

ASME RTP-1-2019
(Revision of ASME RTP-1-2017)

Reinforced Thermoset Plastic Corrosion-Resistant Equipment

AN AMERICAN NATIONAL STANDARD



**The American Society of
Mechanical Engineers**

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Mechanical Engineers**

Two Park Avenue • New York, NY • 10016 USA

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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 2019 edition of this Standard contains revisions to the 2017 edition, including metrication of the [Introduction](#), [Parts 1](#) through [8](#), and [Mandatory Appendices M-1](#) through [M-13](#). The 2019 edition was approved by the American National Standards Institute on July 26, 2019.

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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Reinforced Thermoset Plastic Corrosion-Resistant Equipment

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INTRODUCTION

(19)

GENERAL

The use of reinforced thermoset plastic (RTP) vessels, with maximum allowable working pressure (MAWP) and maximum allowable external working pressure (MAEWP) not exceeding 15.0 psig (103 kPag) external and/or 15.0 psig (103 kPag) 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.

UNITS

Either U.S. Customary Units or SI Units may be used to demonstrate compliance with the requirements of this Standard. It is not permissible to use a combination of both systems of units. Values are listed in the Standard with U.S. Customary Units as the primary units and with SI Units shown parenthetically. The SI Units values have been converted from the U.S. Customary Units values. Conversion of units shall be performed to ensure that dimensional consistency is maintained. For either system of units, the Qualified Designer is responsible for ensuring that all units are consistent and correct.

A supplement to the Standard is included as a convenience to the user to provide typical SI Units and commonly used conversion factors. Additional conversion factors are available in IEEE/ASTM SI 10.

ASME RTP-1-2019 SUMMARY OF CHANGES

Following approval by the ASME Committee and ASME, and after public review, ASME RTP-1-2019 was approved by the American National Standards Institute on July 26, 2019.

In ASME RTP-1-2019, SI units have been added in the Introduction, Parts 1 through 8, and Mandatory Appendices M1 through M13. In addition, the edition includes the following changes identified by a margin note, **(19)**.

<i>Page</i>	<i>Location</i>	<i>Change</i>
xii	Statement of Policy on the Use of the ASME Single Certification Mark and Code Authorization in Advertising	Revised
xii	Statement of Policy on the Use of ASME Marking to Identify Manufactured Items	Revised
xv	Introduction	“Units” paragraph added
1	1-200	Revised
4	Form 1-1	(1) Formerly Table 1-1, redesignated (2) Items 3.2 and 5.1 revised (3) Item 5.7 added
3	1-230	Added
3	1-300	Revised
3	1-400	Revised
8	1-520	Subparagraph (c) revised
10	Form 1-2	(1) Formerly Table 1-2, redesignated (2) General Note (a)(2) revised
12	Form 1-3	(1) Formerly Table 1-3, redesignated (2) General Note (a)(1) revised
15	2A-300	(1) Subparagraph (a) revised (2) Subparagraph (a)(3) added
20	3-100	Subparagraph (b) revised
20	3-300	(1) Title revised (2) Definitions of <i>design temperature</i> , <i>intermittent loads</i> , and <i>sustained loads</i> revised
22	3A-130	Subparagraph (c) added
26	3A-261	Subparagraph (e) revised
28	3A-350	Subparagraph (a) revised
28	3A-410	Revised
30	3A-500	Revised
31	3A-730	Subparagraph (e) revised
31	3B-100	Revised
35	4-110	Revised

<i>Page</i>	<i>Location</i>	<i>Change</i>
35	4-115	Added
35	4-320	Subparagraph (g) revised
44	Figure 4-6	"6:1 taper typ." callout revised to "Taper (typ.)," and General Note (a) revised
46	Figure 4-8	General Note (a) revised
48	Figure 4-10(a)	Formerly Figure 4-10, revised and redesignated
49	Figure 4-10(b)	Added
54	Table 4-2	Revised
58	6-500	Revised
60	6-930	(1) Subparagraph (d)(1)(-a) added and subsequent subparagraph redesignated (2) Subparagraph (d)(2) revised
61	6-950	Subparagraph (d) revised
63	Table 6-1	(1) In first column, "Wet blisters" revised to "Blisters," and related entries in second and last columns revised (2) Notes for "Wet-out" and "Maximum % repairs" revised
66	7-600	Subparagraphs (g) and (h) revised
67	Table 7-1	General Note (a) revised
67	7-610	Subparagraph (b) revised
68	Table 7-2	Req. Nos. (1) and (5) revised
69	Table 7-3	General Note (a) and Note (1) revised
68	7-620	Subparagraphs (a) and (b) revised
69	7-1000	First sentence and subparas. (a)(2) and (c)(2) revised
76	Form M1A-1	Formerly Table M1A-1, redesignated
77	M1A-430	Title revised
78	Form M1B-1	Formerly Table M1B-1, redesignated
80	Form M1C-1	Formerly Table M1C-1, redesignated
82	M1D-200	Last paragraph added
84	Form M1D-1	Formerly Table M1D-1, redesignated
85	M2-200	Revised
89	Form M2E-1	Formerly Table M2E-1, redesignated
90	Form M2E-2	Formerly Table M2E-2, redesignated
91	Form M2F-1	Formerly Table M2F-1, redesignated
93	M3-200	Revised
101	M3-330	Revised
104	M3-400	Revised
107	M3-510	Revised
109	M3-600	Revised in its entirety
110	Table M3-1	Revised
116	Table M3-2	Revised
117	Table M3-3	Revised
118	Table M3-4	Revised
120	M4-300	Subparagraphs (a) and (c) revised
122	M5-100	Subparagraphs (b) and (c) revised
124	Form M5-1	Formerly Table M5-1, redesignated

<i>Page</i>	<i>Location</i>	<i>Change</i>
125	Form M5-2	Formerly Table M5-2, redesignated
131	Table M6-1	Item 2 revised
135	Figure M6-1	Revised
137	Figure M6-3	Item (b) revised
138	M7-210	Subparagraph (c) revised
139	M7-500	Revised
140	M7-630	Revised
140	M7-642	Revised
141	M7-644	Subparagraph (d) revised
141	M7-663	Subparagraph (d) revised
145	Mandatory Appendix M-9	Definitions of <i>certify</i> , <i>quality assurance</i> , and <i>quality control</i> revised
154	M12B-200	Subparagraph (a) revised
155	M12B-600	Subparagraph (c) revised
156	Table M12B-2	Editorially reformatted
157	M12B-613.1	Subparagraph (a) revised
158	Form M12B-3	Formerly Table M12B-3, redesignated
160	M12B-632	Revised
161	Form M12B-5	Formerly Table M12B-5, redesignated
162	Form M12B-6	Formerly Table M12B-6, redesignated
164	Form M12B-7	Formerly Table M12B-7, redesignated
166	Form M12B-8	Formerly Table M12B-8, redesignated
169	M12D-420	Revised
173	M12D-510	Subparagraph (a) revised
175	Figure M12D-6	Revised
176	Figure M12D-7	Revised
178	Figure M12D-8	Revised
177	M12D-920	Revised
181	Figure M12G-1	Revised
187	M12H-400	Subparagraph (a) revised
191	Form M13-1	Formerly Table M13-1, redesignated
212	Table NM2-1	(1) Last column heading and General Note (a) revised (2) General Note (e) added
214	Table NM2-2	(1) Editorially reformatted (2) General Note (a) revised
216	Table NM2-3	(1) Editorially reformatted (2) General Note (a) revised, and former General Note (b) redesignated as Note (1)
229	NM3-100	Note revised
235	NM3-331	Revised
265	Form NM6-1	Formerly Table NM6-1, redesignated
266	Form NM6-2	Formerly Table NM6-2, redesignated
267	Form NM6-3	Formerly Table NM6-3, redesignated
270	Form NM6-6	Formerly Table NM6-6, revised and redesignated
272	Form NM6-7	Formerly Table NM6-7, redesignated

<i>Page</i>	<i>Location</i>	<i>Change</i>
274	Form NM7-1	Formerly Table NM7-1, redesignated
275	Form NM7-2	Formerly Table NM7-2, redesignated
280	NM8-200	Subparagraph (c) revised
286	NM10-300	Revised
287	NM10-400	Revised
287	NM10-500	Revised
293	NM12-320	Subparagraphs (a) and (b) added
293	NM12-330	Subparagraphs (a) and (b) added
294	NM12-350	Revised
294	NM12-360	Revised
294	NM12-400	Revised
332	SI Units	First paragraph revised

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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 15.0 psig (103 kPag) external and/or 15.0 psig (103 kPag) 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 15.0 psig (103 kPag)

(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

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 15.0 psig (103 kPag).

(2) *Without Proof Test of As-Constructed Laminate.* The MAWP shall not be greater than 2.0 psig (14 kPag).

(b) *Maximum External Pressure*¹

(1) *With Proof Test of As-Constructed Laminate.* The MAEWP shall not be greater than 15.0 psig (103 kPag).

(2) *Without Proof Test of As-Constructed Laminate.* The MAEWP shall not be greater than 2.0 psig (14 kPag).

(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 [Form 1-1](#), item 3.

Operating temperatures to 180°F (82°C) 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 (82°C) 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 temperature applications require special design attention, and consultation with the resin manufacturer is essential.

1-200 USER'S BASIC REQUIREMENTS SPECIFICATION

(19)

It is the responsibility of the User, or an Agent acting on the User's 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

¹ Refer to [para. 6-930\(d\)](#) for Proof Test requirements.