

SECTION X

2025

ASME Boiler and
Pressure Vessel Code
An International Code

**Fiber-Reinforced Plastic
Pressure Vessels**

Currently in preview, click buy full version

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

2025 ASME Boiler & Pressure Vessel Code

2025 Edition

July 1, 2025

X FIBER-REINFORCED PLASTIC PRESSURE VESSELS

ASME Boiler and Pressure Vessel Committee
on Fiber-Reinforced Plastic Pressure Vessels



The American Society of
Mechanical Engineers

Two Park Avenue • New York, NY • 10016 USA

Date of Issuance: July 1, 2025

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

All rights reserved. “ASME” and the above ASME symbols are registered trademarks of The American Society of Mechanical Engineers. No part of this document may be copied, modified, distributed, published, displayed, or otherwise reproduced in any form or by any means, electronic, digital, or mechanical, now known or hereafter invented, without the express written permission of ASME. No works derived from this document or any content therein may be created without the express written permission of ASME. Using this document or any content therein to train, create, or improve any artificial intelligence and/or machine learning platform, system, application, model, or algorithm is strictly prohibited.

Library of Congress Catalog Card Number: 56-3934

Adopted by the Council of The American Society of Mechanical Engineers, 1914; latest edition 2025.

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

Copyright © 2025 by
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
All rights reserved
Printed in U.S.A.

TABLE OF CONTENTS

List of Sections		xi
Foreword		xv
Statement of Policy on the Use of the ASME Single Certification Mark and Code Authorization in Advertising		xvii
Statement of Policy on the Use of ASME Marking to Identify Manufactured Items		xviii
Personnel		xviii
Correspondence With the Committee		xli
Introduction		xliii
Summary of Changes		xlviii
Cross-Referencing in the ASME BPVC		xlix
Part RG	General Requirements	1
Article RG-1	Scope and Jurisdiction	1
RG-100	Scope	1
RG-110	Application Limitations	1
RG-120	Jurisdiction of Section X	2
Article RG-2	Organization	3
RG-200	Organization of This Section	3
Article RG-3	Responsibilities and Duties	4
RG-300	Responsibilities and Duties	4
RG-310	User's Responsibilities — Design Specification	4
RG-320	Fabricator's Responsibilities	4
RG-330	Inspector's Duties	6
Article RG-4	Fabrication Methods	7
RG-400	Fabrication Methods	7
Part RM	Material Requirements	8
Article RM-1	General Requirements	8
RM-100	Laminate Materials	8
RM-110	Fiber System	8
RM-120	Resin System	8
RM-140	Use of Two or More Materials Specifications or Processes in Fabricating a Class I Vessel	10
RM-150	Mechanical Properties of Lamina for Class II Vessels	10
Article RM-2	Miscellaneous Pressure Parts	11
RM-200	General Requirements	11
RM-210	Miscellaneous Metallic Parts	11
Part RD	Design Requirements	12
Article RD-1	General	12
RD-100	Scope	12

RD-110	Definitions	12
RD-120	Loadings	13
RD-130	Design Restrictions	14
RD-140	Design Allowances for Degradation	14
RD-150	Methods of Fabrication in Combination	14
RD-160	Proof of Design Adequacy	14
Article RD-2	Shells of Revolution Under Internal Pressure	15
RD-200	General	15
Article RD-3	Shells of Revolution Under External Pressure	16
RD-300	General	16
RD-310	Qualification of Vessels for External Pressure Service	16
Article RD-4	Secondary Bonding	17
RD-400	Design of Secondary Bonded Joints	17
Article RD-5	Openings and Their Reinforcement	18
RD-500	General	18
RD-510	Qualification	18
RD-520	Restrictions for Class II Vessels	18
Article RD-6	Nozzles and Other Connections	19
RD-600	General	19
RD-610	Qualifications	19
RD-620	Integral Flanged Nozzles for Class II Vessels	19
Article RD-7	Bolted Connections	27
RD-700	Flat Heads, Covers, and Blind Flanges	27
RD-710	Bolted Flanged Connections	27
RD-720	Openings in Flat Metallic Heads, Metallic Covers, and Metallic Blind Flanges	28
RD-730	Welded or Brazed Connections to Metal Flat Heads, Covers, or Blind Flanges	28
Article RD-8	Quick-Acting Closures (For Class I Vessels Only)	29
RD-800	General Design Requirements	29
Article RD-9	Attachments and Supports	30
RD-900	General	30
RD-910	Qualification	30
Article RD-10	Access and Inspection Openings	31
RD-1000	General Requirements	31
RD-1010	Equipment of Vessels Requiring Access or Inspection Openings	31
RD-1020	Size of Manhole Openings for Class I Vessels	31
RD-1030	Size of Manhole Openings for Class II Vessels	31
RD-1040	Minimum Gasket Bearing Widths for Manhole Cover Plates	32
RD-1050	Threaded Openings in Class I Vessels	32
RD-1060	Threaded Openings in Class II Vessels	32
Article RD-11	Mandatory Design Rules for Class II Vessels	33
RD-1100	General	33
RD-1110	Design Basis	33
RD-1120	Design Limitations	33
RD-1130	Design Acceptability	33

RD-1140	Loadings	34
RD-1150	Vessel Parts Subject to Design Analysis	34
RD-1160	Laminate Composition	34
RD-1170	Design Rules — Method A	35
RD-1180	Discontinuity Analysis — Method B	50
Article RD-12	Laminate Stiffness Coefficients	55
RD-1200	Laminate Stiffness Coefficients	55
RD-1210	Stiffness Coefficients for Design by Method B Rules	55
RD-1220	Nomenclature	55
RD-1230	Lamina Reduced Stiffness	57
RD-1240	Stiffness Coefficients for the Laminate	58
RD-1250	Procedure for Calculating the Stiffness Coefficients	59
Part RF	Fabrication Requirements	60
Article RF-1	General Requirements	60
RF-100	Scope	60
RF-110	Procedure Specifications	60
Article RF-2	Special Fabrication Requirements for Contact-Molding Process (For Class I Vessels Only)	61
RF-200	Fiber Content	61
RF-210	Form of Fiber Reinforcement	61
RF-220	Molds	62
RF-230	Liners	62
RF-240	Openings in Vessels	62
RF-250	Molded-In Fittings	62
Article RF-3	Special Fabrication Requirements for Centrifugal-Casting Process (For Class I Vessels Only)	63
RF-300	Fiber Content	63
RF-310	Form of Reinforcement	63
RF-320	Mandrels	63
RF-330	Liners	63
RF-340	Openings in Vessels	63
Article RF-4	Special Fabrication Requirements For Filament-Winding Process (Classes I and II)	64
RF-400	Fiber Content	64
RF-410	Form of Reinforcement	64
RF-420	Mandrels	64
RF-430	Liners	65
RF-440	Openings in Vessels	65
Article RF-5	Special Fabrication Requirements For Contact-Molding Process (Classes I and II)	66
RF-500	Fiber Content	66
RF-510	Form of Fiber Reinforcement	66
RF-520	Molds	66
RF-530	Liners	66
RF-540	Openings in Vessels	67

Article RF-6	Special Fabrication Requirements for Matched Molded Heads (Used for Closures for Centrifugally Cast Vessels — for Class I Vessels Only)	68
RF-600	Content	68
RF-610	Form of Fiber Reinforcement	68
RF-620	Molds	69
RF-630	Openings in Heads	69
Article RF-7	Special Fabrication Requirements for Joining Components	70
RF-700	Procedure Specifications and Qualifications	70
Part RQ	Qualification Requirements	71
Article RQ-1	Scope	71
RQ-100	Responsibility for Qualification	71
RQ-110	Maintenance of Procedure Specification and Qualification Records	71
RQ-120	Procedure Specification Qualification Forms	71
RQ-130	Means to Be Used in Qualifying Class I Designs and Fabricating Procedures	72
RQ-140	Means for Qualifying Class II Vessel Design and Fabrication	72
Article RQ-2	Special Requirements for Bag-Molding Procedure Qualification (Class I Vessels)	74
RQ-200	Essential Variables	74
Article RQ-3	Special Requirements for Centrifugal-Casting Procedure Qualification (Class I Vessels)	75
RQ-300	Essential Variables	75
Article RQ-4	Special Requirements for Filament-Winding Procedure Qualification (Class I Vessels)	76
RQ-400	Essential Variables	76
Article RQ-5	Special Requirements for Contact-Molding Procedure Qualification (Class I Vessels)	77
RQ-500	Essential Variables	77
Article RQ-6	Special Requirements for Class II Vessels	78
RQ-600	Essential Design Variables	78
Part ROP	Overpressure Protection	79
Article ROP-1	General Requirements	79
ROP-100	General	79
ROP-110	Definitions	79
ROP-120	Responsibilities	79
ROP-130	Determination of Pressure-Relieving Requirements	79
ROP-140	Overpressure Limits	80
ROP-150	Permitted Pressure Relief Devices	80
ROP-160	Pressure-Setting and Performance Requirements	80
ROP-170	Installation	80
Part RT	Rules Governing Testing	82
Article RT-1	Testing Requirements	82
RT-100	Scope	82
RT-110	Fabricator's Responsibility	82
RT-120	Inspector's Duties	82

Article RT-2	Design and Procedure Qualification Test Requirements for Class I Vessels	83
RT-200	General	83
RT-210	Qualification Checks and Examinations	83
RT-220	Qualification Tests	84
Article RT-3	Quality Control Test and Examination Requirements for Class I Vessels	87
RT-300	General	87
RT-310	Frequency of Cyclic Pressure and Qualification Pressure Tests	87
RT-320	Frequency of Determination of Weight of Resin and Fiber	87
RT-330	Frequency of Volumetric Expansion Tests	87
RT-340	Frequency of Thickness Checks	87
Article RT-4	Production Test Requirements for Class I Vessels	88
RT-400	General	88
RT-410	Visual Examination	88
RT-420	Thickness Check	89
RT-430	Vessel Weight	89
RT-440	Barcol Hardness Test	89
RT-450	Hydrostatic Leakage Test	89
RT-460	Conditions Under Which Pneumatic Leakage Test May Be Used	90
Article RT-5	Hydrostatic Testing Procedures and Equipment for Class I and Class II Vessels	91
RT-500	Provision of Vents at High Points	91
RT-510	Test Gages	91
RT-520	Calibration of Acoustic Emission Equipment	91
Article RT-6	Acceptance Test Procedure for Class II Vessels	92
RT-600	General	92
RT-610	Acceptance Checks and Examinations	92
RT-620	Acceptance Tests	92
RT-630	Penetrant Examination	93
Article RT-7	Determination of Mechanical Properties of Lamina for Use With Class II Vessels	94
RT-700	Required Mechanical Properties of the Lamina	94
Article RT-8	Test Methods for Determining Damage-Based Design Criterion	96
RT-800	Scope	96
RT-810	Referenced Documents	96
RT-820	Apparatus, Loading Procedure, and Data Analysis	96
Part RI	Inspection Requirements	97
Article RI-1	General	97
RI-100	Scope	97
RI-110	Qualification of Inspectors	97
RI-120	Access for Inspector	97
RI-130	Inspector's Duties	97
RI-140	Inspection of Material	98
RI-150	Inspection During Fabrication	98
RI-160	Alternative Inspection for Multiple, Duplicate Fabrication	98

Article RI-2	Special Inspection Requirements for Bag Molding (Class I Vessels)	99
RI-200	Check of Bag-Molding Procedure Specification Qualification	99
RI-210	Visual Inspection	99
Article RI-3	Special Inspection Requirements for Centrifugal Casting (Class I Vessels)	100
RI-300	Check of Centrifugal-Casting Procedure Specification Qualification . . .	100
RI-310	Visual Inspection	100
Article RI-4	Special Inspection Requirements for Filament Winding	101
RI-400	Check of Filament-Winding Procedure Specification Qualification . . .	101
RI-410	Visual Inspection	101
Article RI-5	Special Inspection Requirements for Contact Molding	102
RI-500	Check of Contact-Molding Procedure Specification Qualification	102
RI-510	Visual Inspection	102
Part RS	Marking, Stamping, and Reports	103
Article RS-1	Contents, Methods, and Means of Marking	103
RS-100	Required Marking for Vessels	103
RS-110	Application of Stamp to Vessel	103
RS-120	Part Marking	104
RS-130	Nameplate	104
Article RS-2	Use of Certification Mark Stamp	105
RS-200	Certification Mark Stamp Bearing Official Mark	105
Article RS-3	Report Forms	106
RS-300	Fabricator's Data Reports	106
Mandatory Appendix 1	Quality Control System	107
1-100	General	107
1-110	Outline of Some of the Features to Be Included in the Quality Control System	107
Mandatory Appendix 2	Capacity Conversions for Safety Valves	109
Mandatory Appendix 4	Glossary of Terms Related to Fiber-Reinforced Plastics	110
Mandatory Appendix 5	Specific Gravity of Liquid Resins	118
5-100	Introduction	118
5-200	Apparatus	118
5-300	Safety Precautions	118
5-400	Procedure	118
5-500	Calculations	118
5-600	Report	118
Mandatory Appendix 6	Structural Laminate Visual Acceptance Criteria	119
6-100	Structural Laminate Visual Acceptance Criteria	119
Mandatory Appendix 7	Standard Units for Use in Equations	124
Mandatory Appendix 8	Class III Vessels With Liners for High Pressure Fluids in Stationary Service	125
8-100	Scope	125
8-200	General	126
8-300	Materials	126
8-400	Design	127
8-500	Fabrication	128

8-600	Examination	129
Mandatory Appendix 9	Establishing Governing Code Editions, Addenda, and Cases for FRP Pressure Vessels	142
9-100	General	142
9-200	Design	142
9-300	Materials	142
9-400	Fabrication	142
9-500	Examination	142
9-600	Inspection	143
9-700	Testing	143
9-800	Overpressure Protection	143
9-900	Field Assembly	143
9-1000	Certification	143
Mandatory Appendix 10	Laminates With Load-Sharing Metallic Shells for High Pressure Service	144
10-100	Scope	144
10-200	General Requirements	144
10-300	Materials	145
10-400	Fabrication	148
10-500	Examination and Testing Requirements	150
10-600	Laminate Procedure Qualification	154
10-700	Inspector's Duties	156
Nonmandatory Appendix AA	Suggested Methods of Preliminary Design for Class I Vessels	158
Article AA-1	General	158
AA-100	Scope	158
Article AA-2	Shells of Revolution Under Internal Pressure	159
AA-200	General	159
AA-210	Die-Formed Heads, Pressure on Concave Side	160
Article AA-3	Shells of Revolution Under External Pressure	161
AA-300	General Requirements	161
Article AA-4	Reinforcement of Openings in Vessels	162
AA-400	General Requirements	162
AA-410	Reinforcement for Internal Pressure	162
Article AA-5	Attachments and Supports	163
AA-500	General	163
AA-510	Attachments	163
AA-520	Supports	163
Nonmandatory Appendix AB	Installation and Operation	166
AB-100	Introduction	166
Nonmandatory Appendix AC	Discontinuity Stresses for Class II, Method B Vessels	168
Article AC-1	Examples of Discontinuity Stresses	168
AC-100	Example Illustrating the Application of Discontinuity Analysis	168
Article AC-2	Examples of Stress Analysis of Cylindrical Shells	174
AC-200	Sign Convention and Nomenclature	174
AC-210	Principal Stresses and Stress Intensities Due to Internal Pressure	175
AC-220	Bending Analysis for Uniformly Distributed Edge Loads	175

AC-230	Displacements, Bending Moments, and Shearing Forces in Terms of Conditions at Reference Edge, $x = 0$	175
AC-240	Principal Stresses Due to Bending	176
Article AC-3	Examples of Stress Analysis of Spherical Shells	177
AC-300	Scope	177
AC-310	Nomenclature and Sign Convention	177
AC-320	Principal Stresses and Stress Intensities Resulting From Internal or External Pressure	178
AC-330	Bending Analysis for Uniformly Distributed Edge Loads	179
AC-340	Alternate Bending Analysis of a Hemispherical Shell Subjected to Uniformly Distributed Edge Loads	180
Article AC-4	Examples of Stress Analysis of Flat Circular Heads	181
AC-400	Scope	181
AC-410	Nomenclature and Sign Convention	181
AC-420	Pressure and Edge Loads on Circular Flat Plates	181
AC-430	Flat Plate Pressure Vessel Heads	182
AC-440	Geometry Constants	183
AC-450	Stress Intensities in a Flat Plate	184
Nonmandatory Appendix AD	Laminate Theory	185
AD-100	Scope	185
AD-200	Standard Notation	185
AD-300	Basic Assumptions	186
AD-310	Nomenclature	186
AD-400	Lamina (Ply) Properties	186
AD-500	Illustrative Example	186
AD-510	Strain-Space Failure Envelopes	195
Nonmandatory Appendix AF	Examples for Design Rules for Class II Vessels	200
AF-100	General	200
AF-200	Cylindrical Shells Under Uniform Internal Pressure (See RD-1171.1)	200
AF-210	Spherical Shells Under Internal Pressure (See RD-1171.2)	200
AF-300	Cylindrical Shells Under External Pressure (See RD-1172.1)	200
AF-310	Spherical Shells Under Uniform External Pressure (See RD-1172.2)	201
AF-400	Thickness of Heads Under Internal Pressure (See RD-1173.1)	201
AF-410	Thickness of Heads Under External Pressure (See RD-1173.2)	201
AF-420	Reinforcement of Openings and Nozzle Attachments (See RD-1174.2)	201
AF-500	Head-To-Shell Joint Overlay Subject to Internal Pressure (See RD-1175.2)	202
Nonmandatory Appendix AG	Guide to Information Appearing on Certificate of Authorization (See Figure AG-1)	203
Nonmandatory Appendix AH	Guidance for the Use of U.S. Customary and SI Units in the ASME Boiler and Pressure Vessel Code	205
AH-100	Use of Units in Equations	205
AH-200	Guidelines Used to Develop SI Equivalents	205
AH-300	Soft Conversion Factors	207
Nonmandatory Appendix AI	Rigorous NASA SP-8007 Solution for Lateral and Longitudinal Pressure	208
AI-100	. . . . .	208

AI-200	Buckling Example	209
Nonmandatory Appendix AJ	Forms Required by Section X	212
Nonmandatory Appendix AK	Lamina Elastic Constants — Micromechanics	255
AK-100	Lamina Elastic Constants	255
AK-200	Nomenclature	255
AK-300	Preliminary Calculations	255
AK-400	Micromechanics Equations for a Unidirectional Layer	256
AK-500	Micromechanics of a Randomly Distributed, Fiber-Reinforced Lamina	258
Nonmandatory Appendix AL	Fire and Excessive Heat Exposure Guidance	264
AL-100	General	264
AL-200	Suggested Methods to Mitigate Fire Exposure	264
Figures		
RD-620.3	Flange Tolerances	23
RD-620.4(a)	Plate-Type Gussets	24
RD-620.4(b)	Typical Cone-Type Gusset	24
RD-620.5	Flush Nozzle Installation	25
RD-620.6	Penetrating Nozzle Installation	26
RD-700.1	Acceptable Types of Flat Heads for Class I Vessels	27
RD-1120.1	Design Limitations for Class II Vessels	34
RD-1174.2	Dimensions of Reinforcing Pad and Nozzle Overlays	38
RD-1174.3	Stress Concentration Factors for a Circular Hole in a Pressurized Cylindrical Shell	40
RD-1175.2	Head/Shell or Shell/Shell Overlay Dimensions	41
RD-1176.1	Design of Full-Face Nozzle Flanges	44
RD-1176.2	Values of V (Integral Flange Factor)	46
RD-1176.3	Values of F (Integral Flange Factor)	47
RD-1176.4	Values of f (Hub Stress Correction Factor)	48
RD-1176.5	Values of T , Z , Y , and U (Terms Involving K)	49
RD-1220.1	Moment Resultants	56
RD-1220.2	In-Plane Force Resultants	56
RD-1220.3	Coordinate Systems	57
RD-1250.1	Geometry of an N -Layered Laminate	59
RF-210.1	Fiber Side Wall Lay-Up for Bag Molding	61
RF-210.2	Head or End Preform for Cylindrical Vessel	61
RF-610.1	Fiber Preform and Insert for Head for Centrifugally Cast Vessel	68
RF-610.2	Fiber Head or End Preformed Inserts for Centrifugally Cast Vessel Heads	69
RS-100.1	Official Certification Mark to Denote the American Society of Mechanical Engineers' Standard	103
RS-132.1	Form of Stamping and Marking	104
8-700.5.11.1-1	Pendulum Impact Test	140
10-201-1	General Arrangement	144
10-201-2	Laminate Termination	145
10-201-3	Laminate Step	145
AA-522.1	Saddle-Type Supports	164
AA-523.1	Ring or Flange Support	164

AA-524.1	Metal Attachment in Vessel End	165
AA-524.2	Metal Attachments in Thickened Ends	165
AC-100.1	. . . . .	172
AC-100.2	. . . . .	172
AC-100.3	. . . . .	172
AC-100.4	. . . . .	173
AC-100.5	. . . . .	173
AC-200	Symbols and Sign Convention	174
AC-310	. . . . .	178
AC-410	. . . . .	182
AC-421	. . . . .	182
AC-422	. . . . .	182
AC-430	. . . . .	182
AC-431	. . . . .	183
AD-201	. . . . .	185
AD-202	Reference Coordinates	186
AD-500	. . . . .	187
AD-503	. . . . .	191
AD-505	. . . . .	191
AD-510	Failure Envelopes — Example Laminate in Strain Space	199
AG-1	Sample Certificate of Authorization	204
Q-115.1	Schematic Views of Permissible Joint Designs for Adhesive-Bonded Cylinder Joints for Tensile Tests (Revision B — 2023)	222
 Tables		
RM-120.1	Resin Systems Required Certification by Resin Manufacturer	9
RM-120.2	Resin Systems Required Test by Vessel Fabricator	9
RD-620.1	Flange and Nozzle Dimensions for Hand Lay-Up and Pressure-Molded Flanges	21
RD-1173.2	Values of Spherical Radius Factor K_o for Ellipsoidal Heads With Pressure on Convex Side	37
RT-620.1	Evaluation Criteria	93
6-100.1	Structural Laminate Visual Acceptance Criteria for Class I Pressure Vessels	120
6-100.2	Structural Laminate Visual Acceptance Criteria for Class II Pressure Vessels	122
7-100.1	Standard Units for Use in Equations	124
8-300.4.1-1	Resin Systems: Required Certifications and Tests	127
8-600.2.1-1	Visual Acceptance Criteria for FRP Laminate (U.S. Customary Units) .	130
8-600.2.1-2	Visual Acceptance Criteria for FRP Laminate (SI Units)	131
8-700.2.1-1	Qualification Tests	136
10-305.1-1	Resin Supplier Certifications	146
10-305.1-2	Tests by Laminate Manufacturer	147
10-307-1	Pre-Preg Supplier Certifications	147
10-307-2	Pre-Preg Systems Tests by CRPV Manufacturer	148
10-503-1	Visual Acceptance Criteria for FRP Laminate (U.S. Customary Units) .	151

10-503-1M	Visual Acceptance Criteria for FRP Laminate (SI Units)	153
10-503-2	Acoustic Emission Evaluation Criteria	154
AC-440.1	. . . . .	184
AD-500	Assumed Lamina Elastic and Strength Properties	187
AD-501	Transformed Modulus Components, 10 ⁶ psi	189
AD-506	Matrices for Illustrative Example	192
AD-507.2	Off-Axis Mechanical Strain	194
AD-507.3	On-Axis Mechanical Strain	194
AD-510	Strain-Space Envelope Coordinates	197
AG-1	Guide to Information Appearing on Certificate of Authorization (See Figure AG-1)	203
AJ-1	Latest Revision and Year Date of Forms Referenced in This Code . . .	212
AJ-2	Guide for Completing Form RP-1 (Revision F — 2023)	236
AJ-3	Guide for Completing Form RP-2 (Revision D — 2023)	239
AJ-4	Guide for Completing Form RP-3 (Revision H — 2025)	242
AJ-5	Guide for Completing Form RP-4 (Revision D — 2023)	245
AJ-6	Guide for Completing Form RP-5 (Revision D — 2023)	247
AJ-7	Guide for Completing Fabricator's Data Report CPV-1	250
 Forms		
Q-106	Recommended Form for Qualifying the Vessel Design and the Procedure Specification Used in Fabricating Bag-Molded and Centrifugally Cast Fiber-Reinforced Plastic Pressure Vessels (Class I)	213
Q-107	Recommended Form for Qualifying the Vessel Design and the Procedure Specification Used in Fabricating Filament-Wound Fiber-Reinforced Plastic Pressure Vessels (Class I)	215
Q-108	Recommended Form for Qualifying the Vessel Design and the Procedure Specification Used in Fabricating Contact-Molded, Fiber-Reinforced Plastic Pressure Vessels (Class I)	217
Q-115	Recommended Form for Qualifying the Design and the Procedure Specification Used in Adhesive Bonding of Parts of Fiber-Reinforced Plastic Pressure Vessels (Class I)	220
Q-120	Procedure Specification for Class II Vessels	224
RP-1	Fabricator's Data Report for Fiber-Reinforced Plastic Pressure Vessels (Class I)	234
RP-2	Fabricator's Partial Data Report (Class I)	237
RP-3	Fabricator's Data Report for Class II Vessels	240
RP-4	Fabricator's Partial Data Report for Class II Vessels	243
RP-5	Fabricator's Data Report Supplementary Sheet	246
CPV-1	Fabricator's Data Report for Composite Reinforced Pressure Vessels (Class III)	248
CPV-2	Recommended Form for Qualifying the Laminate Design and the Laminate Procedure Specification Used in the Fabrication of Composite Reinforced Pressure Vessels (Class III)	252
Endnotes	. . . . .	266

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 Inservice Inspection of Nuclear Power Plant Components
 - 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*

(25)

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. The rules 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. The 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.

The 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 the Code. Requests for revisions, new rules, Code cases, or interpretations shall be addressed to the staff secretary in writing and shall give full particulars in order to receive consideration and action (see the Correspondence With the Committee page). 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 the Code, the singular shall be interpreted as the plural, and vice versa.

The words "shall," "should," and "may" are used in the Code 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, 2025

TECHNICAL OVERSIGHT MANAGEMENT COMMITTEE (TOMC)

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

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

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

Special Working Group on High Temperature Technology (TOMC)

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

Subgroup on Research and Development (TOMC)

S. C. Roberts, <i>Chair</i>	R. B. Keating
S. J. Rossi, <i>Staff Secretary</i>	R. E. McLaughlin
R. W. Barnes	E. M. Ortman
N. A. Finney	D. Andrei, <i>Contributing Member</i>
G. W. Galanes	

Honors and Awards Committee (TOMC)

E. M. Ortman,	B. K. Nutter
G. W. Galanes	R. E. McLaughlin
D. W. Lamond	

Subgroup on Strategic Initiatives (TOMC)

N. A. Finney, <i>Chair</i>	R. B. Keating
S. J. Rossi, <i>Staff Secretary</i>	R. E. McLaughlin
R. W. Barnes	E. M. Ortman
G. W. Galanes	S. C. Roberts
G. W. Hembree	M. Wadkinson

ADMINISTRATIVE COMMITTEE

R. E. McLaughlin, <i>Chair</i>	B. K. Nutter
N. A. Finney, <i>Vice Chair</i>	E. M. Ortman
S. J. Rossi, <i>Staff Secretary</i>	M. J. Pischke
G. W. Galanes	M. D. Rana
R. B. Keating	S. C. Roberts
D. W. Lamond	R. R. Stevenson
B. Linnemann	M. Wadkinson

Task Group on Field Sites (TOMC)

R. V. Wielgoszinski, <i>Chair</i>	J. Hoskinson
M. Vazquez, <i>Staff Secretary</i>	D. T. Peters
P. Becker	G. Scribner
T. Bedeaux	

MARINE CONFERENCE GROUP

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