

ASME RTP-1–2017
(Revision of ASME RTP-1–2015)

Reinforced Thermoset Plastic Corrosion-Resistant Equipment

AN AMERICAN NATIONAL STANDARD



**The American Society of
Mechanical Engineers**

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Two Park Avenue • New York, NY • 10016 USA

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CONTENTS

Foreword	x
Statement of Policy on the Use of Certification Marks and Code Authorization in Advertising	xi
Statement of Policy on the Use of ASME Marking to Identify Manufactured Items	xi
Committee Roster	xii
Introduction	xiv
Summary of Changes	xv
Part 1 General Requirements	1
1-100 Introduction	1
1-200 User's Basic Requirements Specification	2
1-300 Fabricator's Design Report	7
1-400 Inspection	7
1-500 Fabricator's Quality Control Program	8
Part 2 Materials	12
2-100 Scope	12
2-200 Laminate Compositions	12
2-300 Materials	12
Subpart 2A Requirements for Representative Flat Laminates	13
2A-100 Introduction	13
2A-200 Laminate Requirements	13
2A-300 Requirements for Physical and Mechanical Properties	16
2A-400 Test Methods	17
2A-500 Records	17
2A-600 Additional Standard Laminate Compositions for Subpart 2A	17
Subpart 2B Requirements for Laminates Developed Using the Lamination Analysis Method (Type X)	17
2B-100 Laminate Composition	17
2B-200 Requirements for Physical and Mechanical Properties	18
2B-300 Test Methods	18
2B-400 Records	18
Subpart 2C Permissible Tolerances for Laminate Thickness Variation	18
2C-100 Tolerance for Average Spot Thickness	18
2C-200 Tolerance for Average Thickness of a Major Part	18
2C-300 Exceptions and Adjustments	18
Part 3 Design	19
3-100 Scope	19
3-200 General	19
3-300 Definitions	19
Subpart 3A Design by Rules	20
3A-100 Loadings	20
3A-200 Design for Total Internal Pressure	21
3A-300 Design for External Pressure	24
3A-400 Seismic, Wind, and Snow Loadings	27
3A-500 Large Diameter RTP Equipment Body Flanges	28
3A-600 Vessels Supported by Shell Attachments	28
3A-700 Reinforcement of Circular Openings	28
3A-800 Secondary Bond Shear Stress	29

Subpart 3B	Design by Stress Analysis	29
3B-100	Introduction	29
3B-200	Design Acceptability	30
3B-300	Loading	31
3B-400	Design	31
3B-500	Stress Criteria	31
3B-600	External Pressure	32
3B-700	Attachments	32
Part 4	Fabrication	33
4-100	Scope	33
4-200	Large Diameter Body Flanges	33
4-300	Shell Joints	33
4-400	Flanged Nozzles	34
4-500	Manways	35
4-600	Reinforcement of Cutouts	35
4-700	Tolerances	35
4-800	Balsa Wood Cored Plates	35
Part 5	Overpressure Protection	52
5-100	Basis for Design	52
5-200	Protection Against Overpressure	52
5-300	Type of Overpressure Protection	52
5-400	Location of Overpressure Protection Devices	52
5-500	Installation Practices	52
5-600	Overpressure Device Set Pressure	52
5-700	Relief Device Sizing	52
5-800	Discharge Lines From Pressure Relief Devices	52
5-900	Responsibility for Design and Selection	53
Part 6	Inspection and Tests	54
6-100	Scope	54
6-200	Inspector	54
6-300	Inspection and Responsibility	54
6-400	Conditions for Inspection	54
6-500	Equipment Design	55
6-600	Materials	55
6-700	Fabrication	55
6-800	Fabricator's Quality Assurance Program	55
6-900	Final Inspection	55
Part 7	Shop Qualification	64
7-100	Scope	64
7-200	General	64
7-300	Fabricator's Facilities and Equipment	64
7-400	Personnel	64
7-500	Quality Control Program, Document Handling, and Record System	64
7-600	Demonstration of Capability (Demonstration Laminates)	64
7-700	Minimum Test Values From Demonstration Laminates	67
7-800	Demonstration Vessel	67
7-900	Identifying Demonstration Laminates	68
7-1000	Laboratory Test and Test Report Requirements for Demonstration Laminates	68

Part 8	Certification	70
8-100	Scope	70
8-200	General	70
8-300	Certification Process	70
8-400	ASME RTP-1 Certificate of Authorization Holder	70
8-500	Issuance of Certification	70
8-600	Designated Oversight	71
8-700	Data Reports	71
8-800	ASME RTP Certified Mark and Certified Designator	71
Figures		
3-1	Toriconical Head Dimensions	23
3-2	Toriconical Head Dimensions for External Pressure	27
4-1	Torispherical Heads	36
4-2	Flat-Bottom Tank Knuckle Detail	37
4-3	Joint Arrangement	39
4-4	Flush Nozzle Installation	40
4-5	Penetrating Nozzle Installation	41
4-6	Bottom Drain Detail	42
4-7	Stiffener Details for Half-Round, Trapezoidal, and Filament Wound Band Configurations	43
4-8	Support Skirt Attachment Detail	44
4-9	Fabrication Tolerances	45
4-10	Nozzle Flange Dimensions for Class 150 Bolting	46
4-11	Flanged Nozzle Lay-Up Method	47
4-12	Nozzle Installation and Cutout Reinforcement Location Alternate	48
4-13	Nozzle Gussets	49
4-14	Flange Tolerances	50
4-15	Flat Cored Bottom Knuckle Detail	50
7-1	Dimensions for Tensile Test Specimen	69
8-1	Official ASME Certification Mark With RTP Designator	71
Tables		
1-1	User's Basic Requirements Specification (UBRS)	3
1-2	Fabricator's Data Report	9
1-3	Fabricator's Partial Data Report	11
2A-1	Standard Laminate Composition Type I	14
2A-2	Standard Laminate Composition Type II	15
2A-3	Minimum Values of Flat Laminates	16
4-1	Flange Flatness Tolerance	51
4-2	Typical Dimensions of Manways	51
4-3	Shear Bond Length	51
6-1	RTP Visual Inspection Acceptance Criteria	59
7-1	Required Resins and Acceptable Fabrication Processes for Demonstration Laminates	65
7-2	Dimensional Requirements for Hand Lay-Up and Spray-Up Demonstration Laminates	66
7-3	Reinforcement Requirements for Hand Lay-Up and Spray-Up Demonstration Laminates	66
Mandatory Appendices		
M-1	Reinforcement Materials Receiving Procedures	73
M-2	Matrix Materials Receiving Procedures	82
M-3	Calculations Using the Classical Lamination Theory (CLT) Analysis Method	89
M-4	Quality Control Program	112
M-5	Qualification of Laminators and Secondary Bonders	114
M-6	Demonstration Vessel	121

M-7	Repair Procedures	129
M-8	Acoustic Emission Examination	134
M-9	Glossary	136
M-10	Reference Documents	140
M-11	Submittal of Technical Inquiries to the Reinforced Thermoset Plastic Corrosion-Resistant Equipment Committee	143
M-12	Dual Laminate Vessels	145
M-13	Balsa Wood Receiving and Inspection Procedures	182
Figures		
M3-1	Moment Resultants	91
M3-2	Force Resultants	91
M3-3	Geometry and Notation for an <i>n</i> -Layered Laminate	91
M3-4	Coordinate Systems	92
M5-1	Pipe Test Piece	117
M5-2	Secondary Bond Test Assembly	118
M5-3	Secondary Bond Test Specimen	119
M6-1	ASME RTP-1 Demonstration Vessel	126
M6-2	Post-Test Sectioning of Vessel for Final Inspection and Display	127
M6-3	Witness of Hydrotest of ASME RTP-1 Demonstration Vessel (Attachment No. 3)	128
M12C-1	Support Ledges Showing Recommended Weld Locations Away From Thermoformed Bends	159
M12D-1	Maximum Offset Allowed for Joints Between Sheets With Different Thicknesses	161
M12D-2	Visual Features of Hot Gas Welds	163
M12D-3	Illustrations of Flow Lines	163
M12D-4	Heat-Affected Zone Patterns	164
M12D-5	Butt Fusion Welds Showing Melt Flow Lines	164
M12D-6	Nozzle Construction for Penetrating Nozzle	166
M12D-7	Nozzle and Manway Constructions	167
M12D-8	Bottom Nozzle Constructions	168
M12G-1	Dual Laminate Demonstration Vessel	173
M12G-2	Post-Test Sectioning of Dual Laminate Demonstration Vessel for Final Inspection and Display	178
Tables		
M1A-1	Veil and Mat Reinforcement Log Sheet	74
M1B-1	Roving Reinforcement Log Sheet	76
M1C-1	Fabric Reinforcement Log Sheet	78
M1D-1	Milled Fiber Reinforcement Log Sheet	81
M2E-1	Resin Log Sheet	86
M2E-2	Curing Agents Log Sheet	87
M2F-1	Common Additives Log Sheet	88
M3-1	Properties for Materials in the Design Example	106
M3-2	Lamina Input for CLT Calculations	107
M3-3	Stresses, Strains, and Strength Ratios	109
M3-4	Woven Roving Layer Modeled as a Balanced and Symmetric Three-Ply Laminate	110
M5-1	Laminator Qualification Report	115
M5-2	Secondary Bonder Qualification Report	116
M6-1	User's Basic Requirements Specification (UBRS)	122
M8-1	Acceptance Criteria Per Channel	134
M12B-1	ASTM Specifications for Thermoplastic Polymers	146
M12B-2	Typical Thermoplastic Polymer Properties	147
M12B-3	Thermoplastic Sheet or Roll Receiving Log	149
M12B-4	Thermoplastic Sheet Visual Inspection Acceptance Criteria	150
M12B-5	Welding Material Receiving Log	152

M12B-6	Bonding Resin Receiving Log	153
M12B-7	Conductive Material Receiving Log	155
M12B-8	Thermoplastic Shape Receiving Log	157
M12D-1	Visual Weld Defects	162
M12E-1	Lining Visual Inspection Acceptance Criteria	171
M12G-1	User's Basic Requirements Specification (UBRS)	174
M12H-1	Weld Strength Requirements	180
M13-1	Balsa Wood Core Inspection Sheet	183
Nonmandatory Appendices		
NM-1	Design Examples	184
NM-2	Design of Integral Body Flanges	203
NM-3	Seismic, Wind, and Snow Loadings	219
NM-4	Hold-Down Lug Design	226
NM-5	Ring Support of Vessels	236
NM-6	Example of a Fabricator's Quality Control Program	250
NM-7	Acceptance Inspection by User's Inspector	264
NM-8	Handling and Shipping	271
NM-9	Installation of RTP Vessels	273
NM-10	Requirements and Responsibilities of User (or User's Agent), Fabricator, Inspector, and Certified Individual	276
NM-11	Design for 250-lb Concentrated Load on a Torispherical Head	280
NM-12	FRP Flange Design	282
NM-13	Stress Analysis Methods	286
NM-15	Flat Cored Plate Design	308
NM-16	External Pressure Design Example for Cylindrical Shells	311
NM-17	Stiffener Design Calculations	314
Figures		
NM1-1	Toriconical Head	185
NM1-2	Stress Intensity in a Toriconical Head	187
NM1-3	Horizontal Tank	189
NM1-4	Pressure Distribution	190
NM1-5	Saddle Reaction	191
NM1-6	Stress Along Top Meridian, Initial Try	192
NM1-7	Stress Along 45-deg Meridian, Initial Try	193
NM1-8	Stress Along 90-deg Meridian, Initial Try	194
NM1-9	Stress Along 135-deg Meridian, Initial Try	195
NM1-10	Stress Along Bottom Meridian, Initial Try	196
NM1-11	Stress Along Top Meridian, Final Try	198
NM1-12	Stress Along 45-deg Meridian, Final Try	199
NM1-13	Stress Along 90-deg Meridian, Final Try	200
NM1-14	Stress Along 135-deg Meridian, Final Try	201
NM1-15	Stress Along Bottom Meridian, Final Try	202
NM2-1	Design of Flat-Face Integral Body Flanges With Full-Face Gaskets	207
NM2-2	Values of F (Integral Flange Factors)	208
NM2-3	Values of f (Hub Stress Correction Factors)	209
NM2-4	Values of T , U , Y , and Z (Terms Involving K)	210
NM2-5	Values of V (Integral Flange Factors)	212
NM2-6	Design of Flat-Face Integral Body Flanges With Full-Face Gaskets (Example Calculation — 72-in. Flange at 30 psi)	213
NM4-1	Wound-On Hold-Down Lug	227
NM4-2A	Secondary Bonded Hold-Down Lug, Type A	228
NM4-2B	Secondary Bonded Hold-Down Lug, Type B	229
NM4-3	Moment Coefficient, M_L	230
NM4-4	Uplift Coefficient, P_G	230
NM4-5	Recommended Hold-Down Clip	232
NM5-1	Lugs on Band	237

NM5-2	Moment Coefficient, M_L	238
NM5-3	Split-Ring Flange	239
NM5-4	Ring Support of Vessels	241
NM5-5	Geometric Quantities	242
NM5-6	Ring Design Chart for Three Lugs	244
NM5-7	Ring Design Chart for Four Lugs	245
NM5-8	Ring Design Chart for Eight Lugs	246
NM5-9	Example Cross Section	248
NM5-10	Lug	249
NM6-1	Organization Chart	252
NM7-1	Recommended Fabrication Tolerances	269
NM8-1	Lifting Vessel With Spreader Bar	271
NM8-2	Strongback for Lifting	271
NM8-3	Use of Strongbacks	272
NM9-1	Flat-Face Valve Flange to Flat-Face RTP Nozzle Flange and Full-Face Gasket	273
NM9-2	Raised-Face Valve Flange to Flat-Face RTP Nozzle Flange With Filler Ring and Full-Face Gasket	274
NM9-3	Flange Bolt Tightening	275
NM10-1	RTP-1 Flowchart	279
NM11-1	Stress Function	281
NM12-1	Flange Dimensioning Details	282
NM12-2	Flange Loading Conditions	283
NM13A-1	Sign Conventions for Cylindrical Segments	304
NM13B-1	Sign Conventions for Spherical Segments	304
NM13C-1	Sign Conventions for Flat Plates	305
NM13C-2	Simply Supported Flat Plate	305
NM13C-3	Edge Loads on Flat Plates	305
NM13C-4	Flat Plate Vessel Head	305
NM13C-5	Flat Plate to Cylinder Joint	305
NM13D-1	Example Pressure Vessel	305
NM13D-2	Forces and Moments in Pressure Vessel Example	306
NM13D-3	Hemispherical Head	306
NM13D-4	Cylindrical Shell	306
NM13D-5	Flat Plate Head	306
NM15-1	Equivalent Solid and Cored Plates	309
NM17-1	Stiffener Moment of Inertia for a Half-Round	314
NM17-2	Stiffener Moment of Inertia for a Trapezoidal Stiffener	316
NM17-3	Stiffener Moment of Inertia for a Filament Wound Band	318
Tables		
NM1-1	Example 1, Vessel With a Toriconical Lower Head	188
NM1-2	Wall Thickness in a Horizontal Tank	197
NM2-1	Typical Body Flange Dimensions and Recommended Bolt Torque Values for RTP Body Flanges	204
NM2-2	Body Flange Design Using Full-Face Gaskets, Maximum Stress Less Than 3,000 psi — Type II Laminates	205
NM2-3	Body Flange Design Using Full-Face Gaskets, Maximum Stress Less Than 1,800 psi — Type I Laminates	206
NM2-4	Values of T , Z , Y , and U (Factors Involving K)	215
NM6-1	Mixing Data Sheet	256
NM6-2	Component Data Sheet	257
NM6-3	Document Control Sheet	258
NM6-4	Document Distribution List	259
NM6-5	Document Preparation and Distribution Responsibility	260
NM6-6	Nonconformity Correction Report	261
NM6-7	QC Manual Master Revision List	263

NM7-1	RTP Equipment Inspection Requirements	265
NM7-2	Inspection Checklist for RTP Equipment	266
NM13C-1	Multiplying Factors	293
SI Units	320

FOREWORD

The function of the Reinforced Thermoset Plastic (RTP) Corrosion-Resistant Equipment Committee is to establish rules of safety governing the design, fabrication, and inspection during construction of such equipment, and to interpret these rules when questions arise regarding their intent. In formulating the rules, the Committee considers the needs of users, material manufacturers, fabricators, and inspectors of this equipment. The objective of the rules is to afford 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 are recognized.

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 Fabricator's freedom to choose any method of design or any form of construction that conforms to the rules of this Standard.

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

The Committee meets regularly to consider requests for interpretations and revisions of the rules, and to develop new rules as dictated by technological development. Inquiries must be addressed to the Secretary in writing and must give full particulars in order to receive consideration and a written interpretation. Proposed revisions to this Standard resulting from inquiries will be presented to the Standards Committee for appropriate action.

Proposed revisions to this Standard approved by the Committee are submitted to the American National Standards Institute and published at <http://cstools.asme.org/csconnect/PublicReviewPage.cfm> to invite comments from all interested persons. After the allotted time for public review and final approval by ASME, revisions are published in updates to this Standard. They may be used beginning with the date of issuance. Revisions become mandatory as requirements 6 months after such date of issuance.

The first edition of this Standard was issued on December 31, 1989. The 2017 edition of this Standard contains revisions to the 2015 edition and was approved by the American National Standards Institute on August 3, 2017.

Requests for interpretations or suggestions for revision should be sent to the Secretary, RTP Standards Committee, The American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990.

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INTRODUCTION

GENERAL

The use of reinforced thermoset plastic (RTP) vessels, with maximum allowable working pressure (MAWP) and maximum allowable external working pressure (MAEWP) not exceeding 15 psig external and/or 15 psig internal above any hydrostatic head, that contain corrosive and otherwise hazardous materials, dictates the need for rules and/or stress analysis concerning materials of construction, design, fabrication, quality control, and inspection of such equipment. In developing rules for RTP, the Committee has adapted the principles of rules included in Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code, wherever they are applicable.

Adaption of standard rules to RTP requires recognition of differences that exist between metallic materials and RTP. These differences are addressed in the remainder of this Introduction.

MATERIALS AND ASSEMBLY

In the absence of ASTM standards, RTP laminate specifications (Part 2) have been developed for use with this ASME Standard. These specifications include laminate composition and properties. Laminates (composites) manufactured by contact molding and by filament winding are covered.

These materials of construction are not available in commerce as mill shapes such as sheet and plate for forming and joining by the Fabricator. They are produced in situ on a mandrel or mold by the Fabricator during fabrication of RTP equipment components. Each Fabricator, as part of his or her shop qualification to this Standard, must demonstrate capability to produce laminates meeting the requirements of the laminate specifications.

Assembly of components such as shells, heads, and nozzles requires joining by secondary bonding. This

operation involves fit-up, surface preparation, and overwrapping with a laminate of composition equivalent to the laminates being joined. Secondary Bonders must be qualified individually by the procedures detailed in Mandatory Appendix M-5.

DESIGN

Design by formulas and by stress analysis are both included in this Standard. Consideration is given both to ultimate strength and to limiting strain. Time and temperature dependence of RTP laminate properties are recognized.

The ultimate stress consideration is required to ensure safety against catastrophic failure over a reasonably long term. The design factors of Subparts 3A and 3B include consideration of variability of quality in the labor-intensive fabricating operation. The strain considerations are required to ensure long-term operation under cyclic stress (fatigue) without cracking the resin matrix of the composite laminate, thus maintaining maximum corrosion resistance. More than 20 years of successful experience, together with test data, have shown these considerations to be valid.

INSPECTION

Reliance is placed on careful auditing of the Fabricator's Quality Control Program and close visual inspection of equipment during fabrication and of finished equipment.

NONMANDATORY APPENDICES

Nonmandatory Appendices are provided in this Standard for reference only. The content of Nonmandatory Appendices is not a requirement even when referenced in mandatory parts of this Standard.

ASME RTP-1–2017 SUMMARY OF CHANGES

Following approval by the RTP Committee and ASME, and after public review, ASME RTP-1–2017 was approved by the American National Standards Institute on August 3, 2017.

ASME RTP-1–2017 includes the following changes identified by a margin note, (17).

<i>Page</i>	<i>Location</i>	<i>Change</i>
xiv	Introduction	Nonmandatory Appendices section added
1	1-130	Second paragraph of subpara. (c) revised
2	1-200	In first paragraph, second sentence revised
	1-220	Subparagraph (a)(3) revised
7	1-300	Second paragraph revised
	1-310	Added
8	1-500	(1) In para. 1-520(a), first sentence revised (2) Paragraphs 1-530, 1-540, and 1-550 deleted
9	Table 1-2	Item 8 revised
11	Table 1-3	Fabricator’s Partial Data Report revised
12	2-310	(1) Third sentence revised (2) Subparagraph (b)(6) added
16	2A-300	Subparagraph (b) revised
18	2B-200	Second sentence of subpara. (a) revised
19	3-200	Subparagraph (g) revised
23	3A-250	(1) In subpara. (a), second and third paragraphs revised and new fourth paragraph added (2) In last paragraph of subpara. (a), numerator in equation for L_c revised (3) Subparagraph (c) revised (4) Subparagraph (e) editorially revised
	Fig. 3-1	Revised
26	3A-350	(1) In subpara. (a), numerator in equation for L_c revised and new fifth paragraph added (2) Nomenclature for D_c and D_o revised (3) Nomenclature for D_i deleted (4) Nomenclature for t_{kr} added (5) Subparagraph (c) revised
27	Fig. 3-2	Added
	3A-360	Nomenclature for L_s revised

<i>Page</i>	<i>Location</i>	<i>Change</i>
34	4-330	Subparagraphs (c) and (d) revised
39	Fig. 4-3	Third sentence of General Note deleted
57	6-930	First paragraph of subpara. (d) revised
58–63	6-950	Last paragraph of subpara. (c) revised
	Table 6-1	On last page, Notes column for final entry revised
64, 65	7-600	Subparagraphs (b)(2) and (d) revised
70–72	Part 8	(1) Revised in its entirety (2) Figure 1-1 relocated from Part 1 and redesignated as Figure 8-1
112, 113	Mandatory Appendix M-4	Editorially revised; “must” revised to “shall” throughout
122	Table M6-1	Item 2 revised
129	M7-300	Last paragraph revised
134	Table M8-1	Title revised
140–142	Mandatory Appendix M-10	Updated
145	M12A-100	Subparagraphs (a), (c), and (e) revised
	M12B-100	Revised
	M12B-200	In first paragraph, sixth sentence revised
146–148	Table M12B-1	Revised in its entirety
	M12B-400	Subparagraphs (a) and (b) revised
	M12B-500	Revised in its entirety
	M12B-600	Revised in its entirety
	Table M12B-2	Revised in its entirety
	M12B-611	Revised
	M12B-612	Subparagraphs (a) and (c) revised
	M12B-613	(1) Former M12B-613.1 deleted and former M12B-613.2 through M12B-613.5 redesignated as M12B-613.1 through M12B-613.4, respectively (2) M12B-613.3 revised in its entirety (3) M12B-613.4 revised
	M12B-614.1	Revised
	M12B-614.2	Revised in its entirety
150	M12B-614.3	Revised in its entirety
	M12B-614.4	First sentence of subpara. (a) revised

<i>Page</i>	<i>Location</i>	<i>Change</i>
151–154	M12B-632	Subparagraph (a) revised
	M12B-634.1	Last sentence of subpara. (a) deleted
	Table M12B-6	(1) Reference to “Shelf life” deleted (2) Column 5 for Shelf Life Expiration Date deleted, and remaining columns renumbered
	M12B-634.2	Revised
156	M12B-652	Subparagraphs (a) and (b) revised
	M12B-654.1	Revised
	M12B-654.2	Subparagraphs (a) and (b) revised
	M12B-654.3	Revised in its entirety
	M12B-654.4	Revised
172	M12G-510	Subparagraph (d) revised
	M12G-520	Last sentence deleted
179, 180	M12H-300	Revised in its entirety
	M12H-311	Revised in its entirety
	M12H-312	Revised
	M12H-313	Editorially revised; “will” replaced with “shall” throughout
	M12H-400	Revised in its entirety
	Table M12H-1	(1) Deleted (2) Former Table M12H-2 redesignated as new Table M12H-1 and revised
	M12H-500	Revised
250	M12H-600	Added
	Nonmandatory Appendix NM-6	Editorially revised
273, 274	NM9-300	Subparagraphs (b), (g), (h), (i)(1), and (i)(5) revised
275	Fig. NM9-3	General Note (a) revised
307	Nonmandatory Appendix NM-14	Deleted

SPECIAL NOTE:

The interpretations to ASME RTP-1 are no longer included in the edition. Interpretations can be accessed on the ASME Web site under the Committee Pages at <http://cstools.asme.org/>.

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REINFORCED THERMOSET PLASTIC CORROSION-RESISTANT EQUIPMENT

Part 1 General Requirements

1-100 INTRODUCTION

Part 1 of this Standard defines the requirements that are applicable to all reinforced thermoset plastic corrosion resistant vessels fabricated to this Standard and shall be used in conjunction with the specific requirements in other Parts and Mandatory Appendices of this Standard.

1-110 Scope

(a) This Standard applies to stationary vessels used for the storage, accumulation, or processing of corrosive or other substances at pressures not exceeding 15 psig external and/or 15 psig internal above any hydrostatic head.

(b) In relation to the geometry of vessels, the scope of this Standard shall include the following:

(1) where external piping is to be connected to the vessel

(-a) the first threaded joint for screwed connections

(-b) the face of the first flange for bolted connections

(-c) the vessel side sealing surface for proprietary connections or fittings

(2) the vessel attachment joint when an attachment is made to either the external or internal surface of the vessel

(3) covers for vessel openings, such as manhole and handhole covers

(4) the vessel side sealing surface for proprietary fittings, such as gages and instruments, for which rules are not provided by this Standard

1-120 Exclusions

The following types of reinforced thermoset plastic equipment are excluded from the rules of this Standard:

(a) vessels with MAWP or MAEWP in excess of 15 psig

(b) hoods, ducts, and stacks

(c) fans and blowers

(d) vessel internals such as entrainment separators, chevron blades, packing support plates, and liquid distribution plates

(e) pumps

(f) pipe or piping (see ASME B31.3)

(g) fully buried underground closed vessels

1-130 Application Limitations

(17)

Vessels specified, designed, fabricated, and certified by the Fabricator as conforming to this Standard shall be limited to the following pressure and temperature limits:

(a) *Maximum Internal Pressure*¹

(1) *With Proof Test of As-Constructed Laminate.* The MAWP, measured at the top of the vessel, shall not be greater than 15 psig.

(2) *Without Proof Test of As-Constructed Laminate.* The MAWP shall not be greater than 2 psig.

(b) *Maximum External Pressure*¹

(1) *With Proof Test of As-Constructed Laminate.* The MAEWP shall not be greater than 15 psig.

(2) *Without Proof Test of As-Constructed Laminate.* The MAEWP shall not be greater than 2 psig.

(c) *Temperature Limits.* The design temperature shall be limited to a value for which mechanical properties have been determined by the procedures in paras. 2A-300(b) and 2B-200(a), and the chemical resistance has been established by the material selection process identified in Table 1-1, item 3.

Operating temperatures to 180°F maximum are commonly encountered and a large body of mechanical property and chemical resistance data exists to facilitate design. The design temperature shall not be less than the maximum operating temperature. See para. 3-300. Applications above 180°F require that the designer recognizes and accounts for possible reduced mechanical properties at the elevated temperature and possibly decreasing mechanical properties with time as a consequence of thermal and chemical exposure. Such elevated

¹ Refer to para. 6-930(d) for Proof Test requirements.

temperature applications require special design attention, and consultation with the resin manufacturer is essential.

(17) 1-200 USER'S BASIC REQUIREMENTS SPECIFICATION

It is the responsibility of the User, or an Agent acting on his/her behalf, who intends that a vessel be designed, constructed, inspected, tested, and certified to be in compliance with this Standard, to provide or cause to be provided for such vessel a User's Basic Requirements Specification (UBRS). The UBRS shall set forth the intended design conditions of the vessel to provide the basis for design and shall identify the external environment to which the vessel will be exposed, the intended function of the vessel, mechanical loads imposed on the vessel, specific installation requirements, and specific codes and laws applicable at the location where the vessel will be installed. The User also shall specify within the UBRS the type of resin required or define the contents to which the vessel shall be exposed.

See Table 1-1 for User's Basic Requirements Specification.

1-210 Service Restrictions

(a) When a vessel is to be used in a *critical service*, it shall be the responsibility of the User or the User's designated Agent to declare such in the UBRS.

(b) This Standard provides generalized guidelines to help the User or User's Agent in determining when a vessel should be declared to be in *critical service*. However, the User or User's Agent has sole authority and responsibility for such declaration. Any such declaration made is not a function of the scope, requirements, or content of this Standard, or of any firm or individual (other than the User or User's Agent) involved in any part of the process of using or determining proper use of the Standard.

(c) *Critical service* should be declared when the operating environment complies with all of the following conditions specified in (1) through (4) or the condition specified in (5):

(1) MAWP or MAEWP for the vessel is equal to or exceeds ± 5 psig and

(2) vessel is located in close proximity to areas frequented by personnel on a regular basis such that abrupt failure of the vessel would be likely to threaten the life or health of personnel and

(3) substance contained in the vessel is of such nature that if abruptly released it could threaten the life or health of personnel and

(4) substance contained is known by the User or User's Agent to degrade the physical strength properties of the RTP laminate at an abnormally high rate or

(5) substance contained is known by the User to be an insidious and extremely poisonous gas or liquid

of such a nature that a very small amount of the gas or of the vapor of the liquid mixed or unmixed with air is dangerous to life when inhaled, or of such a nature that a very small amount of the substance in contact with the body may be absorbed and cause a toxic reaction that is dangerous to life. By *insidious* is meant the substance is of such nature that exposure to the substance might result in a discomfort level not sufficient to warn of potentially severe and irreversible damage to an individual's health.

(d) Quantities in the system, concentrations, pressure, temperature, the nature of the environment, substance properties such as flammability and toxicity, and the potential for environmental pollution should also be considered by the User or User's Agent in order to determine whether a critical service should be declared.

1-220 Critical Service Requirements

(17)

(a) When a User or User's Agent has declared in the UBRS that a vessel is to be used in *critical service*, the following shall apply:

(1) Regardless of design pressure, all vessels declared to be in critical service shall be subjected to a Proof Test of the as-constructed laminate. Refer to para. 6-930(d).

(2) The vessel shall be specified, fabricated, and inspected to be in full compliance with Level 1, Critically Corrosion Resistant, visual inspection criteria as described in Table 6-1.

(3) Design factors for the physical strength properties of the laminate shall be at least 125% of those specified elsewhere in this Standard. Greater design factors may be warranted based on analysis of the expected design conditions and such factors as are outlined in para. 1-210(d). If so, they shall be specified by the User or User's Agent.

(4) Acoustic emission testing of RTP vessels has been found useful in identifying major defects. Its use as an additional verification of integrity for vessels to be used in critical service is optional.

(5) Postcure of critical service vessels is optional but should be given consideration. Postcure of RTP laminates is known to improve certain mechanical properties of the laminate and reduce residual styrene content, and may improve the corrosion resistance of the laminate. Other mechanical properties, such as elongation, may be reduced by postcure.

Consultations with the resin manufacturer and Fabricator should be conducted, and where postcure is to be employed, a specification defining procedures, methods, and a time-temperature program shall be specified by the User.

(b) Compared to steel, RTP materials have the following characteristics:

(1) the long-term effects of chemical and thermal degradation on mechanical properties are less well defined