

ASME BOILER AND PRESSURE VESSEL CODE  
AN AMERICAN NATIONAL STANDARD

SECTION VIII  
Rules for Construction of  
Pressure Vessels

Division 1

1989 EDITION

JULY 1, 1989



ASME BOILER AND PRESSURE VESSEL COMMITTEE  
SUBCOMMITTEE ON PRESSURE VESSELS

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS  
United Engineering Center                      345 East 47th Street                      New York, N.Y. 10017

Currently in preview, click buy full version

# 1989 ASME BOILER AND PRESSURE VESSEL CODE

## SECTIONS

- I Power Boilers
- II Material Specifications
  - Part A — Ferrous Materials
  - Part B — Nonferrous Materials
  - Part C — Welding Rods, Electrodes, and Filler Metals
- III Subsection NCA — General Requirements for Division 1 and Division 2
- III Division 1
  - Subsection NB — Class 1 Components
  - Subsection NC — Class 2 Components
  - Subsection ND — Class 3 Components
  - Subsection NE — Class MC Components
  - Subsection NF — Component Supports
  - Subsection NG — Core Support Structures
  - Appendices
- III Division 2 — Code for Concrete Reactor Vessels and Containments
- IV Heating Boilers
- V Nondestructive Examination
- VI Recommended Rules for Care and Operation of Heating Boilers
- VII Recommended Guidelines for the Care of Power Boilers
- VIII Pressure Vessels
  - Division 1
  - Division 2 — Alternative Rules
- IX Welding and Brazing Qualifications
- X Fiber-Reinforced Plastic Pressure Vessels
- XI Rules for Inservice Inspection of Nuclear Power Plant Components

## ADDENDA

Colored-sheet Addenda, which include additions and revisions to individual Sections of the Code, are published annually and will be sent automatically to purchasers of the applicable Sections up to the publication of the 1992 Code. The 1989 Code is available only in the loose-leaf format; accordingly, the Addenda will be issued in the loose-leaf, replacement-page format.

## INTERPRETATIONS

ASME issues written replies to inquiries concerning interpretation of technical aspects of the Code. The Interpretations for each individual Section will be published separately and will be included as part of the update service to that Section. They will be issued semiannually (July and December) up to the publication of the 1992 Code. Interpretations of Section III, Divisions 1 and 2, will be included with the update service to Subsection NCA. Interpretations are not part of the Code or the Addenda.

## CODE CASES

The Boiler and Pressure Vessel Committee meets regularly to consider proposed additions and revisions to the Code and to formulate Cases to clarify the intent of existing requirements or provide, when the need is urgent, rules for materials or constructions not covered by existing Code rules. Those Cases which have been adopted will appear in the appropriate 1989 Code Cases book: (1) Boilers and Pressure Vessels and (2) Nuclear Components. Supplements will be sent automatically to the purchasers of the Code Cases books up to the publication of the 1992 Code.

Currently in preview, click buy full version

## FOREWORD

The American Society of Mechanical Engineers set up a committee in 1911 for the purpose of formulating standard rules for the construction of steam boilers and other pressure vessels. This committee is now called the Boiler and Pressure Vessel Committee.

The Committee's function is to establish rules of safety governing the design, fabrication, and inspection during construction of boilers and pressure vessels, and to interpret these rules when questions arise regarding their intent. In formulating the rules, the Committee considers the needs of users, manufacturers, and inspectors of pressure vessels. The objective of the rules is to afford reasonably certain protection of life and property and to provide a margin for deterioration in service so as to give a reasonably long, safe period of usefulness. Advancements in design and material and the evidence of experience have been recognized.

The Boiler and Pressure Vessel Committee deals with the care and inspection of boilers and pressure vessels in service only to the extent of providing suggested rules of good practice as an aid to owners and their inspectors.

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 Boiler and Pressure Vessel Committee meets regularly to consider revisions of the rules, new rules as dictated by technological development, Code Cases, and requests for interpretations. Requests for interpretation must be addressed to the Secretary in writing and must give full particulars in order to receive consideration and a written interpretation (see Mandatory Appendix covering preparation of technical inquiries). Proposed revisions to the Code resulting from inquiries will be presented to the Main Committee for appropriate action. The action of the Main Committee becomes effective only after confirmation by letter 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 and published in *Mechanical Engineering* to invite comments from all interested persons. After the allotted time for public review and final approval by ASME, revisions are published annually in Addenda to the Code.

Code Cases may be used in the construction of components to be stamped with the ASME Code symbol beginning with the date of their approval by ASME.

After Code revisions are approved by ASME, they may be used beginning with the date of issuance shown on the Addenda. Revisions become mandatory as minimum requirements six months after such date of issuance, except for boilers or pressure vessels contracted for prior to the end of the six-month period.

Manufacturers and users of components are cautioned against making use of revisions and Cases that are less restrictive than former requirements without having assurance that they have been accepted by the proper authorities in the jurisdiction where the component is to be installed.

Each state and municipality in the United States and each province in Canada that adopts or accepts one or more Sections of the Boiler and Pressure Vessel Code is invited to appoint a representative to act on the Conference Committee to the Boiler and Pressure Vessel Committee. Since the members of the Conference Committee are in active contact with the administration and enforcement of the rules, the requirements for inspection in this Code correspond with those in effect in their respective jurisdictions. The required qualifications for an Authorized Inspector under these rules may be obtained from the administrative authority of any state, municipality, or province which has adopted these rules.

The Boiler and Pressure Vessel Committee in the formulation of its rules and in the establishment of maximum design and operating pressures considers materials, construction, methods of fabrication, inspection, and safety devices. Permission may be granted to regulatory bodies and organizations publishing safety standards to use a complete Section of the Code

by reference. If usage of a Section, such as Section IX, involves exceptions, omissions, or changes in provisions, the intent of the Code might not be attained.

Where a state or other regulatory body, in the printing of any Section of the Boiler and Pressure Vessel Code, makes additions or omissions, it is recommended that such changes be clearly indicated.

The National Board of Boiler and Pressure Vessel Inspectors is composed of chief inspectors of states and municipalities in the United States and of provinces in Canada that have adopted the Boiler and Pressure Vessel Code. This Board, since its organization in 1919, has functioned to uniformly administer and enforce the rules of the Boiler and Pressure Vessel Code. The cooperation of that organization with the Boiler and Pressure Vessel Committee has been extremely helpful.

It should be pointed out that the state or municipality where the Boiler and Pressure Vessel Code has been made effective has definite jurisdiction over any particular installation. Inquiries dealing with problems of local character should be directed to the proper authority of such state or municipality. States, provinces, municipalities, or other regulatory bodies may, if there is any question or doubt as to the proper interpretation, refer the question to the Boiler and Pressure Vessel Committee.

The Specifications for base materials given in Section II, Parts A and B, are identical with or similar to those of The American Society for Testing and Materials. When reference is made in an ASME Material Specification to an ASTM Specification for which a companion ASME Specification exists, the reference shall be interpreted as applying to the ASME Material Specification. Specifications for welding materials given in Section II, Part C, are identical with or similar to those of the American Welding Society. Not all materials included in the ASME Material Specifications in Section II have been adopted for Code use. Usage is limited to those materials and grades adopted by at least one

of the other Sections of the Code for application under rules of that Section. All materials allowed by these various Sections and used for construction within the scope of their rules shall be furnished in accordance with ASME Material Specifications contained in Section II except where otherwise provided in Code Cases or in the applicable Section of the Code. Materials covered by these Specifications are acceptable for use in items covered by the Code Sections only to the degree indicated in the applicable Section. Materials for Code use should preferably be ordered, produced, and documented on this basis; however, material produced under an ASTM Specification may be used in lieu of the corresponding ASME Specification, provided the requirements of the ASTM Specification are identical (excluding editorial differences) or more stringent than the ASME Specification for the Grade, Class, or Type produced and provided that the material is confirmed as complying with the ASTM Specification. Material produced to an ASTM specification with requirements different from the requirements of the corresponding ASME Specification may also be used in accordance with the above, provided the material manufacturer or vessel manufacturer certifies with evidence acceptable to the Authorized Inspector that the corresponding ASME Specification requirements have been met. Material produced to an ASME or ASTM Material Specification is not limited as to country of origin.

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.

Publication of the SI (Metric) Edition of the ASME Boiler and Pressure Vessel Code was discontinued with the 1986 Edition. Effective October 1, 1986, the SI Edition was withdrawn as an ASME Boiler and Pressure Vessel Code document.

# STATEMENT OF POLICY ON THE USE OF CODE SYMBOLS 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 Code Symbols for marking items or constructions which 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 Code Symbols for the benefit of the users, the enforcement jurisdictions, and the holders of the symbols who comply with all requirements.

Based on these objectives, the following policy has been established on the usage in advertising of facsimiles of the symbols, 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 which might so indicate. An organization holding a Code Symbol 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."

The ASME Symbol 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 a Code Symbol who may also use the facsimile in advertising to show that clearly specified items will carry the symbol. General usage is permitted only when all of a manufacturer's items are constructed under the rules.

# 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 official Code Symbol Stamp described in the governing Section of the Code.

Markings such as "ASME," "ASME Standard," or any other marking including "ASME" or the various Code Symbols shall not be used on any item which 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 which 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.

Currently in preview, click buy full version

# PERSONNEL

## ASME Boiler and Pressure Vessel Committee

### Subcommittees, Subgroups, and Working Groups

As of December 31, 1988

#### MAIN COMMITTEE

W. R. Mikesell, <i>Chairman</i>	G. G. Karcher
R. J. Cepluch, <i>Vice Chairman</i>	E. C. Kistner, Jr.
G. M. Eisenberg, <i>Secretary</i>	W. G. Knecht
B. W. Bace	J. R. MacKay
M. D. Bernstein	T. J. Mawson
R. J. Bosnak	T. G. McCarty
M. N. Bressler	D. J. McDonald
D. A. Canonico	U. R. Miller
L. J. Chockie	C. C. Neely
H. F. Dobel	T. E. Northup
W. D. Doty	R. F. O'Neill
J. R. Farr	R. F. Reedy
B. D. Hackney	M. L. Snow, Jr.
W. C. Ham	J. W. Tackett
H. L. Hime	R. E. Feigel, <i>Alternate</i>
M. H. Jawad	

#### HONORS AND AWARDS COMMITTEE

H. F. Dobel, <i>Chairman</i>	R. C. Hudson
G. M. Eisenberg, <i>Secretary</i>	M. H. Jawad
J. R. Farr	E. C. Kistner, Jr.
C. E. Ford	E. G. Nisbett
G. E. Fratcher	R. K. Sager, Jr.
W. L. Garvin	J. W. Tackett
O. F. Hedden	

#### EXECUTIVE COMMITTEE (MAIN COMMITTEE)

R. J. Cepluch, <i>Chairman</i>	C. E. Ford
W. R. Mikesell, <i>Vice Chairman</i>	B. D. Hackney
G. M. Eisenberg, <i>Secretary</i>	E. C. Kistner, Jr.
R. J. Bosnak	H. A. Manning
L. J. Chockie	D. J. McDonald
J. R. Farr	R. F. Reedy

#### HONORARY MEMBERS (MAIN COMMITTEE)

J. D. Andrew, Jr.	E. L. Kemmler
R. D. Bonner	E. M. Kloebler
P. M. Brister	J. E. Lattan
H. M. Canavan	J. LeCoff
J. S. Clarke	F. N. Moschini
W. E. Cooper	C. E. Rawlins
G. E. Fratcher	W. R. Smith, Sr.
R. M. Gibson	W. E. Somers
R. C. Griffin	D. B. Wesstrom
W. L. Harding	F. S. G. Williams
E. J. Hemzy	L. P. Zick

#### MARINE CONFERENCE GROUP

J. Tiratto, <i>Chairman</i>	G. C. Johnson
C. F. Banks	E. F. Murphy
V. W. Bugg	

#### CONFERENCE COMMITTEE

M. L. Snow, Jr. — Tennessee <i>(Chairman)</i>	J. T. Little — Arizona
D. J. McDonald — National Board of Boiler and Pressure Vessel Inspectors <i>(Secretary)</i>	B. M. Lovelady — Memphis and Shelby County, Tennessee
D. C. Barnett, Jr. — Florida	C. C. Mann — New Orleans, Louisiana
D. E. Beaner — Pennsylvania	R. J. Mannion — New Hampshire
G. Black — Washington	S. M. Matthews — Texas
V. Bogosian — Illinois	I. W. Mault — Manitoba, Canada
E. Brandt — Los Angeles, California	H. T. McEwen — Mississippi
J. E. Brennan — Ohio	A. W. Meiring — Indiana
W. E. Brown — Kansas	E. E. Morgan — Colorado
N. B. Burkheimer — Maryland	J. W. Morvant — Louisiana
R. D. Cather — Alaska	R. F. Mullaney — Vancouver, Canada
A. Colvin, Jr. — Washington, D.C.	D. Newquist — Nebraska
R. A. Coomes — Kentucky	R. D. O'Connor — Connecticut
Z. C. Cordero — Michigan	H. Parker, Jr. — Nevada
J. G. Cvar — Delaware	J. C. Parsell — Utah
A. W. Diamond — Newfoundland, Canada	R. D. Reetz — North Dakota
M. H. Diehl, Jr. — Maryland	R. Sauve — Quebec, Canada
F. G. Dolen — New Jersey	M. Shuff — West Virginia
C. R. Erickson — California	J. L. Smith — Alberta, Canada
E. Everett — Georgia	R. P. Sullivan — Maine
J. J. Fowles — New Brunswick, Canada	N. Surtees — Saskatchewan, Canada
J. W. Greenawalt, Jr. — Oklahoma	C. W. Thompson — Arkansas
S. L. Hall — North Carolina	M. W. A. West — Prince Edward Island, Canada
V. Harding — Hawaii	R. B. West — Iowa
J. Hicks — Virginia	M. J. Wheel — Vermont
C. Hinson — Oregon	R. K. White — New York
J. D. Hoh — Missouri	T. F. Wickham — Rhode Island
W. J. Holmes — Chicago, Illinois	H. J. Wright — Ontario, Canada
R. M. Johnson — California	R. A. Yeo — Nova Scotia, Canada
A. Justin — Minnesota	
V. Kanable — Wisconsin	
G. M. Kuetemeyer — Milwaukee, Wisconsin	

**SUBCOMMITTEE ON POWER BOILERS (SC I)**

E. C. Kistner, Jr., <i>Chairman</i>	W. T. Higginbotham
J. R. MacKay, <i>Vice Chairman</i>	R. Leone
M. E. Sheehan, <i>Secretary</i>	W. L. Lowry, Jr.
S. G. Bankar	R. F. Manning
D. L. Berger	M. Mattina
M. D. Bernstein	R. G. Presnak
D. A. Canonico	R. D. Schueler, Jr.
A. R. Faulkner	R. L. Williams
D. N. French	R. A. Yeo
F. R. Gerety	L. W. Yoder

**Subgroup on Care of Power Boilers (SC I)**

W. T. Higginbotham, <i>Chairman</i>	C. R. Hoefs
C. J. Berg	E. A. Holden
H. F. Dobel	E. C. Kistner, Jr.
D. O. Downey	D. J. McDonald
W. Hall	R. A. Yeo
R. R. Hess	J. R. Zahorsky

**Subgroup on Piping (SC I)**

R. L. Williams, <i>Chairman</i>	R. R. Hess
F. R. Gerety, <i>Secretary</i>	W. L. Lowry, Jr.
D. L. Berger	T. C. McGough
M. D. Bernstein	R. G. Presnak
A. J. Breugelmans	L. J. Sas
A. R. Faulkner	L. W. Yoder
W. Hall	

**Subgroup on Design (SC I)**

R. D. Schueler, Jr., <i>Chairman</i>	R. Leone
R. F. Manning, <i>Vice Chairman</i>	K. C. Morrison
R. V. Wielgoszinski, <i>Secretary</i>	A. Nassif
M. D. Bernstein	D. R. Palmer
M. A. Farrugia	C. H. Walters
W. R. Hankins	R. A. Yeo
G. L. Kasparian	

**Subgroup on Materials (SC I)**

A. R. Faulkner, <i>Chairman</i>	D. N. French
S. G. Bankar	J. S. Hunter
D. A. Canonico	J. M. Tanzosh

**Subgroup on General Requirements (SC I)**

M. D. Bernstein, <i>Chairman</i>	J. T. Pillow
F. R. Gerety, <i>Secretary</i>	W. E. Somers
R. R. Hess	C. H. Walters
R. Leone	R. L. Williams
W. L. Lowry, Jr.	R. A. Yeo
T. C. McGough	L. W. Yoder

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

R. Leone, <i>Chairman</i>	W. T. Higginbotham
D. L. Berger, <i>Secretary</i>	J. S. Kandola
S. G. Bankar	J. T. Pillow
D. N. French	R. D. Schueler, Jr.
J. Hainsworth	R. V. Wielgoszinski
W. Hall	

**SUBCOMMITTEE ON MATERIALS SPECIFICATIONS (SC II)**

J. P. Millman, <i>Secretary</i>	R. A. Moen
A. Cohen	E. G. Nisbett
W. D. Edsall	W. R. Sylvester
M. Gold	J. W. Tackett
G. C. Hsu	E. O. Woolridge
E. I. Landerman	A. W. Zeuthen
W. A. McRoberts	

**Subgroup on Steel Plates (SC II)**

A. W. Zeuthen, <i>Chairman</i>	P. R. Slimmon
W. D. Edsall	J. M. Tanzosh
J. F. Longenecker	E. O. Woolridge

**Subgroup on Steel Tubular Products (SC II)**

W. R. Sylvester, <i>Chairman</i>	R. P. Meineke
E. A. Jonas	E. J. Rozic, Jr.
W. C. Mack	R. H. Zong

**Subgroup on Steel Castings, Forgings, and Boltings (SC II)**

E. G. Nisbett, <i>Chairman</i>	E. I. Landerman
R. F. Cappellini	W. A. McRoberts
B. M. Dingman	E. O. Woolridge
T. Graham	

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

G. C. Hsu, <i>Chairman</i>	W. R. Keaney
J. W. Tackett, <i>Secretary</i>	A. P. Seidler
A. Cohen	R. T. Webster
B. B. Hood	M. J. Weiss

**SUBCOMMITTEE ON NUCLEAR POWER (SC III)**

R. F. Reedy, <i>Chairman</i>	W. C. Ham
E. F. Gerwin, <i>Vice Chairman</i>	W. G. Knecht
K. Ennis, <i>Secretary</i>	D. F. Landers
J. R. Barbee	J. Lang
R. W. Barnes	H. A. Manning
R. J. Bosnak	W. N. McLean
E. B. Branch	C. A. Moore
M. N. Bressler	T. E. Northup
L. J. Chockie	W. R. Smith, Sr.
J. B. Christofferson	M. F. Sullivan
R. L. Dick	R. P. Sullivan
H. F. Dobel	S. W. Tagart, Jr.
W. D. Doty	R. E. Tome
F. R. Drahos	

**Subgroup on General Requirements (SC III & 3C)**

H. F. Dobel, <i>Co-Chairman</i>	M. J. Meyer
J. R. Barbee	A. J. Moellenbeck
R. B. Bremmer	R. E. Muise
E. F. Gerwin	L. C. Oakes
K. R. Hooks	M. F. Sullivan
R. D. Kulchak	R. P. Sullivan
M. Malloy	G. M. Tolson

**Special Working Group on Dynamic Analysis (SG-D) (SC III)**

R. Wray, <i>Chairman</i>	A. E. Meligi
M. K. Au-Yang	B. J. Mitchell
R. D. Blevins	T. M. Mulcahy
G. J. Bohm	S. W. Tagart, Jr.
P.-Y. Chen	J. N. Underwood
A. H. Hadjian	J. Wallach

**Working Group on Quality Assurance (SG-GR) (SC III & 3C)**

R. D. Kulchak, <i>Co-Chairman</i>	J. D. Lenardson
R. C. Arthurs	M. J. Meyer
J. N. Babcock, Jr.	R. E. Muise
J. R. Barbee	G. C. Pratt
J. V. Bosco	R. Siever
R. B. Bremmer	S. A. Sparacino
B. W. Burak	J. F. Strunk
J. G. Harkness	M. F. Sullivan
K. R. Hooks	G. M. Tolson

**Special Working Group on Faulted Conditions (SG-D) (SC III)**

G. J. Bohm, <i>Chairman</i>	D. P. Munson
P. L. Anderson	P. R. Olson
C. W. Bruny	R. F. Perry
G. Bushnell	W. Pink
M. Hartzman	J. Wallach

**Working Group on Duties and Responsibilities (SG-GR) (SC III & 3C)**

A. J. Moellenbeck, <i>Chairman</i>	A. S. Laurenson
J. E. Ayotte	J. R. Luke
J. E. Crowe	B. D. Rall
A. C. Eberhardt	R. T. Rose
R. C. Howard	W. K. Sowder
D. R. Kulla	R. E. Weber

**Working Group on Vessels (SG-D) (SC III)**

G. D. Cooper, <i>Chairman</i>	R. W. Mikitka
C. W. Bruny	C. A. Moore
N. W. Edwards	P. P. Raju
J. F. Finn, Jr.	H. S. Thornton
F. P. Hill, Jr.	R. E. Tome
A. Merend	A. Walsenko

**Working Group on Data Report Forms (SG-GR) (SC III & 3C)**

R. E. Muise, <i>Chairman</i>	B. W. Burak
C. W. Allison	W. K. Sowder
R. C. Arthurs	M. F. Sullivan
J. N. Babcock, Jr.	

**Working Group on Piping (SG-D) (SC III)**

G. C. Slagis, <i>Chairman</i>	D. F. Landers
S. Gils	S. E. Moore
A. B. Glickstein	E. D. Mysinger
D. J. Guzy	E. C. Rodabaugh
R. W. Haupt	M. S. Sills
R. S. Hill III	E. O. Swain
R. B. Jenkins	L. E. Wright
M. Z. Khlafallah	M. P. Zyne
G. T. Kitz	

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

W. G. Knecht, <i>Chairman</i>	W. N. McLean
C. W. Allison	W. A. McRoberts
W. H. Borter	R. A. Moen
B. G. Carlton	K. E. Moore
F. R. Drahos	D. A. Olsson
G. B. Georgiev	C. J. Pieper
E. F. Gerwin	R. E. Schuessler
R. M. Hanschka	H. A. Sepp, Jr.
J. E. Harris	N. M. Simpson
R. W. Jackson	W. J. Sperko
R. M. Jessee	A. Taboada
E. I. Landerman	R. E. Tschirch
J. Lang	E. H. Williams
J. F. Longenecker	

**Working Group on Pumps (SG-D) (SC III)**

D. B. Nickerson, <i>Chairman</i>	D. R. Hyatt
C. S. Boster	D. M. Kitch
H. L. Brammer	P. J. Nagengast
R. B. Camper	J. J. Ranft
F. P. Colon	H. Taffarodi
D. L. Cummings	J. H. Wawrzoniak

**Subgroup on Design (SC III)**

C. A. Moore, <i>Chairman</i>	D. F. Landers
R. W. Barnes, <i>Secretary</i>	W. N. McLean
E. B. Branch	R. W. Mikitka
M. N. Bressler	E. C. Rodabaugh
W. G. Brussalis, Jr.	B. L. Silverblatt
G. D. Cooper	G. C. Slagis
N. W. Edwards	J. D. Stevenson
W. F. English, Jr.	J. H. Wawrzoniak
F. P. Hill, Jr.	K. R. Wichman

**Working Group on Valves (SG-D) (SC III)**

W. N. McLean, <i>Chairman</i>	J. J. McGavin
R. R. Brodin	H. R. Sonderegger
J. M. Cowley	J. C. Tsacoyeanes
R. J. Kiessel	R. G. Visalli
W. G. Knecht	J. R. Zahorsky
R. Koester	

**Working Group on Component Supports (SG-D) (SC III)**

M. N. Bressler, <i>Chairman</i>	R. J. Masterson
J. M. Benenati	A. E. Meligi
R. D. Ciatto	E. D. Mysinger
J. R. Cole	A. Nguyen
R. P. Deubler	H. Noreen, Jr.
R. W. Haupt	G. M. Quinn
H. T. H. Hui	C. L. Ray, Jr.
T. Karppinen	H. K. Shaw
Z. A. Kravets	E. O. Swain
T. C. LaCroix	M. P. Zyne
A. S. Laurenson	

**Working Group on Core Support Structures (SG-D) (SC III)**

B. L. Silverblatt, <i>Chairman</i>	J. F. Mullooly
T. Vetter, Jr., <i>Secretary</i>	E. Steinkamp
W. F. English, Jr.	

**Working Group on FRP Pipe (SG-D) (SC III)**

L. Loziuk, <i>Chairman</i>	A. B. Glickstein
F. R. Gerety	

**Subgroup on Pressure Relief (SC III)**

F. C. Cherny, <i>Chairman</i>	S. F. Harrison, Jr.
R. A. Cedel	H. Honig
J. J. Chappell	K. Ijzerman
R. J. Doelling	D. Kadakia
W. D. Greenlaw	D. M. Pattarini

**Subgroup on Elevated Temperature Construction (SC III)**

A. W. Dalcher, <i>Chairman</i>	M. T. Jakub
J. M. Tanzosh, <i>Secretary</i>	R. M. Mello
C. C. Bigelow	V. Regis

**Subgroup on Containment Systems for Spent Fuel and High Level Waste Transport Packagings (SC III)**

E. F. Gerwin, <i>Chairman</i>	J. V. Massey
K. B. Sorenson, <i>Secretary</i>	R. E. Nickell
W. H. Brinkman	W. H. Rogers, Jr.
H. H. Chung	J. Santucci
K. Goldmann	W. W. Teper
R. T. Haelsig	T. C. Thompson
B. B. Hood	C. H. Walters
R. H. Jones	S. Yukawa
R. W. Lambert	

**Working Group on General Requirements (SG-NUPACK) (SC III)**

K. Goldman, <i>Chairman</i>	D. L. Tevis
J. V. Massey	

**Working Group on Material (SG-NUPACK) (SC III)**

S. Yukawa, <i>Chairman</i>	J. G. Merkle
T. J. Griesbach	M. W. Schwartz
B. B. Hood	F. A. Simonen
J. T. Martin	K. B. Sorrenson
P. McConnell	M. P. Walsh

**Working Group on Design (SG-NUPACK) (SC III)**

D. G. Abbott	W. W. Teper
M. E. Balmert	T. C. Thompson
A. G. Eggers	H. H. Woo
R. E. Nickell	

**Working Group on Fabrication and Examination (SG-NUPACK) (SC III)**

W. H. Brinkman, *Chairman*

**JOINT ACI-ASME COMMITTEE ON CONCRETE COMPONENTS FOR NUCLEAR SERVICE (SC-3C)**

J. P. Allen III, <i>Chairman</i>	R. D. Kulchak
J. Karian, <i>Secretary</i>	D. Marano
J. F. Artuso	D. P. Moore
R. M. Attar	R. G. Oesterle
T. M. Brown	F. Rinaldi
B. A. Erler	B. B. Scott
D. J. Haavik	C. P. Siess
T. E. Johnson	J. D. Stevenson
F. W. Joyce	R. N. White

**Subgroup on Materials, Construction, and Examination (SC-3C)**

D. J. Haavik, <i>Chairman</i>	J. Gutierrez
J. P. Allen III	F. W. Joyce
J. F. Artuso	D. Marano
R. M. Attar	D. P. Moore
J. E. Barry	G. R. Murphy
J. F. Best	H. Nierlich
S. Bhuyan	L. C. Noriega
G. L. Fisher	S. K. Sen
C. L. Grover	

**Working Group on Concrete Inspectors Qualifications (SG-M, C, & E) (SC-3C)**

F. W. Joyce, <i>Chairman</i>	R. J. Vurpillat
J. F. Artuso	R. E. Wilson
C. E. Jaycox	

**Subgroup on Design (SC-3C)**

B. B. Scott, <i>Chairman</i>	F. S. Ople, Jr.
T. M. Brown	F. Rinaldi
L. I. Cheng	R. E. Shewmaker
J. F. Fulton	J. D. Stevenson
T. E. Johnson	A. Walser
R. G. Oesterle	M. J. Holley, Jr., Observer

**Working Group on Testing and Protection Against Overpressure (SG-D) (SC-3C)**

T. M. Brown, <i>Chairman</i>	H. T. Hill
S. Guha-Majumdar	N. J. Tuholski

**Subgroup on Core Support Structures (SC-3C)**

R. Vollman	G. T. Yahr
------------	------------

**SUBCOMMITTEE ON HEATING BOILERS (SC IV)**

T. H. Milton, <i>Chairman</i>	M. Mattina
F. P. Barton, <i>Vice Chairman</i>	K. McTague
K. I. Baron, <i>Secretary</i>	R. I. Mullican
J. E. Ayotte	E. A. Nordstrom
R. B. Duggan	S. V. Voorhees
G. E. Fratcher	C. H. Walters
J. W. Greenawalt, Jr.	R. H. Weigel
W. L. Haag	J. I. Woodworth
G. L. Kasparian	

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

J. I. Woodworth, <i>Chairman</i>	W. D. Hayen
F. P. Barton	K. McTague
W. H. Dormer, Jr.	R. H. Weigel
J. Giambrone	

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

G. E. Fratcher, <i>Chairman</i>	G. R. Lewis
F. P. Barton	K. McTague
W. L. Garvin	E. A. Nordstrom
J. W. Greenawalt, Jr.	C. W. Staats
W. L. Haag	K. J. Szigety
B. Klinke	E. Wenczl

**Subgroup on Cast Iron Boilers (SC IV)**

K. McTague, <i>Chairman</i>	R. H. Weigel
R. B. Duggan	J. I. Woodworth
W. L. Garvin	

**SUBCOMMITTEE ON NONDESTRUCTIVE EXAMINATION (SC V)**

J. R. MacKay, <i>Chairman</i>	G. W. Hembree
R. C. Hudson, <i>Vice Chairman</i>	P. J. Herbert
G. P. Mancini, <i>Secretary</i>	E. T. Hughes
A. S. Birks	B. C. Jersild
J. B. Christofferson	R. M. Jessee
B. H. Clark, Jr.	F. B. Kovacs
J. G. Cvar	S. Markowitz
L. T. Detlor	T. G. McCarty
B. E. Foster	W. C. McGaughey
H. C. Graber	J. P. Sunukjian
O. F. Hedden	D. A. White

**Subgroup on Radiography (SC V)**

T. G. McCarty, <i>Chairman</i>	B. C. Jersild
W. L. Bierwirth	C. Johnson
L. T. Detlor	F. B. Kovacs
B. E. Foster	S. Markowitz

**Subgroup on Ultrasonics (SC V)**

P. J. Herbert, <i>Chairman</i>	R. W. McClung
N. O. Cross	W. C. McGaughey
O. F. Hedden	R. Paillaman
W. T. Higginbotham	F. J. Sattler
E. T. Hughes	J. C. Spanner, Sr.
J. F. Manning	F. R. A. Turner

**Subgroup on Acoustic Emission (SC V)**

D. A. White, <i>Chairman</i>	J. F. Manning
B. H. Clark, Jr.	J. R. Mitchell
N. O. Cross	J. M. Nieters
P. M. Horrigan	J. C. Spanner, Sr.

**Subgroup on General Requirements and Surface Examination (SC V)**

H. C. Graber, <i>Chairman</i>	B. H. Clark, Jr.
A. S. Birks	J. G. Cvar
W. G. Blankenship	R. M. Jessee
A. S. Britton	L. C. Ludwig
J. O. Brown	R. McGuire
J. B. Christofferson	J. P. Sunukjian

**SUBCOMMITTEE ON PRESSURE VESSELS (SC VIII)**

J. R. Farr, <i>Chairman</i>	R. W. Mikitka
R. J. Cephuch, <i>Vice Chairman</i>	U. R. Miller
A. J. Roby, <i>Secretary</i>	E. E. Morgeneegg
A. P. Ahrendt	C. C. Neely
J. O. Brown	R. F. O'Neill
S. M. Caldwell	F. O. Parnkopf
W. J. Carter	A. Selz
S. C. Cyr	A. M. Smolen
R. E. Feigel	D. A. Staskelunas
G. E. Fratcher	E. A. Steen
W. L. Garvin	J. J. Szigety
B. D. Hackney	J. W. Tackett
H. L. Hime	K. K. Tam
M. H. Jawad	E. L. Thomas, Jr.
G. G. Karcher	J. S. Brzuszkiewicz, Staff Representative
J. LeCoff	
S. M. Matthews	

**Special Working Group on Heat Transfer Equipment (SC VIII)**

J. H. Kissel, <i>Chairman</i>	G. G. Karcher
U. R. Miller, <i>Vice Chairman</i>	A. Lohmeier
H. A. Schmidt, Jr., <i>Secretary</i>	A. P. Rochino
C. F. Andreone	J. E. Soehrens
D. E. Bolt	A. I. Soler
G. Borushko	W. A. Treff
S. M. Caldwell	S. Yokell
T. K. Haldas	

**Special Working Group on High Pressure Vessels (SC VIII)**

J. R. Sims, Jr., <i>Chairman</i>	G. J. Mraz
M. E. Sheehan, <i>Secretary</i>	E. G. Nisbett
D. J. Burns	L. Ohlsson
C. M. Elwonger	E. R. Sliwinski
R. G. Fasiczka	A. M. Smolen
R. E. Feigel	J. F. Sullivan
D. M. Fryer	F. W. Tatar
J. F. Harvey	D. A. Wells
D. P. Kendall	

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

C. C. Neely, <i>Chairman</i>	P. M. Nightengale
R. E. Tillberg, <i>Secretary</i>	A. S. Olivares
A. P. Ahrendt	A. M. Smolen
W. J. Carter	A. J. Spencer
W. L. Garvin	D. A. Staskelunas
C. R. Good	E. A. Steen
S. M. Matthews	W. J. Stuber

**Subgroup on Materials (SC VIII)**

J. W. Tackett, <i>Chairman</i>	E. G. Nisbett
H. L. Hime, <i>Secretary</i>	D. W. Rahoi
W. D. Doty	K. K. Tam
J. Hainsworth	D. A. Wells
J. D. McLoughlin	

**Subgroup on Design (SC VIII)**

R. F. O'Neill, <i>Chairman</i>	R. W. Mikitka
R. E. Knoblock, <i>Secretary</i>	U. R. Miller
M. R. Bauman	K. Mokhtarian
J. R. Farr	A. Selz
J. A. Hayward	J. W. Stokes
J. L. Jacobowitz	K. K. Tam
M. H. Jawad	E. L. Thomas, Jr.
G. G. Karcher	

**Working Group on Noncircular Vessels (SG-D) (SC VIII)**

A. Selz, <i>Chairman</i>	A. M. Smolen
G. Ganeshan	B. K. Thakur
H. E. Gordon	E. L. Thomas, Jr.
P. M. Nightengale	J. L. Urner
R. K. Rothenbucher	S. V. Voorhees
K. V. Shipes	

**Subgroup on Fabrication and Inspection (SC VIII)**

J. O. Brown, <i>Chairman</i>	M. J. Houle
R. F. O'Neill, <i>Secretary</i>	H. Lewis, Jr.
G. Bibel	F. O. Parnkopf
R. W. Boyce	H. C. Rauschenplat
S. C. Cyr	R. E. Schuessler
R. E. Feigel	J. J. Szigety
H. B. France	R. F. Wagner

**Working Group on Layered Vessels (SGFI) (SC VIII)**

F. O. Parnkopf, <i>Chairman</i>	J. L. Jacobowitz
A. M. Smolen, <i>Secretary</i>	H. C. Rauschenplat
S. M. Caldwell	M. A. Tracy
G. E. Fratcher	

**SUBCOMMITTEE ON WELDING (SC IX)**

B. D. Hackney, <i>Chairman</i>	B. R. Newmark
R. K. Sager, <i>Vice Chairman</i>	P. P. Norris
P. D. Stumpf, <i>Secretary</i>	S. D. Reynolds, Jr.
B. L. Alia	B. S. Russell
M. L. Carpenter	W. K. Scattergood
H. R. W. Cobb	J. L. Smith
H. R. Conaway	W. J. Sperko
W. D. Doty	G. W. Spohn III
J. G. Feldstein	D. J. Stull
P. D. Flenner	K. C. Taber
M. J. Houle	D. L. Tevis
R. A. LaPointe	R. R. Young
R. E. Lorentz, Jr.	J. B. Christofferson, <i>Alternate</i>
R. P. Meineke	W. J. Wagner, <i>Alternate</i>
A. H. Miller	

**Subgroup on Materials (SC IX)**

R. E. Lorentz, Jr., <i>Chairman</i>	R. K. Sager
M. L. Carpenter	C. E. Spaeder
H. R. Conaway	W. J. Sperko
M. V. Davis	K. C. Taber
P. D. Flenner	J. W. Tackett
R. M. Jessee	R. R. Young
A. H. Miller	

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

B. R. Newmark, <i>Chairman</i>	J. L. Smith
M. V. Davis	A. J. Spencer
R. M. Jessee	K. C. Taber
R. P. Meineke	C. E. Wainwright
A. S. Olivares	

**Subgroup on Procedure Qualification (SC IX)**

M. J. Houle, <i>Chairman</i>	A. H. Miller
B. L. Alia	S. D. Reynolds, Jr.
R. K. Brown, Jr.	D. E. Smith
H. R. W. Cobb	W. J. Sperko
J. G. Feldstein	

**Subgroup on Performance Qualification (SC IX)**

M. J. Houle, <i>Chairman</i>	P. P. Norris
D. A. Bowers, Jr.	W. K. Scattergood
J. B. Christofferson	G. W. Spohn III
P. D. Flenner	D. L. Tevis
R. A. LaPointe	W. J. Wagner

**Subgroup on Brazing (SC IX)**

M. L. Carpenter, <i>Chairman</i>	A. H. Miller
R. A. LaPointe	J. Serre

**SUBCOMMITTEE ON REINFORCED PLASTIC PRESSURE VESSELS (SC X)**

D. M. Bertelsman, <i>Chairman</i>	L. E. Hunt
J. Yarmush, <i>Secretary</i>	W. J. Johns
D. H. Barton	J. A. Kidd
J. H. Bouchard	F. R. Pflederer
L. C. Daniels	J. A. Rolston
T. J. Fowler	A. I. Snyder
S. V. Hoa	C. H. Walters

**SUBCOMMITTEE ON NUCLEAR INSERVICE INSPECTION  
(SC XI)**

S. H. Bush, <i>Chairman</i>	R. C. Howard
K. I. Baron, <i>Secretary</i>	L. R. Katz
C. W. Allison	R. D. Kerr
W. F. Anderson	J. J. Lance
A. C. Ashton	J. Matte III
W. H. Bamford	T. J. Mawson
R. L. Beverly	G. C. Millman
A. J. Birkle	R. E. Muise
L. J. Chockie	T. G. Parker
D. C. Cowfer	G. J. Pitzl
M. J. Crisler	R. L. Powers
D. D. Davis	P. C. Riccardella
E. A. DeBarba	R. F. Sammataro
A. M. DiBiasio	M. L. Snow, Jr.
F. E. Gregor	R. W. Swayne
L. B. Gross	R. J. Tamminga
R. H. Hansen	J. C. Tobin
O. F. Hedden	S. D. Weinman, Staff Representative
H. T. Hill	
J. P. Houstrup	

**Special Working Group on Plant Life Extension (SC XI)**

L. R. Katz, <i>Chairman</i>	J. T. McCumber
L. B. Gross, <i>Secretary</i>	H. McShane
T. L. Bailey	E. A. Merrick
A. J. Birkle	D. R. Payne
L. D. Bustard	D. A. Piccione
D. D. Davis	D. Sattar
T. M. Erwin	W. B. Scott
W. L. Garvin	V. N. Shah
F. E. Gregor	E. A. Siegel
B. Gutherman	P. P. Stancavage
D. L. Harrison	A. Taboada
D. R. Hostetler	R. J. Tamminga
J. P. Houstrup	L. B. Tittle
R. C. Howard	S. A. Traiforos
M. E. Lapides	

**Special Working Group on Core Supports (SC XI)**

J. C. Tobin, <i>Chairman</i>	J. J. Lance
H. Behnke	R. A. Moen
S. Chandra	J. F. Mullooly
R. M. Gribble	B. L. Silverblatt
E. T. Ishizaka	E. Steinkamp

**Special Working Group on Pipe Wall Thinning (SC XI)**

S. H. Bush, <i>Chairman</i>	P. C. Riccardella
V. K. Chexal	J. C. Rivers
T. N. Epps III	J. C. Spanner, Jr.
T. L. Gerber	A. Taboada
J. P. Houstrup	R. J. Tamminga
D. S. Kerr	P. C. S. Woo

**Special Working Group on Pressure Testing (SC XI)**

R. C. Howard, <i>Chairman</i>	C. E. Jensen
M. P. Lintz, <i>Secretary</i>	S. Ranganath
E. D. Crane	F. J. Schaaf, Jr.
R. M. Gamble	J. H. Uhl
S. R. Gosselin	R. A. Yonekawa

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

R. L. Beverly, <i>Chairman</i>	M. P. Lintz
A. L. Bradshaw	J. E. Staffiera
L. B. Gross	R. W. Swayne
V. H. Hight	

**Subgroup on Water-Cooled Systems (SC XI)**

A. J. Birkle, <i>Chairman</i>	G. C. Millman
T. F. Lentz, <i>Secretary</i>	C. V. Moore
C. W. Allison	R. L. Powers
W. F. Anderson	L. Sage
A. C. Ashton	M. L. Snow, Jr.
D. D. Davis	R. J. Tamminga
L. B. Gross	F. Tehranchi
T. C. Hinkle	D. L. Tevis
C. E. Jensen	J. H. Uhl
L. R. Katz	G. Wasilenko
R. E. Legate	

**Working Group on Component Supports (SG-WCS) (SC XI)**

D. D. Davis, <i>Chairman</i>	L. F. Lake
E. Beffa	G. C. Millman
G. L. Belew	R. L. Powers
G. A. Delp	R. F. Tegethoff
G. P. Knippel	M. P. Zyne
C. N. Krishnaswamy	

**Working Group on General Requirements (SG-WCS) (SC XI)**

R. J. Tamminga, <i>Chairman</i>	L. B. Gross
T. M. Zwick, <i>Secretary</i>	R. H. Hansen
W. F. Anderson	C. E. Hartz
R. G. Edl	R. K. Mattu
J. C. Goulart	D. L. Tevis
D. A. Graham	

**Working Group on Pumps and Valves (SG-WCS) (SC XI)**

C. E. Jensen, <i>Chairman</i>	W. C. Holston
M. P. Lintz, <i>Secretary</i>	R. K. Mattu
A. Cardillo	D. R. Payne
F. C. Cherny	L. Sage
C. E. Hartz	E. V. Werry

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

L. Sage, <i>Chairman</i>	A. A. Koehl
J. C. Rivers, <i>Secretary</i>	T. F. Lentz
A. C. Ashton	M. P. Lintz
E. D. Crane	W. B. Scott
D. A. Gallino	F. Tehranchi
T. C. Hinkle	J. H. Uhl
M. R. Hum	R. J. Von Osinski
C. E. Jensen	

**Subgroup on Gas-Cooled Systems (SC XI)**

R. H. Hansen, *Chairman*

**Subgroup on Liquid-Metal Cooled Systems (SC XI)**

J. Matte III, <i>Chairman</i>	L. R. Monson
C. G. McCarger, <i>Secretary</i>	L. J. Nemeth
W. L. Chase	W. J. Rowan
S. Hattori	G. Seed
R. Hundal	J. C. Tobin
H. C. Jung	T. J. Walker
E. Larson	

**Working Group on Liquid-Metal Reactor Covers (SG-LMCS) (SC XI)**

W. L. Chase, <i>Chairman</i>	E. Larson
L. J. Nemeth, <i>Secretary</i>	J. Matte III
S. Hattori	G. Seed
R. Hundal	

**Subgroup on Containment (SC XI)**

R. F. Sammataro, <i>Chairman</i>	D. R. Pitcairn
J. E. Staffiera, <i>Secretary</i>	C. G. Ranganath
W. J. Briggs	A. J. Spencer
K. K. N. Chao	J. F. Strunk
N. W. Edwards	P. W. Ward
F. E. Gregor	R. N. Watson
H. T. Hill	K. R. Wichman

**Working Group on Concrete Pressure Components (SG-C) (SC XI)**

H. T. Hill, <i>Chairman</i>	J. F. Fulton
W. J. Briggs, <i>Secretary</i>	S. Guha-Majumdar
H. G. Ashar	C. N. Krishnaswamy
T. L. Bradley	C. G. Ranganath
C. A. Byrd	A. M. Salley
K. K. N. Chao	P. W. Ward

**Subgroup on Evaluation Standards (SC XI)**

W. H. Bamford, <i>Chairman</i>	D. M. Norris
J. P. Houstrup, <i>Secretary</i>	S. Ranganath
C. Y. Cheng	P. C. Riccardella
R. C. Cipolla	W. L. Server
T. J. Griesbach	W. A. Van Der Sluys
K. Iida	K. K. Yoon
R. E. Johnson	S. Yukawa
M. Kupinski	

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

T. J. Griesbach, <i>Chairman</i>	M. Kupinski
R. M. Gamble, <i>Secretary</i>	S. D. Leshnoff
A. S. Amar	R. M. Pace
W. F. Anderson	A. G. Panagos
W. H. Bamford	J. S. Panesar
H. Behnke	J. H. Phillips
A. F. Billy	S. W. Pullins
J. M. Bloom	P. N. Randall
R. C. Cipolla	S. Ranganath
W. C. Cliff	W. L. Server
E. Friedman	V. N. Shah
R. B. Ganta	E. A. Siegel
S. R. Gosselin	F. A. Simonen
J. P. Houstrup	G. M. Wilkowski
K. Ijzerman	K. K. Yoon
R. E. Johnson	S. Yukawa

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

R. C. Cipolla, <i>Chairman</i>	D. M. Norris
J. M. Bloom, <i>Secretary</i>	J. S. Panesar
A. S. Amar	P. C. Paris
W. H. Bamford	P. P. Raju
M. Basol	S. Ranganath
C. Y. Cheng	W. L. Server
N. W. Edwards	F. A. Simonen
E. Friedman	G. M. Wilkowski
T. J. Griesbach	J. E. Wilson
J. P. Houstrup	K. K. Yoon
K. Iida	S. Yukawa
M. Kupinski	V. A. Zilberstein
J. G. Merkle	

**Subgroup on Nondestructive Examination (SC XI)**

E. A. DeBarba, <i>Chairman</i>	G. J. Dau
J. C. Spanner, Sr., <i>Secretary</i>	F. J. Dodd
D. C. Adamonis	M. R. Hum
R. L. Beverly	J. J. Lance
D. A. Brunner	C. R. Osman
C. B. Cheezem	T. G. Parker
J. F. Cook	R. J. Scott
D. C. Cowfer	J. C. Spanner, Jr.

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

D. C. Cowfer, <i>Chairman</i>	O. DeMiranda
N. R. Bentley, <i>Secretary</i>	F. J. Dodd
D. C. Adamonis	R. Kellerhall
D. A. Brunner	J. J. Lance
C. B. Cheezem	J. Muscara
W. T. Clayton	M. J. Saporito
G. J. Dau	J. C. Spanner, Jr.
T. N. Epps III	T. T. Taylor

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

J. F. Cook, <i>Chairman</i>	C. R. Osman
V. H. Hight, <i>Secretary</i>	J. M. Ray
J. E. Cavender, Jr.	R. J. Scott
D. R. Dadson	M. F. Sherwin
N. Economos	A. L. Smith
D. O. Henry	J. C. Spanner, Sr.
W. C. Koepke	

**Special Working Group on Eddy Current Examination (SC XI)**

D. O. Henry, <i>Chairman</i>	M. J. Gallagher
B. Curtis, <i>Secretary</i>	R. H. Ingraham
J. M. Benson	J. H. Kang
S. D. Brown	R. J. Kurtz
A. Curtis	R. E. Marlow
C. J. Denton	S. A. Redner
D. R. Dodson	D. D. Weber
R. H. Ferris	

**Subgroup on Repairs and Replacements (SC XI)**

T. J. Mawson, <i>Chairman</i>	R. D. Kerr
M. J. Crisler, <i>Secretary</i>	W. Kooy
E. T. Baker III	R. S. Lewis
J. D. Boardman	R. E. Muise
B. W. Burak	D. R. Payne
J. Derrico	G. J. Pitzl
A. M. DiBiasio	R. R. Stevenson
W. L. Garvin	R. W. Swayne
R. E. Gimple	S. Tobey
O. F. Hedden	J. C. Tobin
R. C. Howard	A. J. Walcutt
E. T. Ishizaka	S. J. Walmsley
W. R. Johnson	R. A. Yonekawa
W. N. Keisler	

**Working Group on Repairs (SG-RR) (SC XI)**

J. Derrico, <i>Chairman</i>	W. N. Keisler
J. D. Boardman	R. D. Kerr
R. W. Boyce	D. R. Pitcairn
R. E. Cantrell	F. J. Schaaf, Jr.
R. F. Hollander	R. W. Swayne
E. T. Ishizaka	S. Tobey

**Special Working Group on Repairs by Welding (SG-RR) (SC XI)**

S. Tobey, <i>Chairman</i>	H. J. Kaplan
M. E. Reese, <i>Secretary</i>	R. A. LaPointe
C. Brookbank	W. E. Mayott
R. E. Cantrell	B. R. Newmark
B. R. Crowley	P. P. Norris
W. V. Gwaltney	D. L. Tevis
M. J. Houle	E. H. Williams
W. R. Johnson	

**Working Group on Replacements (SG-RR) (SC XI)**

A. M. Di Biasio, <i>Chairman</i>	W. Kooy
R. E. Gimple, <i>Secretary</i>	R. E. Legate
E. T. Baker III	G. J. Pitzl
C. E. Hartz	R. R. Stevenson
O. F. Hedden	A. J. Walcutt
W. C. Holston	R. A. Yonekawa
R. C. Howard	

**SUBCOMMITTEE ON PROPERTIES OF METALS (SC-P)**

D. A. Canonico, <i>Chairman</i>	F. Masuyama
J. P. Millman, <i>Secretary</i>	R. A. Moen
A. P. Ahrendt	R. K. Nanstad
T. M. Cullen	A. J. Palmer
W. D. Doty	D. W. Raho
A. R. Faulkner	B. W. Roberts
M. Gold	D. I. Roberts
D. G. Harman	C. E. Spaeder
S. O. Hilton	J. W. Tackett
E. T. Ishizaka	R. T. Webster

**Subgroup on Strength, Ferrous Alloys (SC-P)**

M. Gold, <i>Chairman</i>	S. O. Hilton
A. P. Ahrendt	J. F. Longenecker
D. A. Canonico	R. A. Moen
T. M. Cullen	D. W. Raho
R. M. Curran	B. W. Roberts
R. J. Diletto	D. I. Roberts
J. J. Heger	C. E. Spaeder

**Subgroup on Strength, Nonferrous Alloys (SC-P)**

R. T. Webster, <i>Chairman</i>	R. A. Rosenberg
M. H. Gilkey	E. Shapiro
B. B. Hood	L. E. Shoemaker
W. R. Keaney	J. W. Tackett

**Subgroup on Strength of Weldments (SC-P) & (SC IX) (Joint Subgroup)**

W. D. Doty, <i>Chairman</i>	D. I. Roberts
H. R. W. Cobb	R. K. Sager
B. W. Roberts	C. E. Spaeder

**Subgroup on Toughness (SC-P)**

R. K. Nanstad, <i>Chairman</i>	E. G. Nisbett
J. M. Barsom	A. Selz
R. F. Cappellini	I. Sprung
H. T. Corten	R. D. Stout
W. Hanzalek	M. F. Wheatcroft
W. S. Hazelton	S. Yukawa
E. I. Landerman	R. Zawierucha

**Working Group on Nonnuclear Application (SG-T) (SC-P)**

A. Selz, <i>Chairman</i>	M. F. Wheatcroft
E. G. Nisbett	R. Zawierucha
R. D. Stout	

**Working Group on Nuclear Application (SG-T) (SC-P)**

E. I. Landerman, <i>Chairman</i>	W. S. Hazelton
R. F. Cappellini	A. Selz

**Working Group on Toughness Criteria (SG-T) (SC-P)**

J. M. Barsom	S. Yukawa
R. K. Nanstad	

**SUBCOMMITTEE ON SAFETY VALVE REQUIREMENTS (SC-SVR)**

E. C. Kistner, Jr., <i>Chairman</i>	W. D. Greenlaw
W. L. Garvin, <i>Vice Chairman</i>	H. I. Gregg
C. J. Gomez, <i>Secretary</i>	S. F. Harrison, Jr.
G. C. Batz	W. D. Hayen
M. D. Bernstein	F. J. Howes
J. Cahoon, Jr.	M. A. Robinson
R. A. Cedel	A. J. Spencer
O. J. Cox, Jr.	L. L. Thompson
E. C. Cullie	F. W. Weidner
R. J. Doelling	

**Subgroup on General Requirements (SC-SVR)**

M. D. Bernstein, *Chairman*      C. A. Neumann  
W. D. Hayen                              M. A. Robinson  
F. J. Howes                                L. L. Thompson  
D. Kadakia

**Subgroup on Testing (SC-SVR)**

O. J. Cox, Jr., *Chairman*              V. M. DeLuca  
R. A. Cedel                                S. F. Harrison, Jr.  
E. C. Cullie                                F. W. Weidner

**Subgroup on Design (SC-SVR)**

W. D. Greenlaw, *Chairman*          R. J. Doelling  
G. C. Batz                                 H. I. Gregg  
J. Cahoon, Jr.                            G. W. Neerbasch

**SUBCOMMITTEE ON DESIGN (SC-D)**

M. H. Jawad, *Chairman*                O. F. Hedden  
R. I. Jetter, *Vice Chairman*          C. A. Moore  
J. Yarmush, *Secretary*                W. J. O'Donnell  
T. K. Burr                                 R. F. O'Neill  
W. J. Carter                                R. D. Schueler, Jr.  
J. R. Farr                                  M. P. Schwartz

**Subgroup on Openings (SC-D)**

M. P. Schwartz, *Chairman*          P. P. Raju  
R. W. Mikitka, *Secretary*            M. D. Rana  
S. C. Lou                                  E. C. Rodabaugh  
R. B. Luney                                H. H. Schneider  
K. Mokhtarian                          R. W. Schneider  
K. C. Morrison                          H. K. Shaw  
D. R. Palmer                                G. M. Tunnell, Jr.

**Subgroup on External Pressure (SC-D)**

W. J. Carter, *Chairman*                W. J. Koves  
D. J. Green                                H. W. Marsh  
J. S. Kandola                               C. D. Miller

**Subgroup on Design Analysis (SC-D)**

T. K. Burr, *Chairman*                    T.-H. Liu  
K. S. Ahluwalia                          A. Lohmeier  
R. S. Barsoum                            T. V. Narayanan  
S. Chattopadhyay                        S. S. Palusamy  
C. Chen                                    T. P. Pastor  
A. G. Eggers                                M. W. Ringer, Jr.  
H. M. Fishman                            E. R. Sliwinski  
J. L. Hechmer                              E. L. Thomas, Jr.  
A. Kalnins                                 R. J. Thomas

**Subgroup on Elevated Temperature Design (SC-D)**

R. I. Jetter, *Chairman*                    R. K. Mattu  
J. M. Corum, *Secretary*                L. C. S. Nieh  
C. R. Brinkman                          W. J. O'Donnell  
R. D. Campbell                          D. I. Roberts  
J. B. Conway                              C. C. Schultz, Jr.  
A. W. Dalcher                            L. K. Severud  
D. S. Griffin                                A. L. Snow  
M. T. Jakub                                W. Veljovich  
C. W. Lawton                              B. C. Wei  
S. Majumdar

**Subgroup on Fatigue Strength (SC-D)**

W. J. O'Donnell, *Chairman*          D. P. Jones  
C. R. Brinkman                          C. W. Lawton  
B. Gowda                                 M. J. Manjoine  
J. A. Hayward                            A. Merend  
J. L. Hechmer                              G. C. Millman  
L. A. James

**SUBCOMMITTEE ON BOILER AND PRESSURE VESSEL ACCREDITATION (SC-BPVA)**

C. E. Ford, *Chairman*                    R. C. Howard  
D. J. McDonald, *Vice Chairman*      D. S. Korzec  
*Chairman*                                    T. H. Milton  
M. Gutierrez, *Secretary*                E. F. Murphy  
G. P. Mancini, *Assistant Secretary*    M. L. Snow, Jr.  
S. C. Cyr                                    J. M. Whelan  
D. M. Fischer                              C. B. Zekas  
W. D. Greenlaw                            J. R. Farr, Alternate

**SUBCOMMITTEE ON NUCLEAR ACCREDITATION (SC-NA)**

H. A. Manning, *Chairman*              R. C. Howard  
M. N. Bressler, *Vice Chairman*        W. G. Knecht  
A. Bagner, *Secretary*                    J. Lang  
C. W. Allison                              J. D. Lenardson  
E. T. Baker, III                            G. F. McDonald, Jr.  
R. B. Bremmer                            R. E. Muise  
D. J. Carreira                              T. E. Quaka  
R. E. Feigel                                M. L. Snow, Jr.  
J. E. Harris

# CONTENTS

A Detailed Contents Precedes Each Part and the Appendices

Foreword .....	v
Statements of Policy .....	vii
Personnel .....	ix
Introduction .....	1
<b>Subsection A</b>	<b>General Requirements</b>
Part UG	General Requirements for All Methods of Construction and All Materials .....
	13
<b>Subsection B</b>	<b>Requirements Pertaining to Methods of Fabrication of     Pressure Vessels</b>
Part UW	Requirements for Pressure Vessels Fabricated by Welding .....
Part UF	Requirements for Pressure Vessels Fabricated by Forging .....
Part UB	Requirements for Pressure Vessels Fabricated by Brazing .....
	101 137 145
<b>Subsection C</b>	<b>Requirements Pertaining to Classes of Materials</b>
Part UCS	Requirements for Pressure Vessels Constructed of Carbon and Low Alloy Steels .....
Part UNF	Requirements for Pressure Vessels Constructed of Nonferrous Materials .....
Part UHA	Requirements for Pressure Vessels Constructed of High Alloy Steel .....
Part UCI	Requirements for Pressure Vessels Constructed of Cast Iron .....
Part UCL	Requirements for Welded Pressure Vessels Constructed of Material With Corrosion Resistant Integral Cladding, Weld Metal Overlay Cladding, or With Applied Linings .....
Part UCD	Requirements for Pressure Vessels Constructed of Cast Ductile Iron .....
Part UHT	Requirements for Pressure Vessels Constructed of Ferritic Steels With Tensile Properties Enhanced by Heat Treatment .....
	157 177 193 203 211 221 225

Part ULW	Requirements for Pressure Vessels Fabricated by Layered Construction .....	237
Part ULT	Alternative Rules for Pressure Vessels Constructed of Materials Having Higher Allowable Stresses at Low Temperature .....	265
Tables .....		275
Mandatory Appendices .....		491
Nonmandatory Appendices .....		723
SI Units .....		869
Index .....		873

# INTRODUCTION

## SCOPE

### U-1 SCOPE<sup>1</sup>

(a) For the scope of this Division, pressure vessels are containers for the containment of pressure, either internal or external. This pressure may be obtained from an external source, or by the application of heat from a direct or indirect source, or any combination thereof.

(b) This Division is divided into three Subsections, Mandatory Appendices, and Nonmandatory Appendices. Subsection A consists of Part UG, covering the general requirements applicable to all pressure vessels. Subsection B covers specific requirements that are applicable to the various methods used in the fabrication of pressure vessels. It consists of Parts UW, UF, and UB dealing with welded, forged, and brazed methods, respectively. Subsection C covers specific requirements applicable to the several classes of materials used in pressure vessel construction. It consists of Parts UCS, UNF, UHA, UCI, UCD, UHT, ULW, and ULT dealing with carbon and low alloy steels, nonferrous metals, high alloy steels, cast iron, clad and lined material, cast ductile iron, ferritic steels with properties enhanced by heat treatment, layered construction, and low temperature materials, respectively. Subsection C also contains tables of maximum allowable stress values for these classes of materials.

The Mandatory Appendices address specific subjects not covered elsewhere in this Division and their requirements are mandatory when the subject covered is included in construction under this Division. The Nonmandatory Appendices provide information and suggested good practices.

(c) The following classes of vessels are not considered to be within the scope of this Division:

(1) those within the scope of other Sections;

(2) fired process tubular heaters;  
(3) pressure containers which are integral parts or components of rotating or reciprocating mechanical devices, such as pumps, compressors, turbines, generators, engines, and hydraulic or pneumatic cylinders where the primary design considerations and/or stresses are derived from the functional requirements of the device;

(4) except as covered in U-1(f), structures whose primary function is the transport of fluids from one location to another within a system of which it is an integral part, that is, piping systems;

(5) piping components, such as pipe, flanges, bolting, gaskets, valves, expansion joints, fittings, and the pressure containing parts of other components, such as strainers and devices which serve such purposes as mixing, separating, snubbing, distributing, and metering or controlling flow, provided that pressure containing parts of such components are generally recognized as piping components or accessories;

(6) a vessel for containing water<sup>2</sup> under pressure, including those containing air, the compression of which serves only as a cushion, when none of the following limitations are exceeded:

(a) a design pressure of 300 psi;

(b) a design temperature of 210°F.

(7) a hot water supply storage tank heated by steam or any other indirect means when none of the following limitations is exceeded:

(a) a heat input of 200,000 Btu/hr;

(b) a water temperature of 210°F;

(c) a nominal water containing capacity of 120 gal;

(8) vessels having an internal or external operating pressure [see 3-1(f)] not exceeding 15 psi with no limitation on size [see UG-28(e)];

(9) vessels having an inside diameter, width,

<sup>1</sup>In those applications where there are laws or regulations issued by Municipal, State, Provincial or Federal Authorities covering pressure vessels, these laws or regulations should be reviewed to determine size or service limitations of the coverage which may be different or more restrictive than those given in this paragraph.

<sup>2</sup>The water may contain additives provided the flash point of the aqueous solution at atmospheric pressure is 185°F or higher. The flash point shall be determined by the methods specified in ASTM D 93 or in ASTM D 56, whichever is appropriate.