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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The next edition of this Standard is scheduled for publication in 2019. This Standard will become effective 6 months after the Date of Issuance.

ASME issues written replies to inquiries concerning interpretations of technical aspects of this Standard. Periodically certain actions of the ASME RTP Committee may be published as Cases. Cases and interpretations are published on the ASME Web site under the Committee Pages at http://cstools.asme.org/ as they are issued.

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The American Society of Mechanical Engineers
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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 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.

STATEMENT OF POLICY ON THE USE OF CERTIFICATION MARKS 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 Codes and Standards. 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 Codes and Standards may state this capability in its advertising literature.

Organizations that are authorized to use Certification Marks for making items or constructions that have been constructed and inspected in compliance with ASME Codes and Standards are issued Certificates of Authorization. It is the aim of the Society to maintain the standing of the Certification Marks for the benefit of the users, the enforcement jurisdictions, and the holders of the Certification Marks who comply with all requirements.

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Certified by _____.
(Manufacturer)

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Reinforced Thermoset Plastic Corrosion-Resistant Equipment

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(17)

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)**.

Page	*Location*	*Change*
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

Page	*Location*	*Change*
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

Page	*Location*	*Change*
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
	M12H-600	Added
250	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