ASME RTP-1–2013
(Revision of ASME RTP-1–2011)

Reinforced Thermoset Plastic Corrosion-Resistant Equipment

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

INTENTIONALLY LEFT BLANK

ASME RTP-1–2013
(Revision of ASME RTP-1–2011)

Reinforced Thermoset Plastic Corrosion-Resistant Equipment

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers
Two Park Avenue • New York, NY • 10016 USA

Date of Issuance: November 26, 2013

The next edition of this Standard is scheduled for publication in 2015. 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.

Errata to codes and standards may be posted on the ASME Web site under the Committee Pages to provide corrections to incorrectly published items, or to correct typographical or grammatical errors in codes and standards. Such errata shall be used on the date posted.

The Committee Pages can be found at http://cstools.asme.org/. There is an option available to automatically receive an e-mail notification when errata are posted to a particular code or standard. This option can be found on the appropriate Committee Page after selecting "Errata" in the "Publication Information" section.

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

CONTENTS

Figures

Tables

Mandatory Appendices

Figures

Tables

Nonmandatory Appendices

Figures

Tables

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 2013 edition of this Standard contains revisions to the 2011 edition and was approved by the American National Standards Institute on May 28, 2013.

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.

Based on these objectives, the following policy has been established on the usage in advertising of facsimiles of the Certification Marks, Certificates of Authorization, and references to Codes or Standards 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 a 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 applicable ASME Code or Standard." An ASME corporate logo shall not be used by any organization other than ASME.

The Certification Mark shall be used only for stamping and nameplates as specifically provided in the Code or Standard. However, facsimiles may be used for the purpose of fostering the use of such construction. Such usage may be by an association or a society, or by a holder of a Certification Mark who may also use the facsimile in advertising to show that clearly specified items will carry the Certification Mark. General usage is permitted only when all of a manufacturer's items are constructed under the rules of the applicable Code or Standard.

STATEMENT OF POLICY ON THE USE OF ASME MARKING TO IDENTIFY MANUFACTURED ITEMS

The ASME Codes and Standards provide rules for the construction of various items. These include requirements for materials, design, fabrication, examination, inspection, and stamping. Items constructed in accordance with all of the applicable rules of ASME are identified with the official Certification Mark described in the governing Code or Standard.

Markings such as "ASME," "ASME Standard," or any other marking including "ASME" or the 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.

Items shall not be described on ASME Data Report Forms nor on similar forms referring to ASME that tend to imply that all 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.

ASME's certification related to products means that the capability by the supplier to fulfill requirements in the applicable standard has been reviewed and accepted by ASME. The supplier is responsible for ensuring that products meet, and if applicable continue to meet, the requirements on which the certification is based. This shall be made clear on stampings, labels, or nameplate markings by inclusion of the words:

Certified by _____.
(Manufacturer)

ASME RTP COMMITTEE
Reinforced Thermoset Plastic Corrosion Resistant Equipment

(The following is the roster of the Committee at the time of approval of this Standard.)

STANDARDS COMMITTEE OFFICERS

D. L. Keeler, *Chair*
P. D. Stumpf, *Secretary*

STANDARDS COMMITTEE PERSONNEL

M. W. Arthur, An-Cor Industrial Plastics, Inc.
F. L. Brown, NBBI
J. L. Bustillos, Bustillos & Associates, LLC
B. R. Colley, Ashland Composite Polymers
L. J. Craigie, Composites Resource
R. A. Crawford, L & M Fiberglass, Inc.
R. B. Davis, Ershigs, Inc.
C. R. Green, Fluor, Inc.
B. Hebb, RPS Composites, Inc.
D. H. Hodgkinson, Consultant
W. F. Holtzclaw, Holtec, LLC
D. L. Keeler, Dow Chemical Co.
R. J. Lewandowski, Corrosion Resistant Composite Consultant
S. R. Linnemann, RL Industries, Inc.
H. N. Marsh, Jr., *Contributing Member,* Consultant
B. F. Shelley, DuPont Engineering Co.
K. J. Spoo, Owens Corning
P. D. Stumpf, The American Society of Mechanical Engineers
J. E. Vacek, Dow Chemical Co.
G. A. Van Beek, Southern Co. Services
F. W. Van Name, Consultant
H. T. Wells, Albemarle Corp.
O. W. Siebert, *Honorary Member,* Siebert Materials Engineering, Inc.

SUBCOMMITTEE ON DESIGN AND FABRICATION

D. L. Keeler, *Chair,* Dow Chemical Co.
M. W. Arthur, An-Cor Industrial Plastics, Inc.
J. L. Bustillos, Bustillos & Associates, LLC
J. Criner, Plant Maintenance Services
W. Daugherty, Beetle Plastics, LLC
J. D. Eisenman, Maverick Applied Science, Inc.
C. R. Green, Fluor, Inc.
B. Hebb, Reinforced Plastic Systems
D. H. Hodgkinson, Consultant
F. Z. Krmpotich, Belding Tank Technologies
A. L. Newberry, Femech Engineering
R. W. Newbold, RL Industries, Inc.
D. S. Preston, Belco Manufacturing
J. M. Puthoff, Plas-Tanks Industries, Inc.
K. V. Rathnam, Ershigs, Inc.
B. E. Riseborough, Replacom Engineering
B. F. Shelley, DuPont Engineering Co.
K. Sherman, Beetle Plastics, LLC
Z. Siveski, Bechtel Power
A. Springer, Anvil Corp.
T. G. Toth, Midwest Towers, Inc.
F. W. Van Name, Consultant
R. J. Vatovec, Southern Co. Services
S. L. Wagner, Finite Composites Consulting

SUBCOMMITTEE ON DUAL LAMINATES

G. P. Gentry, *Chair,* DOW Engineering Solutions
S. Zittrer, *Vice Chair,* Lubrizol Advanced Materials
J. K. Argasinski, Solvay Solexis
D. Chandler, Engiplast, Inc.
P. Habib, CPF Dualam, Inc.
B. Hutton, Lubrizol
L. T. Hutton, Arkema, Inc.
S. R. Linnemann, RL Industries, Inc.
G. McCuaiag, CPF Dualam, Inc.
D. Reinke, Augusta Fiberglass
A. Rickert, SYMALIT Linings
T. C. Schoessel, Tri-Clor, Inc.
J. E. Vacek, Dow Chemical Co.

SUBCOMMITTEE ON EDITORIAL

R. B. Davis, Ershigs, Inc.
T. Fridman, Vanasyl LLC
D. H. Hodgkinson, Consultant

SUBCOMMITTEE ON MATERIAL QUALITY ASSURANCE

B. M. Linnemann, *Chair,* RL Industries, Inc.
F. L. Brown, NBBI
B. R. Colley, Ashland Composite Polymers
T. W. Cowley, DuPont Engineering Co.
L. J. Craigie, Composites Resource
R. A. Crawford, L & M Fiberglass, Inc.
R. B. Davis, Ershigs, Inc.
M. E. Guenat, Belco Manufacturing
R. W. Gulley, RL Industries, Inc.
T. Haber, Composite Technologies, LLC
W. F. Holtzclaw, Holtec, LLC
R. J. Lewandowski, Corrosion Resistant Composite Consultant
H. N. Marsh, Jr., *Contributing Member,* Consultant
G. L. Nicholson, Tri-Clor, Inc.
J. R. Richter, Plant Maintenance Services
S. Spahn, Consultant
K. J. Spoo, Owens Corning
R. J. Stadelman, Reichhold, Inc.
F. E. Templeton, Augusta Fiberglass
G. A. Van Beek, Southern Co. Services
G. Ward, AOC, LLC
H. T. Wells, Albemarle Corp.

INTRODUCTION

GENERAL

The use of reinforced thermoset plastic (RTP) vessels, operating at pressures 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.

ASME RTP-1–2013
SUMMARY OF CHANGES

Following approval by the RTP Committee and ASME, and after public review, ASME RTP-1–2013 was approved by the American National Standards Institute on May 28, 2013.

ASME RTP-1–2013 includes the following changes identified by a margin note, **(13)**.

Page	*Location*	*Change*
1	1-110	Subparagraph (b)(4) revised
2	1-200	Last sentence of first paragraph revised
	1-220	Subparagraph (a)(1) revised
3–6	Table 1-1	Sections 4 and 6 revised
7	1-400	Second, third, and fourth paragraphs revised
	1-410	(1) Subparagraph (h) revised (2) Subparagraph (i) deleted
	1-430	First paragraph revised
8	1-520	(1) Subparagraph (b) revised (2) Subparagraph (d) added
9, 10	Table 1-2	Second page revised
11	Table 1-3	Revised
12	1-540	(1) Subparagraph (a)(1) deleted and subsequent subparagraphs redesignated (2) New subparagrah (b) added (3) Previous (b) redesignated as (c) and revised
	1-550	Subparagraphs (a)(1), (a)(2), (a)(3), and (b)(3) revised
13	2-210	Revised
	2-310	Subparagraphs (a) and (b) revised
	2-320	Subparagraph (a) revised
14, 17	2A-223	Subparagraphs (c) and (e) revised
	2A-300	Subparagraphs (b) and (c) revised
17	Table 2A-3	Note (1) revised
	2A-400	Subparagraph (a) revised
18	2A-600	Subparagraphs (a) and (b) revised
19	2B-400	Revised
	2C-100	Revised

Page	*Location*	*Change*
20, 21	3-300	Definitions of *maximum allowable external working pressure* (formerly *maximum allowable external gage pressure*) and *maximum allowable working pressure* revised
22	3A-125	Revised
	3A-126	Revised
23	3A-221	Subparagraph (a) revised
	3A-222	Subparagraph (a) revised
24, 25	3A-250	Subparagraphs (a) and (e) revised
	3A-260	Subparagraph (f) revised
26	3A-310	(1) Nomenclature for *KD* revised (2) Nomenclature for Z_p corrected by errata (3) Note (1) added (4) Existing Note designated as (2)
28	3A-462	Subparagraph (a) revised
29	3A-700	Subparagraph (b) revised
30	3B-100	First paragraph revised
	3B-220	Subparagraph (e) revised
32	3B-600	First sentence revised
	3B-700	Revised
33, 34	4-110	Revised
	4-320	Subparagraphs (e) and (f) revised
40	Figure 4-4	General Note revised
41	Figure 4-5	General Note revised
42	Table 4-3	General Note revised
44	Figure 4-7	General Note (b) revised
47	Figure 4-10	General Note (c) revised
49	Figure 4-12	Note (1) revised
50	Figure 4-13	Note (2) revised
52	5-110	Subparagraphs (a), (b), and (d) revised
	5-130	Revised
55, 56	6-900	Subparagraph (a)(6) revised
	6-910	Subparagraphs (b)(3) and (b)(4) revised
57, 58	6-930	Subparagraphs (c), (d)(1), and (d)(3) revised
68	7-1000	Subparagraph (c)(1) revised
73	Mandatory Appendix M-1, Article A	Title revised

Page	*Location*	*Change*
82	M2-100	Revised
113	M4-300	Subparagraph (b) revised
137–140	Mandatory Appendix M-9	(1) Definition of *Barcol hardness test* revised (2) Definition of *original document* added (3) Definition of *surfacing veil (mat)* revised to read *surfacing veil*
141	Mandatory Appendix M-10	(1) Addresses of ASME and AWS updated (2) ASME B18.22.1 replaced by ASME B18.21.1 (3) ASTM D3039 added
143	M11-200	Subparagraph (b) revised
206	Table NM2-1	Last entry in fifth column revised
257	Nonmandatory Appendix NM-6, 6.4.2	Revised
282	Figure NM10-1	General Note (b) deleted

SPECIAL NOTE:

The interpretations and cases to RTP-1 are provided in separate sections for the user's convenience.

INTENTIONALLY LEFT BLANK

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.

(13) 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 internal operating pressure 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

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 internal operating pressure, measured at the top of the vessel, shall not be greater than 15 psig.

(2) Without Proof Test of As-Constructed Laminate. The internal operating pressure, measured at the top of the vessel, shall not be greater than 2 psig.

(b) Maximum External Pressure[1]

(1) With Proof Test of As-Constructed Laminate. The limit on external operating pressure is 15 psig.

(2) Without Proof Test of As-Constructed Laminate. The limit on external operating pressure is 2 psig.

(c) Temperature Limits. The operating 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.

In general, operating temperatures to 180°F maximum are commonly encountered and a large body of mechanical property and chemical resistance data exists to facilitate design. 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 temperature applications require special design attention, and consultation with the resin manufacturer is essential.

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