amount of energy is released. To overcome the electrostatic repulsion of these light nuclei so they will collide and fuse, extreme energy is imparted to the nuclei by radio-frequency heating, ohmic heating, neutral beam heating, or other means. These high-energy nuclei are called plasma ions. These plasma ions can be confined by either magnetic fields (such as a tokamak-based system) or by inertial forces (by inertial confinement systems) so that their velocity allows them to collide. Figure FAA-1300-2 illustrates a theoretical magnetic confinement-based fusion system.

The inertial confinement method generally freezes deuterium and tritium (hydrogen isotopes) into small pellets. These pellets are heated and compressed to extreme temperatures and pressures by lasers or X-rays so that the inertia of the pellet mass enables the isotopes to collide and fuse. Deuterium is abundant in hydrogen (0.015% natural abundance on Earth), and tritium isotope has no abundance so must be bred (neutron activation of lithium isotopes produces tritium).

Technical approaches to achieving fusion energy are generally categorized into three methods: magnetic fusion, magneto-inertial fusion, and inertial fusion. All three fusion technologies are being developed in the industry for energy production. The objective of Division 4 is to provide design rules for all fusion devices. These design rules are based on scientific development, knowledge, and operational experience. Tokamak (magnetic fusion energy) designs have to date received the most investment, advanced the most scientifically, and produced the largest pool of operational experience. Thus, Division 4 focuses on magnetic fusion energy systems found in tokamak designs (such as the "D" and spherical plasma geometries). Additional content for non-tokamak fusion systems, as well as systems using fuels other than tritium, will be developed when similar amounts of operational experience have been accrued.

Figure FAA-1300-3 illustrates examples of these developmental technologies and how they relate to the Lawson criterion. Fission–fusion hybrid designs do exist as a concept where generally a subcritical fission reactor is driven by a fusion neutron source. However, these designs are not mature enough to consider at this time.

FAA-1400 PURPOSE OF CLASSIFYING ITEMS IN A FUSION POWER PLANT

Code rules needs to be implemented that are appropriate for the design Code classes. These Code classes are to be applied to the classification of items in fusion energy devices and their supporting systems. The higher-class component rules address those items deemed to be serving a pressure boundary function or a structural integrity function, or both, and lower-class rules address those items deemed not to have a pressure boundary function but that do serve a structural integrity function or other critical functions as determined by the Owner or Designer. These classifications reflect the risk-based approach derived from safety criteria established for fusion-based devices and addressed in either the Division 4 rules or appropriate non-nuclear codes and standards. The Owner or Designer may also decide to use other classification systems (e.g., IAEA-TECDOC-1851) within the Design Specifications.

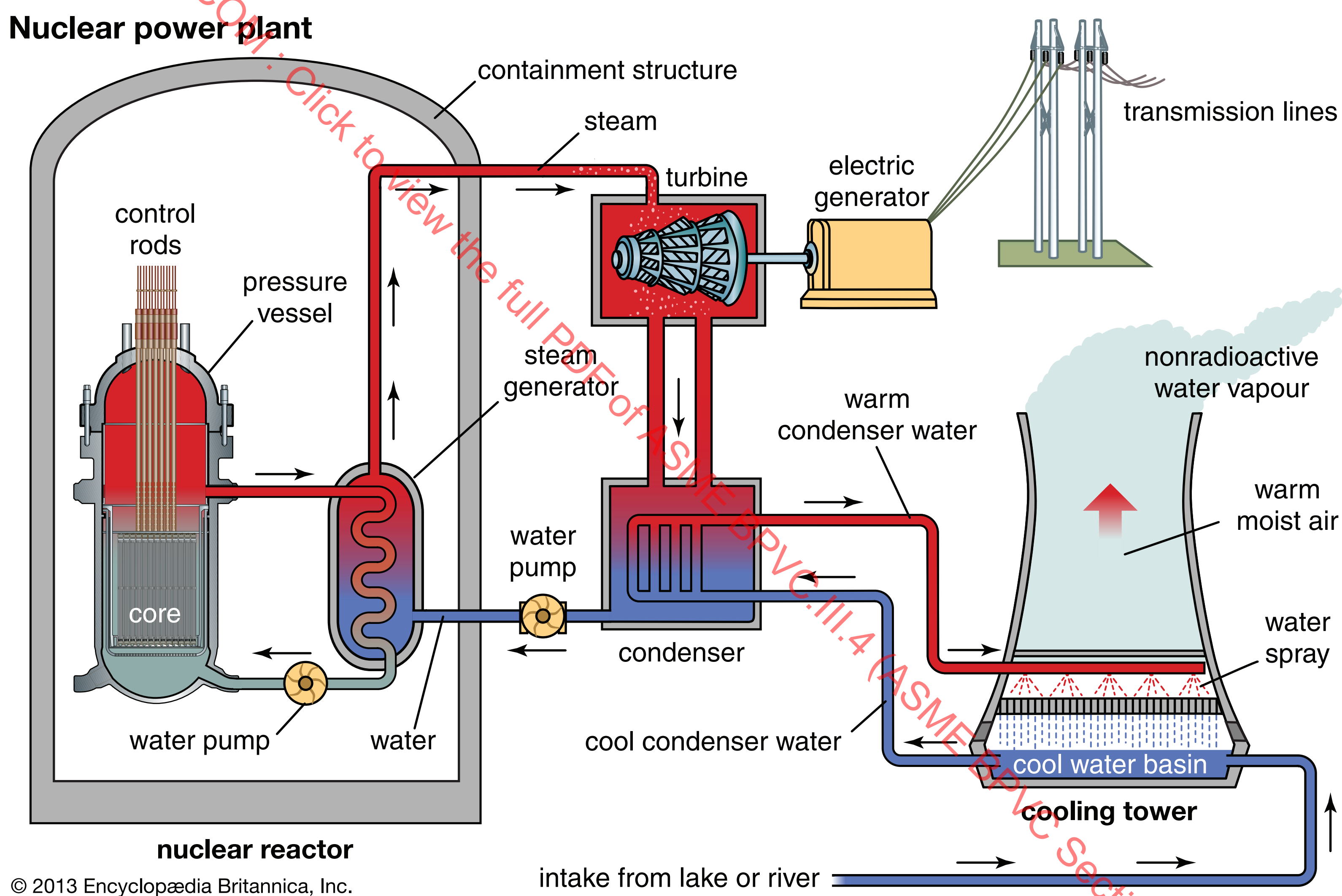
The Owner or Designer may also decide to use a Reliability and Integrity Management (RIM) Program that will define, evaluate, and implement strategies to ensure that Reliability Targets for structures, systems, and components are defined, achieved, and maintained throughout the plant lifetime. The requirements for a RIM Program are in Section XI, Division 2.

FAA-1500 ASPECTS OF CONSTRUCTION COVERED BY DIVISION 4 RULES

(a) Subsection FB contains rules for the material, design, fabrication, examination, testing, overpressure relief, marking, and preparation of reports by the Certificate Holder of items that are intended to conform to the requirements for the classifications defined in the Design Specifications for construction.

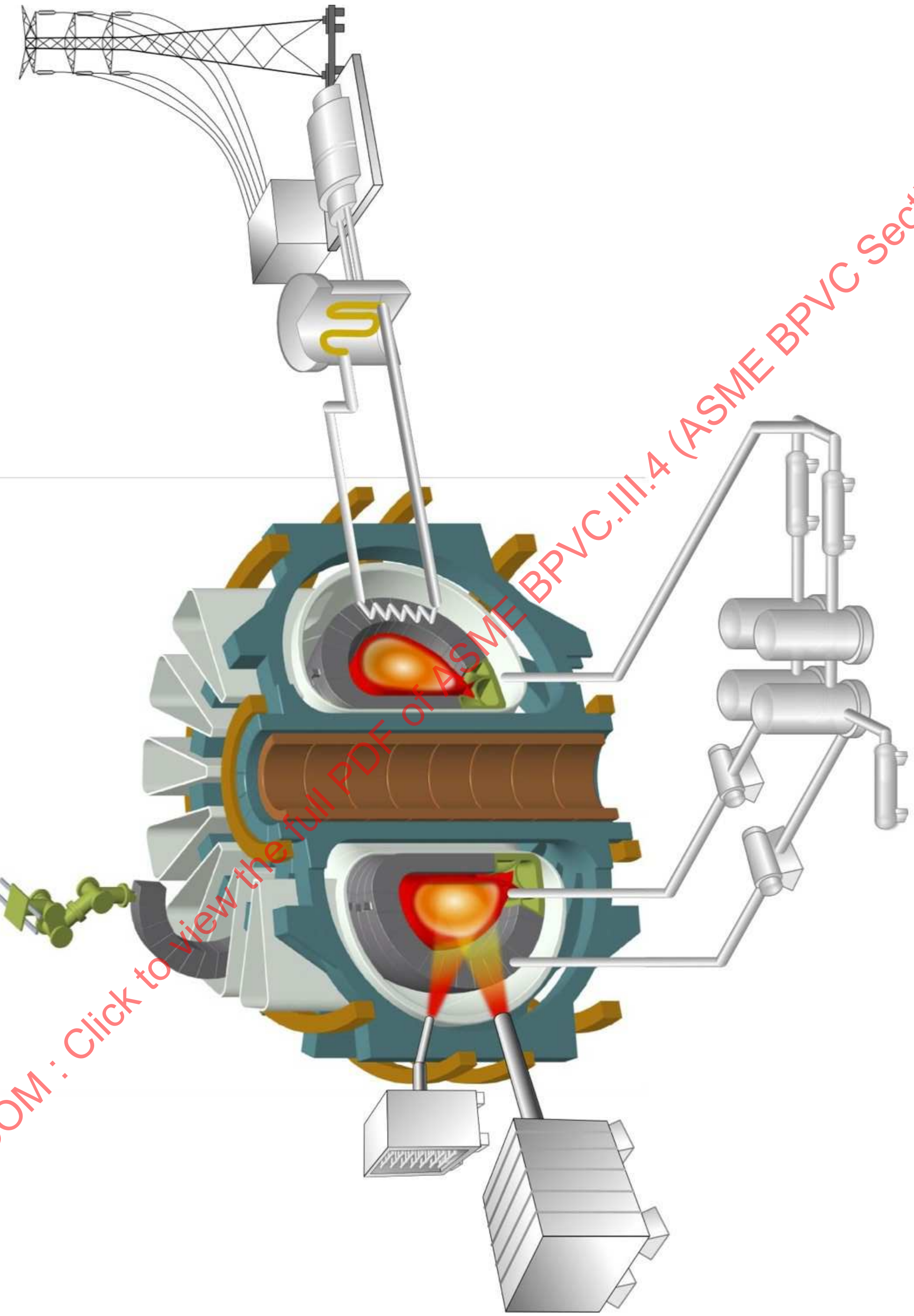
(b) The rules of Subsection FB cover the requirements for strength and pressure integrity of items, the failure of which would violate the pressure-retaining boundary. The rules cover initial construction requirements but do not cover deterioration that might occur in service as a result of corrosion or instability of material.

Figure FAA-1300-1
Typical Light Water Fission System



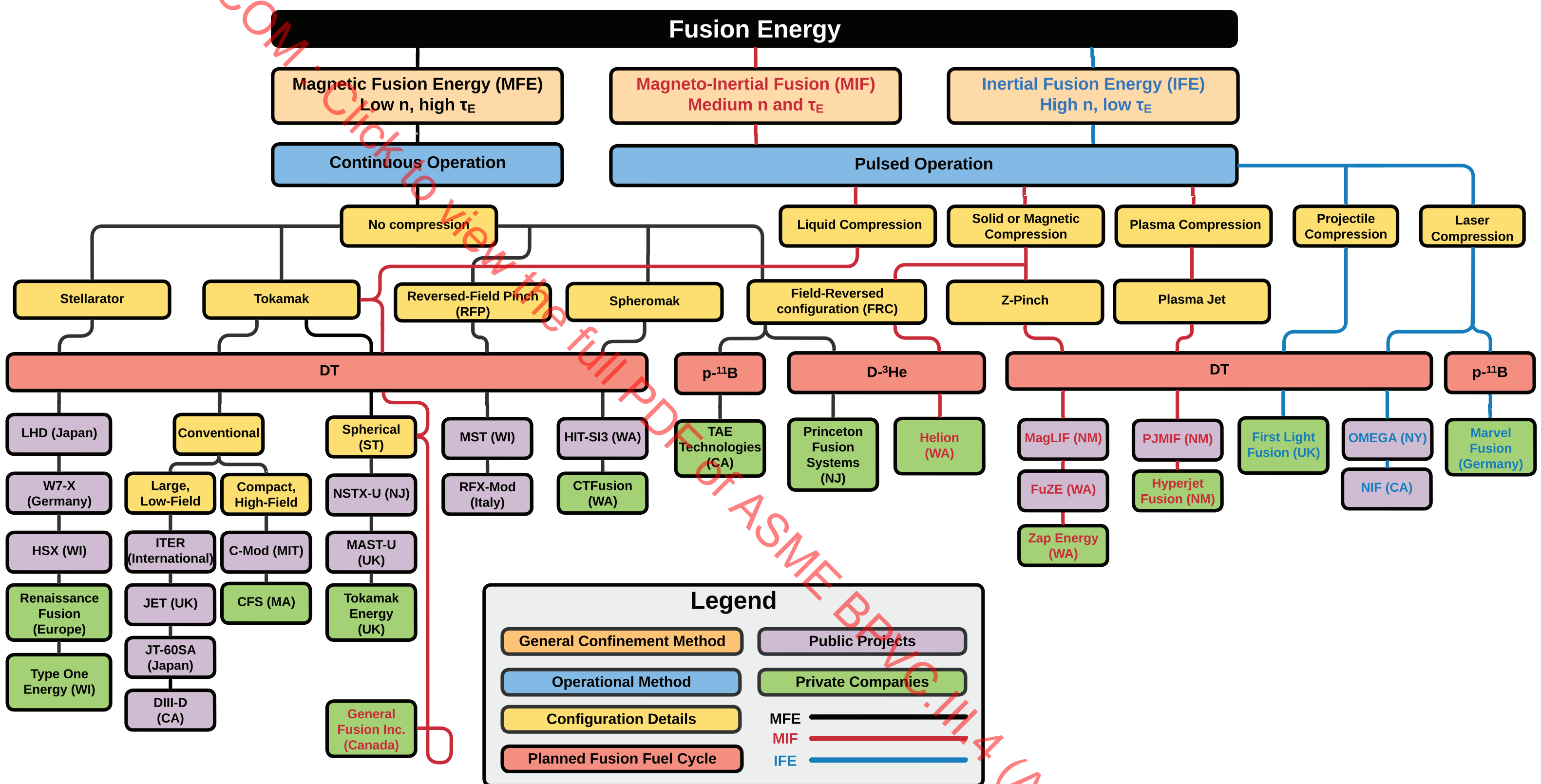
GENERAL NOTE: Reprinted with permission from Encyclopaedia Britannica, © 2018 by Encyclopaedia Britannica, Inc.

Figure FAA-1300-2
A Theoretical Magnetic Confinement–Based Fusion System



GENERAL NOTE: Image courtesy of the National Fusion Research Institute of Korea (NFRI).

Figure FAA-1300-3 Categorization of Developing New Technologies



GENERAL NOTE: Image courtesy of CTFusion, Inc.

NCA-1130 gives further limitations to the rules of Subsection FA.

FAA-1700 BOUNDARIES OF JURISDICTION APPLICABLE TO SUBSECTION FA

FAA-1720 BOUNDARY OF COMPONENTS

The Design Specification shall define the boundary of a component.

FAA-1730 JURISDICTIONAL BOUNDARY

The jurisdictional boundary shall be defined in the Design Specification.

FAA-1800 ELECTRICAL AND MECHANICAL PENETRATION ASSEMBLIES

Electrical and mechanical penetration assemblies shall be constructed in accordance with the rules for vessels, except that the design and the material performing the electrical conducting and insulating functions need not meet the requirements of this Subsection.

ARTICLE FAA-2000
MATERIAL

FAA-2100 GENERAL REQUIREMENTS FOR MATERIAL

FAA-2110 SCOPE OF PRINCIPAL TERMS

(a) The term "material" or "pressure-retaining material" as used in this Subsection applies to items such as vessel shells, heads, and nozzles; pipes, tubes, and fittings; valve bodies, bonnets, and disks; pump casings and covers; and bolting that joins pressure-retaining items.

(b) The term "material organization" is defined in Article NCA-9000.

(c) The requirements of this Article use the term "thickness" to mean "nominal thickness." The following definitions of "nominal thickness" apply:

(1) Plate. The nominal thickness of a plate is the dimension of the short transverse direction.

(2) Forgings

(-a) Hollow Forgings. The nominal thickness of a hollow forging is measured between the inside and outside surfaces (radial thickness).

(-b) Disk Forgings (Axial Length Less Than the Outside Diameter). The nominal thickness of a disk forging is the axial length.

(-c) Flat-Ring Forgings (Axial Length Less Than the Radial Thickness). If the axial length of a flat-ring forging is less than or equal to 2 in. (50 mm), the axial length is the nominal thickness. If the axial length of the forging is greater than 2 in. (50 mm), the radial thickness is the nominal thickness.

(-d) Rectangular Solid Forgings. The nominal thickness of a rectangular solid forging is the forging's least rectangular dimension.

(3) Castings

(-a) Thickness, t, for fracture toughness testing is defined as the nominal pipe wall thickness of the connecting piping.

(-b) Thickness, t, for heat treatment purposes is defined as the thickness of the pressure-retaining wall of the casting, excluding flanges and sections designated by the Designer as non–pressure retaining.

FAA-2120 PRESSURE-RETAINING MATERIAL

FAA-2121 Permitted Material Specifications

(a) Pressure-retaining material shall conform to the requirements of one of the specifications for material given in Section II, Part D, Subpart 1, Tables 2A, 2B, and 4, including all applicable footnotes in the table, and to all of the requirements of this Article that apply to the product form in which the material is used. Where applicable, material specifications in Division 5 may also be considered.

(b) The requirements of this Article do not apply to material for items not associated with the pressure-retaining function of a component, such as shafts, stems, trim, spray nozzles, bearings, bushings, springs, and wear plates, nor to seals, packing, gaskets, valve seats, and ceramic insulating material and special alloys used as seal material in electrical penetration assemblies.

(c) Material made to specifications other than those specified in Section II, Part D, Subpart 1, Tables 2A and 2B may be used for the following applications:

(1) safety valve disks and nozzles, when the nozzles are internally contained by the external body structure

(2) control valve disks and cages, when the valves function for flow control only

(3) line valve disks in valves whose inlet connections are NPS 2 (DN 50) and smaller

(d) Material for instrument line fittings and valves, NPS 1 (DN 25) and smaller, may be of material made to specifications other than those specified in the Design Specification.

(e) Welding and brazing material used in the manufacture of items shall comply with the Design Specification except as otherwise permitted in Section IX, and shall also comply with the applicable requirements of this Article. The requirements of this Article do not apply to material used as backing rings or backing strips in welded joints.

(f) The requirements of this Article do not apply to hard surfacing or corrosion-resistant weld metal overlay that is 10% or less of the thickness of the base material.

FAA-2122 Special Requirements Conflicting With Permitted Material Specifications

Special requirements stipulated in this Article shall apply in lieu of the requirements of the material specification wherever the special requirements conflict with the material specification requirements (see NCA-4256). Where the special requirements include an examination, test, or treatment that is also required by the material specification, the examination, test, or treatment need be performed only once. Required nondestructive examinations shall be performed as specified for each product form. Any examination, repair, test, or treatment required by the material specification or by this Article may be performed by the Material Organization or the Certificate Holder. Any hydrostatic or pneumatic pressure test required by a material specification need not be performed provided the material is identified as not having been pressure tested. Subsequent pressure testing can be performed in the system except where the location of the material in the system or the installation would prevent performing any nondestructive examination required by the material specification. Subsequent performance of the material specification nondestructive examination tests is required.

The stress rupture test of SA-453 and SA-638 for Grade 660 (UNS S66286) is not required for design temperatures of 800°F (427°C) and below.

FAA-2123 Size Ranges

Material outside the limits of size or thickness given in any specification in Section II may be used if the material is in compliance with the other requirements of the specification and no size limitation is given in the rules for construction. In those specifications in which chemical composition, mechanical properties, or other load considerations such as electromagnetic load are indicated to vary with size or thickness, any material outside the specification range shall be required to conform to the composition and mechanical properties shown for the nearest specified range.

FAA-2124 Bolting Material

(a) Material for bolts and studs shall conform to the requirements of the specifications defined in the Design Specification. Material for nuts shall conform to SA-194 or to the specifications defined in the Design Specification.

(b) The use of washers is optional. When used, washers shall be made of wrought material with mechanical properties compatible with the nuts with which the washers are to be used.

FAA-2130 CERTIFICATION OF MATERIAL

All material used in the construction of components shall be certified as required in NCA-3861 and NCA-3862. Certified Material Test Reports are required for pressure-retaining material except as provided by NCA-3861. A Certificate of Compliance may be provided in lieu of a Certified Material Test Report for all other material. Copies of all Certified Material Test Reports and Certificates of Compliance applicable to material used in a component shall be furnished with the material.

FAA-2140 WELDING MATERIAL

For the requirements governing the material to be used for welding, see FAA-2300.

FAA-2150 MATERIAL IDENTIFICATION

The identification of pressure-retaining material and materials welded thereto shall meet the requirements of NCA-4200. Material for small items (as defined in NCA-4200) shall be controlled during manufacture and installation of a component so that material is identifiable as acceptable at all times. Welding and brazing materials shall be controlled during the repair of material and during manufacture and installation so that materials are identifiable as acceptable until consumed in the process.

FAA-2160 DETERIORATION OF MATERIAL IN SERVICE

Consideration of deterioration of material caused by service is the responsibility of the Owner, who shall select material suitable for the conditions stated in the Design Specification with specific attention being given to the effects of service conditions on the properties of the material. Special consideration shall be given to the influence of the effects of irradiation on the properties of material. Any special requirement shall be specified in the Design Specification.

FAA-2170 HEAT TREATMENT TO ENHANCE IMPACT PROPERTIES

Carbon steels, low alloy steels, and high alloy chromium (series 4XX) steels may be heat treated by quenching and tempering to enhance their impact properties. Postweld heat treatment of components at a temperature of not less than 1,100°F (595°C) may be considered to be the tempering phase of the heat treatment.

FAA-2180 PROCEDURES FOR HEAT TREATMENT OF MATERIAL

When heat-treating temperature or time is required by the material specification and the rules of this Subsection, the heat treating shall be performed in temperaturesurveyed and temperature-calibrated furnaces or the heat treating shall be controlled by measurement of material temperature by thermocouples in contact with the material or attached to blocks in contact with the material or by calibrated instruments. Heat treating shall be performed under furnace-loading conditions such that the heat treatment is in accordance with the material specification and the rules of this Subsection.

FAA-2190 NON-PRESSURE-RETAINING MATERIAL

(a) Material in the component support load path not performing a pressure-retaining function that is welded to pressure-retaining material shall meet the requirements of Article FAA-2000.

(b) Material not performing a pressure-retaining function and not in the component support load path (nonstructural attachments) welded at or within $2t$ of the pressure-retaining portion of the component, where t is as defined in FAA-2110(d)(3), need not comply with Article FAA-2000.

FAA-2200 MATERIAL TEST COUPONS AND SPECIMENS FOR FERRITIC STEEL MATERIAL

FAA-2210 PROCEDURE FOR OBTAINING TEST COUPONS AND SPECIMENS FOR QUENCHED AND TEMPERED MATERIAL

The procedure for obtaining test coupons and specimens for quenched and tempered material is related to the product form. Coupon and specimen location and the number of tension test specimens shall be in accordance with the material specifications. References to dimensions signify nominal values.

FAA-2300 WELDING MATERIAL

(a) All welding material used in the construction and repair of components or material, except welding material used for cladding hard surfacing, shall conform to the requirements of the welding material specification or to the requirements for other welding material as permitted in Section IX. In addition, welding material shall conform to the requirements stated in this paragraph and to the rules covering identification in FAA-2150.

(b) The Certificate Holder shall provide the organization performing the testing with the following information, as applicable:

(1) welding process

(2) SFA specification and classification

(3) other identification if no SFA specification applies

(4) minimum tensile strength

(5) drop weight test for material as welded or as heat treated, or both

(6) Charpy V-notch test for material as welded or as heat treated, or both; the test temperature and the lateral expansion or the absorbed energy shall also be provided

(7) the preheat and interpass temperatures to be used during welding of the test coupon

(8) postweld heat treatment time, temperature range, and maximum cooling rate, if the production weld will be heat treated

(9) elements for which chemical analysis is required per the SFA specification or Welding Procedure Specification

(10) minimum delta ferrite

FAA-2400 DIMENSIONAL STANDARDS

Dimensions of standard items shall comply with the standards and specifications listed in Table NCA-7100-1.

FAA-2500 STRUCTURAL MATERIALS

The expected environmental conditions created by fusion energy, such as high fusion neutron flux, elevated and cryogenic temperatures, high magnetic fields, and plasma erosion, highlight the extreme environmental conditions structural materials will operate within. The fusion research community has sought materials with the following characteristics:

(a) radiation resistance to reduce the frequency of component replacement

(b) helium embrittlement resistance

(c) chemical compatibility with coolants and liquid metal or molten salt breeders

(d) phase stability under high magnetic and neutron irradiation conditions

(e) ability to operate at high temperature to help enhance the thermal conversion efficiency

(f) ability to maintain sound and acceptable mechanical properties under fusion neutron irradiation

(g) easy-to-fabricate complex configurations

(h) reduced radiological activation to minimize radioactive waste

Generally, the life-limiting criteria for such structural materials have historically been the thermal and mechanical stresses, thermal creep, and radiation-damage displacements (which lead to radiation embrittlement).

The desire is to have qualified structural materials that meet the characteristics listed above. Fusion-specific materials are under development and are poised to possess these characteristics.

The method for material qualification is under development.

ARTICLE FAA-3000
DESIGN

FAA-3100 GENERAL DESIGN

FAA-3110 PROVISION OF DESIGN SPECIFICATIONS

(a) The Design Specifications shall contain sufficient detail to provide a complete basis for Division 4 construction. Such requirements shall not result in construction that fails to conform with the rules of Division 4. All Design Specifications shall include (1) through (8).

(1) the functions and boundaries of the items covered (see Subsection NCA, NCA 3211.19)

(2) the design requirements (see FAA-2100 and NCA-2140), including all required overpressure protection requirements (see Subsection NCA, NCA-3211.21)

(3) the environmental conditions, including radiation (see Section III Appendices, Nonmandatory Appendix W for further insights and guidance)

(4) the Code classification of the items covered (see Article FAA-2000)

(5) material requirements, including impact test requirements

(6) fracture mechanics data for base metal, weld metal, and heat-affected zone required to use, as applicable, the Mandatory and Nonmandatory Appendices of Section III

(7) when functionality of a component is a requirement, reference to other appropriate documents that specify those operating requirements

(8) the effective Code Edition and Code Cases to be used for construction

(b) The Design Specification shall identify those components or parts that require a preservice examination.

FAA-3130 LOADING CRITERIA

FAA-3131 Loading Conditions

The loadings that shall be taken into account in the design of a component include, but are not limited to, the following:

(a) internal and external pressure

(b) impact loads, including rapidly fluctuating pressures

(c) weight of the component and normal contents under operating or test conditions, including additional pressure due to static and dynamic head of liquids

(d) superimposed loads such as other components, operating equipment, insulation, corrosion- or erosion-resistant linings, and piping

(e) wind loads, snow loads, vibrations, and earthquake loads where specified

(f) reactions of supporting lugs, rings, saddles, or other types of supports

(g) temperature effects

(h) electromagnetic loads

FAA-3132 Design Loadings

The toroidal field (TF) coil and TF coil structures are subject to structural (mechanical) loads and thermal loads. The normal operating conditions of the TF coil and TF coil structures include the following:

(a) constant structural loads

(1) dead loads

(2) preload of the precompression rings at the top and bottom of the coil

(3) energization

(b) constant thermal loads, such as cooldown

(c) variable structural loads that occur during operation

(1) plasma pulsing

(2) loads related to central solenoid (CS) and poloidal field (PF) coils

(d) radiation-decay heat

FAA-3200 DESIGN BY ANALYSIS

FAA-3210 INTRODUCTION TO FAA-3200

Subarticle FAA-3200 is in development. The design rules that will be presented in this subarticle are formulated using the approaches associated with design-by-analysis methodology. Given that commercial fusion technology is the early stages of maturity, the design-by-analysis methods have been chosen because of their adaptability to unique component geometries and structural specificities that might be envisioned with evolving fusion reactor technology research. Furthermore, design-by-analysis methods allow consideration of loads other than those typically considered in other nuclear design codes. As designs become more standardized, the design rules presented herein will be updated or superseded as appropriate and potentially complemented with design-by-formulae approaches.

The design-by-analysis approaches are typically characterized through an identification of the most pertinent damage mechanisms that a specific component is likely to be subjected to beyond those addressed by the design-by-formulae approaches (which typically protect against gross plastic deformation, incremental collapse, and collapse through buckling). Taking account of the guidelines prescribed in IAEA-TECDOC-1851, the rules presented in this subarticle will cover a selected set of damage mechanisms that are anticipated to be experienced by the components within a fusion reactor. As a tentative measure, design rules from Section VIII, Division 2, and Section III, Divisions 1 and 5 may be used in conjunction with the materials and operating conditions for which the design rules have been validated. Extrapolating the use of the rules to other materials or operating conditions without adequate validation should not be assumed as being automatically endorsed.

To that end, this subarticle will also provide cross-references to the pertinent design-by-analysis paragraphs of Section VIII, Division 2, and Section III, Divisions 1 and 5 as appropriate. The applicability of these rules for design assessment should be carefully corroborated with the wider requirements and caveats stipulated in other sections of Section VIII, Division 2. These rules, nevertheless, are to be deemed as constituting interim advice that will be reviewed and updated as appropriate at suitable stages. These updates will rely on current information derived from programs focused on establishing the precise boundary operating conditions. These operation conditions will include but not be limited to the approved materials for different components, their relevant design allowables estimated at fusion-specific conditions, and the operating temperature and irradiation levels. Additionally, since the design rules in Section VIII, Division 2, Part 5 predominantly cater to unirradiated materials, complementary rules might be needed to address highly irradiated materials susceptible to brittle failure modes. The need for complementary rules will be guided by developments in understanding of material behaviors across the full spectrum of anticipated operating conditions.

For each damage mechanism, the design-by-analysis assessment may be carried out via more than one approach (elastic, elastic–plastic, and limit-load methods) to establish the relevant design attributes (e.g., thickness, material choice, component profile) via appropriate design rules. Section VIII, Division 2, Part 5 provides the pertinent guidelines associated with the relevant design attributes for each respective damage mechanism and assessment method along with detailed guidelines on the procedure to be followed for linearization and classification of stresses that feed directly into the assessment criteria for different damage mechanisms. These relevant design attributes may be further complemented with design by analysis using the "direct route" focusing on inelastic methods, where the design resistance is calculated with respect to the ultimate limit state of the structure specific to each failure mode.

Informative guidelines on typical loads and load cases to be considered in a design for operational (normal, abnormal, startup) and testing conditions and typical load case combinations and allowable stresses or load factors to be considered for elastic analysis, limit-load analysis, and elastic–plastic analysis will also be provided. For preliminary guidelines pertaining to these topics, users can refer to Section VIII, Division 2, Part 5, Tables 5.1, 5.3, 5.4 and 5.5. Each of the above operating conditions may involve distinct phases guided by evolving fusion plasma physics studies, which will also consider various damage mechanisms.

The damage mechanisms identified in (a) are derived from IAEA-TECDOC-1851 with an implicit assumption of relevance to fusion components. It would nevertheless be incumbent upon the Designer to independently identify the most pertinent damage mechanisms for any specific component under consideration. Lack of formal regulatory guidelines on safety classification of fusion reactor components renders the ascription of varying levels of safety margins or damage-acceptance limits specific to each component for each damage mechanism irrelevant at this stage. A suitable starting point could be to aim to prevent the onset of each damage mechanism, which nevertheless may be either overly conservative or not conservative depending upon the extent to which the onset of a particular damage mechanism would impact the component-level damage protection requirements. The damage mechanisms will be reviewed and addressed as technology and regulatory expectations become more concretized.

(a) Damage Mechanisms to Be Covered

(1) immediate plastic collapse, immediate plastic instability, immediate plastic flow localization

(2) immediate local fracture due to exhaustion of ductility

(3) fast fracture

(4) thermal creep

(5) ratchetting

(6) fatigue

(7) creep-fatigue

(8) secondary failure modes

(9) buckling

(10) excessive deformation

(b) Environmental Effects

(1) excessive corrosion

(2) excessive plasma erosion

(3) irradiation-induced hardening and embrittlement

(4) irradiation-induced swelling

(5) stress-corrosion cracking

(6) impure helium impact on fatigue and creep-fatigue

Each of the damage-mechanism considerations listed in (a) and (b) will be reviewed for the pertinent acceptance criteria and detailed design procedures to be followed, including guidelines on material models and flow rules to be used. These reviews may also use the results from stress analysis to evaluate the component being designed against the aforementioned damage mechanisms. They will indicate the material properties required to carry out the stress analysis. Contextualized guidelines for special geometric features (e.g., bolts) and interfaces will be provided in separate clauses as appropriate.

FAA-3220 LISTING OF DESIGN-BY-ANALYSIS CONSIDERATIONS

Subarticle FAA-3200, which will include the following paragraphs, is in development:

FAA-3210	Design Criteria
FAA-3211	Basis for Determining Stresses
FAA-3212	Stress Analysis
FAA-3213	Derivation of Stress Intensities
FAA-3214	Derivation of Stress Differences
FAA-3215	Classification of Stresses
FAA-3220	Stress Limits for Other Than Bolts
FAA-3221	Design Loadings
FAA-3222	Level A Service Limits
FAA-3223	Level B Service Limits
FAA-3224	Level C Service Limits
FAA-3225	Level D Service Limits
FAA-3226	Testing Limits
FAA-3227	Applications of Plastic Analysis
FAA-3228	Design Stress Values
FAA-3230	Stress Limits for Bolts
FAA-3231	Design Conditions
FAA-3232	Design Stress Intensity Value

ARTICLE FAA-7000
REFERENCE STANDARDS

FAA-7100 INTRODUCTION

Table FAA-7100-1 lists standards and specifications referenced in Division 4. The table excludes the following:
(a) standards and specifications already listed in Table NCA-7200-2
(b) ASME BPVC Sections

Table FAA-7100-1
Standards and Specifications Referenced in Division 4

Designator	Title	Referenced Edition	Applicable Subsection
The American Society of Mechanical Engineers (ASME)			
ASME NQA-1	Quality Assurance Requirements for Nuclear Facility Applications	2019	All
American Society for Nondestructive Testing (ASNT)			
SNT-TC-1A	Personnel Qualification and Certification in Nondestructive Testing	2011	All
International Atomic Energy Agency (IAEA)			
IAEA-TECDOC-1851	Integrated Approach to Safety Classification of Mechanical Components for Fusion Applications	2018	All
Safety Standard No. GS-R-3	The Management System for Facilities and Activities	2006	All
International Organization for Standardization (ISO)			
ISO 9001	Quality management systems — Requirements	2015	All
ISO 19443	Quality management systems — Specific requirements for the application of ISO 9001:2015 by organizations in the supply chain of the nuclear energy sector supplying products and services important to nuclear safety (ITNS)	2018	All

ARTICLE FAA-8000 CERTIFICATES, NAMEPLATES, CERTIFICATION MARK, AND DATA REPORTS

FAA-8100 AUTHORIZATION TO PERFORM ASME BPVC ACTIVITIES

The rules for certificates, nameplates, the Certification Mark, and Data Reports for fusion components, supports, and support structures under Division 4 shall be the same as the rules established for Division 1 metallic components and metallic core support structures. The only changes shall be the use of Division 4 terminology rather than Division 1 terminology (e.g., Class A and Class B rather than Class 1 and Class 2) and the specification of the use of Division 4.

Authorization to use the ASME Single Certification Mark or to certify work by other means provided in Subpart FAA (see Subsection NCA, Table NCA-8100-1) will be granted by the Society for a 3-yr period pursuant to the provisions set forth in Subsection NCA.

ARTICLE FAA-9000 GLOSSARY

FAA-9100 INTRODUCTION

This Article defines selected terms used in Division 4 for pressure boundary components, supports, and support structures. The definitions in this Glossary shall prevail should a conflict exist with definitions found in Division 1 or other documents referenced in Division 4. Unless terms are defined below, the definitions in Article NCA-9000 shall apply.

FAA-9200 DEFINITIONS

controlled nuclear fusion: the process of fusing nuclei together at a controlled rate. When light nuclei such as deuterium (D) and tritium (T) isotopes are fused, some excess mass is converted to kinetic energy of the reaction products. For D + T, a helium nucleus and a neutron are produced in the fusion reaction. The kinetic energy of these fusion reaction products can be captured by slowing the reaction products in a material so that kinetic energy is converted to heat energy. The heat energy can be used for producing electricity or other industrial uses. The tokamak system is in contact with the fluid and maintains the internal or external fluid pressure. There also may be a reaction such as deuterium-helium 3 or proton-boron 11.

inertial confinement: a nuclear fusion method in which frozen pellets in a vacuum chamber are rapidly compressed with great force by laser beams, X-ray beams, or ion beams.

ITER: an international organization that manages the International Thermonuclear Experimental Reactor (ITER) project.

magnetic confinement: a nuclear fusion method in which nuclei in a vacuum chamber are guided at high velocity by magnetic fields and heated by microwave energy or by a combination of microwave energy and other means so that the high velocity of the nuclei overcomes electrostatic repulsion and fusion reactions occur.

pressure boundary: the area on the surface of a component that has been designed to accept the stresses created by internal or external forces as defined in the Design Specification. (See FAA-2120.)

tokamak: a fusion system using the magnetic confinement method.

SUBPART FAB
MAGNETIC CONFINEMENT

ARTICLE FAB-1000
INTRODUCTION

FAB-1100 SCOPE

There are several methods to accomplish controlled nuclear fusion, two of which are discussed within this Article. One method is magnetic confinement, in which nuclei in a vacuum chamber are guided at high velocity by magnetic fields and heated by microwave energy or a combination of microwave energy and other means so that the high velocity of the nuclei overcomes electrostatic repulsion and fusion reactions occur. Another method, inertial confinement, uses tiny frozen pellets in a vacuum chamber; the pellets are rapidly compressed with great force by laser beams, X-ray beams, or ion beams. The beams ionize some molecules, and the compression force creates a shock wave in the pellet. The shock wave overcomes electrostatic repulsion and the atoms fuse. Both magnetic confinement and inertial confinement control the fusion reaction by the amount of mass and energy input to the process, either by heating or by compression.

FAB-1200 MAGNETIC CONFINEMENT

The tokamak, or the system of magnetic confinement that is used in today's experimental devices and that might be used in future power facilities, uses both resistive and superconducting magnets. The major systems that can make up the tokamak include

(a) resistive or superconducting magnets, or both, including but not limited to the following:

(1) TF coils

(2) PF coils

(3) CS coils

(4) correction coils (CCs)

(b) vacuum vessel (VV)

(c) in-vessel coil systems

(d) in-vessel components, including divertors, breeder blankets, and first-wall tiles

(e) cryostat

(f) VV overpressure suppression system

(g) thermal and radiation shields for magnets

Each of these major systems consists of other subsystems and components that together form a major part of the tokamak.

The tokamak has a confinement structure that also serves as a radiation-shielding barrier; the cryostat and the VV provide the vacuum boundaries. The primary purpose of the cryostat is to provide the environment for the thermal isolation of the resistive and superconducting magnets. The VV is located inside the magnet system and provides the first confinement barrier for the in-vessel radiological inventory (such as unburnt tritium and activated structures).

The thermal shield is mounted between the VV and the superconducting magnets on the inside, and the cryostat and the magnets on the outside. All of these components are mounted inside the cryostat. Inside the VV, the internal replaceable components include breeder blanket modules and divertor cassettes.

FAB-1210 MAGNET SYSTEM

The typical magnet system for a tokamak consists of TF coils, a CS, PF coils, and, if necessary, CCs. The TF coils determine the basic toroidal segmentation of the machine and are chosen to meet the number and size requirements of access ports. An example of this magnet system is shown in Figure FAB-1210-1.

The TF coil case encloses the winding pack and is the main structural component of the magnet system. The TF coil case and the winding pack are structurally linked.

The CS assembly consists of a vertical stack of winding-pack modules, which is supported from the bottom of the TF coils through its preload structure. The number of CS modules is designed to satisfy the plasma-shaping requirements.

The PF coils are attached to the TF coil to allow for radial displacements. The PF coils provide suitable magnetic fields for plasma shaping and position control.