

ASME NM.2-2020
(Revision of ASME NM.2-2018)

Glass-Fiber-Reinforced Thermosetting-Resin Piping Systems

**ASME Standards for Nonmetallic
Pressure Piping Systems**

AN AMERICAN NATIONAL STANDARD



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Mechanical Engineers**

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Two Park Avenue • New York, NY • 10016 USA

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CONTENTS

Foreword	vi	
Committee Roster	vii	
Correspondence With the NPPS Committee	ix	
Introduction	xi	
Summary of Changes	xiii	
Chapter 1	Scope and Definitions	1
1-1	Scope	1
1-2	Terms and Definitions	1
1-3	Abbreviations	4
Chapter 2	Design	5
2-1	Design Conditions	5
2-2	Design Criteria	7
2-3	Pressure Design of Piping Components	12
2-4	Pipe Stress Analysis	22
2-5	Piping Support	26
2-6	Special Criteria	28
Chapter 3	Constituent Materials	31
3-1	General	31
3-2	Materials and Specifications	31
3-3	Temperature Limitations	31
Chapter 4	Standards for Piping Components	33
4-1	Dimensions and Ratings of Components	33
4-2	References	33
4-3	Quality Assurance and Conformance	33
Chapter 5	Fabrication, Assembly, and Erection	40
5-1	General	40
5-2	Bonding	40
5-3	Assembly and Erection	43
Chapter 6	Inspection, Examination, and Testing	47
6-1	Inspection	47
6-2	Examination	47
6-3	Testing	50
6-4	Records	52
Mandatory Appendices		
I	Design of Integral Flat-Face Flanges	53
II	Calculation of Physical and Mechanical Properties Using the Laminate Analysis Method .	63
III	Stress Intensification Factors, Flexibility Factors, and Pressure Stress Multipliers	79

IV	Specification for 55-Deg Filament-Wound Glass-Fiber-Reinforced Thermosetting-Resin (FRP) Pipe	85
V	Inspections and Testing of Reinforcement Materials	90
VI	Examination and Testing Requirements for Vinyl Ester Resin, Polyester Resin, and Additive Materials	100

Nonmandatory Appendices

A	Pipe Support Calculations and Simplified Stress Analysis for FRP Piping System Design .	107
B	Alternative Testing Grips and Brackets (Modification to ASTM D2105)	115
C	Guidance on Repairs	117

Figures

2-2.3.1-1	Allowable Stress Envelope	9
2-3.3.1-1	Nomenclature for Smooth Radius Elbows	14
2-3.3.2-1	Nomenclature for Mitered Elbows	15
2-3.4.1-1	Detail for Fabricated Branch	17
2-3.4.3-1	Detail for Integrally Molded Tees	19
2-3.5.1-1	Knuckle Reinforcement for Torispherical Closures	20
5-2.5.2-1	Adhesive Joint	42
5-2.5.3-1	Wrapped Joints	42
5-3.1.2.1-1	Assembly Tolerances and Alignment	44
5-3.1.2.4-1	Flange Tolerances	45
I-2.3-1	Typical Flange Designs	54
I-3.3-1	Design of Flat-Face Integral Flanges	57
I-3.3-2	Values of V (Integral Flange Factor)	58
I-3.3-3	Values of F (Integral Flange Factor)	58
I-3.3-4	Values of f (Hub Stress Correction Factor)	59
I-3.3-5	Values of T , U , Y , and Z (Terms Involving K)	60
II-2-1	Coordinate System	63
II-4-1	In Place Force Resultants	71
II-4-2	Moment Resultants	72
II-4-3	Notations for Ply Positions and Laminate Stacking Sequence	73
A-5-1	Example Problem Layout	114
B-1-1	Alternative Testing Bracket	116

Tables

2-2.3.6-1	Component Sizes Qualified by Proof-of-Design Testing	11
3-2.1-1	Listed Constituent Materials	31
3-3.1-1	Temperature Limits for Acceptable Polymeric Materials	32
4-1.1-1	Component Specifications	34
4-1.1-2	Test Methods and Other Standards	35
4-1.1-3	Procurement Information	36
4-3.2-1	Visual Inspection Acceptance Criteria	37
6-2.2.2-1	Acceptance Criteria for Bonds	48
I-3.3-1	Flange Factors in Formula Form	61
A-3.1-1	Guidance to Span Lengths	109

Forms

V-2.2-1	Veil and Mat Reinforcement Log Sheet	96
V-3.2-1	Roving Reinforcement Log Sheet	97
V-4.2-1	Fabric Reinforcement Log Sheet	98
V-5.2-1	Milled Fiber Reinforcement Log Sheet	99
VI-6-1	Resin Log Sheet	104
VI-6-2	Curing Agent Log Sheet	105
VI-7.2-1	Common Additives Log Sheet	106

FOREWORD

In 2011, The American Society of Mechanical Engineers (ASME) established the Committee on Nonmetallic Pressure Piping Systems (NPPS) to develop standards for the construction of nonmetallic pressure piping systems. This Committee's goal was to specify construction¹ requirements for nonmetallic piping and piping products; such requirements were not adequately defined in existing standards.

Prior to the development of the ASME Standards for Nonmetallic Pressure Piping Systems, nonmetallic pressure piping requirements were contained within several existing standards. The nonmetallic piping requirements of the ASME B31 Code for Pressure Piping varied across Sections, with some Sections having no requirements for nonmetallic components at all. Other standards and codes, such as ASME RTP-1 and the ASME Boiler and Pressure Vessel Code (BPVC), Section X, included requirements for reinforced thermoset plastic (RTP) corrosion-resistant equipment but not for piping and piping components. ASME BPVC, Section III did have a few Code Cases that addressed requirements for some nonmetallic piping and piping components, including those made from glass-fiber-reinforced thermosetting resin (FRP) and a few thermoplastics, e.g., high-density polyethylene (HDPE) and poly(vinyl chloride) (PVC). However, the scope of these Code Cases was very limited, and in some cases the methodology was nearly 30 years old. The ASME NPPS Standards now serve as a centralized location for NPPS requirements and are developed by committees whose members are experts in this field. The NPPS Committee's functions are to establish requirements related to pressure integrity for the construction of nonmetallic pressure piping systems, and to interpret these requirements when questions arise regarding their intent.

ASME NM.2 provides requirements for construction of FRP piping and piping components. This Standard addresses pipe and piping components that are produced as standard products, and custom products that are designed for a specific application. ASME NM.2-2018 (first edition) was approved by the American National Standards Institute (ANSI) on August 13, 2018.

The 2020 edition includes revisions to Mandatory Appendix II that add example calculations, cautionary notes, and methods to compute classical lamination theory (CTE) of lamina and laminates. Additionally, Nonmandatory Appendix A has been reorganized and revised, and section A-5 has been added. Section A-5 includes a simplified stress analysis of a sample pipeline and illustrates the application of the design approach, equations, and physical properties of NM-2 piping systems. Further, the 2020 edition revises and clarifies figures, definitions, and nomenclature for NM-2 piping systems.

Following approval by the ASME NPPS Standards Committee, ASME NM.2-2020 was approved by the American National Standards Institute (ANSI) on December 9, 2020.

¹ *Construction*, as used in this Foreword, is an all-inclusive term comprising materials, design, fabrication, erection, examination, inspection, testing, and overpressure protection.

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Nonmetallic Pressure Piping Systems

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If the Inquirer is unable to use the online form, he/she may mail the request to the Secretary of the NPPS Standards Committee at the above address. The request for an interpretation should be clear and unambiguous. It is further recommended that the Inquirer submit his/her request in the following format:

- Subject: Cite the applicable paragraph number(s) and the topic of the inquiry in one or two words.
- Edition: Cite the applicable edition of the Standard for which the interpretation is being requested.
- Question: Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for an approval of a proprietary design or situation. Please provide a condensed and precise question, composed in such a way that a “yes” or “no” reply is acceptable.
- Proposed Reply(ies): Provide a proposed reply(ies) in the form of “Yes” or “No,” with explanation as needed. If entering replies to more than one question, please number the questions and replies.
- Background Information: Provide the Committee with any background information that will assist the Committee in understanding the inquiry. The Inquirer may also include any plans or drawings that are necessary to explain the question; however, they should not contain proprietary names or information.

Requests that are not in the format described above may be rewritten in the appropriate format by the Committee prior to being answered, which may inadvertently change the intent of the original request.

Moreover, ASME does not act as a consultant for specific engineering problems or for the general application or understanding of the Standard requirements. If, based on the inquiry information submitted, it is the opinion of the Committee that the Inquirer should seek assistance, the inquiry will be returned with the recommendation that such assistance be obtained.

ASME procedures provide for reconsideration of any interpretation when or if additional information that might affect an interpretation is available. Further, persons aggrieved by an interpretation may appeal to the cognizant ASME Committee or Subcommittee. ASME does not “approve,” “certify,” “rate,” or “endorse” any item, construction, proprietary device, or activity.

Attending Committee Meetings. The NPPS Standards Committee regularly holds meetings and/or telephone conferences that are open to the public. Persons wishing to attend any meeting and/or telephone conference should contact the Secretary of the NPPS Standards Committee.

INTRODUCTION

(20)

The ASME Standards for Nonmetallic Pressure Piping Systems (NPPS) are as follows:

- NM.1 Thermoplastic Piping Systems: This Standard contains requirements for piping and piping components that are produced using thermoplastic resins or compounds. Thermoplastics are a specific group of nonmetallic materials that, for processing purposes, are capable of being repeatedly softened by increase of temperature and hardened by decrease of temperature.
- NM.2 Glass-Fiber-Reinforced Thermosetting-Resin Piping Systems: This Standard contains requirements for piping and piping components that are produced using glass-fiber reinforcement embedded in or surrounded by cured thermosetting resin.
- NM.3 Nonmetallic Materials: This Standard includes specifications for nonmetallic materials (except wood, nonfibrous glass, and concrete) and, in conformance with the requirements of the individual construction standards, methodologies, design values, limits, and cautions on the use of materials. This Standard is divided into three Parts:
 - NM.3.1, Nonmetallic Materials, Part 1 — Thermoplastic Material Specifications: This Part contains thermoplastic material specifications identical to or similar to those published by the American Society for Testing and Materials (ASTM International) and other recognized national or international organizations.
 - NM.3.2, Nonmetallic Materials, Part 2 — Reinforced Thermoset Plastic Material Specifications: This Part contains reinforced thermoset plastic material specifications identical to or similar to those published by ASTM and other recognized national or international organizations.
 - NM.3.3, Nonmetallic Materials, Part 3 — Properties: This Part provides tables and data sheets for allowable stresses, mechanical properties (e.g., tensile and yield strength), and physical properties (e.g., coefficient of thermal expansion and modulus of elasticity) for nonmetallic materials.

It is the owner's responsibility to select the piping standard that best applies to the proposed piping installation. Factors to be considered by the owner include limitations of the standard, jurisdictional requirements, and the applicability of other standards. All applicable requirements of the selected standard shall be met. For some installations, more than one standard may apply to different parts of the installation. The owner is also responsible for imposing requirements supplementary to those of the standard if such requirements are necessary to ensure safe piping for the proposed installation.

Certain piping within a facility may be subject to other codes and standards, including but not limited to the following:

- ASME B31.1, Power Piping: This code contains requirements for piping typically found in electric power generating stations, industrial and institutional plants, geothermal heating systems, and central and district heating and cooling systems.
- ASME B31.3, Process Piping: This code contains requirements for piping typically found in petroleum refineries; onshore and offshore petroleum and natural gas production facilities; chemical, pharmaceutical, textile, paper, ore-processing, semiconductor, and cryogenic plants; food- and beverage-processing facilities; and related processing plants and terminals.
- ASME B31.4, Pipeline Transportation Systems for Liquids and Slurries: This code contains requirements for piping transporting products that are predominately liquid between plants and terminals, and within terminals and pumping, regulating, and metering stations.
- ASME B31.5, Refrigeration Piping and Heat Transfer Components: This code contains requirements for piping for refrigerants and secondary coolants.
- ASME B31.8, Gas Transmission and Distribution Piping Systems: This code contains requirements for piping transporting products that are predominately gas between sources and terminals, including compressor, regulating, and metering stations; and gas gathering pipelines.
- ASME B31.9, Building Services Piping: This code contains requirements for piping typically found in industrial, institutional, commercial, and public buildings, and in multi-unit residences, which does not require the range of sizes, pressures, and temperatures covered in ASME B31.1.

ASME B31.12, Hydrogen Piping and Pipelines: This code contains requirements for piping in gaseous and liquid hydrogen service, and pipelines in gaseous hydrogen service.

National Fuel Gas Code: This code contains requirements for piping for fuel gas from the point of delivery to the connection of each fuel utilization device.

NFPA 99, Health Care Facilities: This standard contains requirements for medical and laboratory gas systems.

NFPA Fire Protection Standards: These standards contain requirements for fire protection systems using water, carbon dioxide, halon, foam, dry chemicals, and wet chemicals.

The ASME NPPS Standards specify engineering requirements deemed necessary for safe design and construction of nonmetallic pressure piping. These Standards contain mandatory requirements, specific prohibitions, and nonmandatory guidance for construction activities. These Standards do not address all aspects of these activities, and those aspects that are not specifically addressed should not be considered prohibited. While safety is the overriding consideration, this factor alone will not necessarily govern the final specifications for any piping installation. With few exceptions, the requirements do not, of practical necessity, reflect the likelihood and consequences of deterioration in service related to specific service fluids or external operating environments. These Standards are not design handbooks. Many decisions that must be made to produce a safe piping installation are not specified in detail within these Standards. These Standards do not serve as substitutes for sound engineering judgment by the owner and the designer. The phrase *engineering judgment* refers to technical judgments made by knowledgeable designers experienced in the application of these Standards. Engineering judgments must be consistent with the philosophy of these Standards, and such judgments must never be used to overrule mandatory requirements or specific prohibitions of these Standards.

To the greatest possible extent, Standard requirements for design are stated in terms of basic design principles and formulas. These are supplemented as necessary with specific requirements to ensure uniform application of principles and to guide selection and application of piping elements. These Standards prohibit designs and practices known to be unsafe and contain warnings where caution, but not prohibition, is warranted.

These Standards generally specify a simplified approach for many of their requirements. A designer may choose to use a more rigorous analysis to develop design and construction requirements. When the designer decides to take this approach, he or she shall provide to the owner details and calculations demonstrating that design, fabrication, examination, inspection, testing, and overpressure protection are consistent with the criteria of these Standards. These details shall be adequate for the owner to verify the validity of the approach and shall be approved by the owner. The details shall be documented in the engineering design.

The designer is responsible for complying with requirements of these Standards and demonstrating compliance with the equations of these Standards when such equations are mandatory. These Standards neither require nor prohibit the use of computers for the design or analysis of components constructed to the requirements of these Standards. However, designers and engineers using computer programs for design or analysis are cautioned that they are responsible for all technical assumptions inherent in the programs they use and for the application of these programs to their design.

These Standards do not fully address tolerances. When dimensions, sizes, or other parameters are not specified with tolerances, the values of these parameters are considered nominal, and allowable tolerances or local variances may be considered acceptable when based on engineering judgment and standard practices as determined by the designer.

Suggested requirements of good practice are provided for the care and inspection of in-service nonmetallic pressure piping systems only as an aid to owners and their inspectors.

The requirements of these Standards are not to be interpreted as approving, recommending, or endorsing any proprietary or specific design or as limiting in any way the manufacturer's freedom to choose any method of design or any form of construction that conforms to the requirements of these Standards.

It is intended that editions of the ASME NPPS Standards not be retroactive. Unless agreement is specifically made between contracting parties to use another edition, or the regulatory body having jurisdiction imposes the use of another edition, the latest edition issued at least 6 months prior to the original contract date for the first phase of activity covering a piping installation shall be the governing document for all design, materials, fabrication, erection, examination, inspection, testing, and overpressure protection for the piping until the completion of the work and initial operation. Revisions to material specifications included in ASME NM.3.1 and ASME NM.3.2 are originated by ASTM and other recognized national or international organizations, and are usually adopted by ASME. However, those revisions do not necessarily indicate that materials produced to earlier editions of specifications are no longer suitable for ASME construction. Both ASME NM.3.1 and ASME NM.3.2 include a Mandatory Appendix, "Guideline on Acceptable ASTM Editions," that lists the latest edition of material specifications adopted by ASME as well as other editions considered by ASME to be identical for ASME construction.

Users of these Standards are cautioned against making use of revisions to these Standards without assurance that they are acceptable to the proper authorities in the jurisdiction where the piping is to be installed.

ASME NM.2-2020 SUMMARY OF CHANGES

Following approval by the ASME NM Committee and ASME, and after public review, ASME NM.2-2020 was approved by the American National Standards Institute on December 9, 2020.

ASME NM.2-2020 includes the following changes identified by a margin note, **(20)**.

<i>Page</i>	<i>Location</i>	<i>Change</i>
xi	Introduction	Updated
1	1-2	(1) Definitions of <i>assembly, erection, lower deviated value (LDV), may, manufacturing, pipe-supporting elements, shall, short-term hydrostatic strength (STHS), should, and supporting structures</i> added (2) Definitions of <i>corrosion barrier</i> and <i>fabrication</i> revised (3) Definition of <i>liner</i> deleted
4	1-3	(1) Abbreviations of <i>LDV (lower deviated value)</i> and <i>STHS (short-term hydrostatic strength)</i> added (2) Abbreviation of <i>LTHS (long-term hydrostatic stress)</i> revised
5	2-1.1	Revised
7	2-2.2.1	Subparagraph (a) revised
8	2-2.3.1	Subparagraph (a)(4) revised
8	2-2.3.2	Revised
11	2-2.3.6	Subparagraphs (b) and (e)(3) revised
12	2-3.2.1	Revised
12	2-3.2.2	Revised
13	2-3.2.3	Revised
13	2-3.3.1	Revised
21	2-3.8.2	Subparagraph (b) revised
23	2-4.4.1	Subparagraph (c) revised
23	2-4.4.2	Revised
24	2-4.4.4	Revised
25	2-4.5	Revised
26	2-5.1	Revised
28	2-5.9.1	Subparagraph (a) revised
33	4-3.3	Revised
43	5-3.1.2.4	Added
45	Figure 5-3.1.2.4-1	Added
54	Figure I-2.3-1	Revised
53	I-3.1	Revised
55	I-3.3	Revised
57	Figure I-3.3-1	Revised

<i>Page</i>	<i>Location</i>	<i>Change</i>
63	Mandatory Appendix II	Revised in its entirety
73	Figure II-4-3	Revised
107	Nonmandatory Appendix A	Revised and section A-5 added

Chapter 1

Scope and Definitions

1-1 SCOPE

(a) This Standard provides requirements for the design, materials, manufacture, fabrication, installation, examination, and testing of glass-fiber-reinforced thermosetting-resin (FRP) piping systems.

(b) FRP piping, as used in this Standard, includes pipe, flanges, bolting, gaskets, valves, fittings, special connecting components, and the pressure-containing or pressure-retaining portions of other piping components, whether manufactured in accordance with references cited in this Standard or specially designed. It also includes hangers and supports and other items necessary to prevent overstressing the pressure-containing components.

1-1.1 Content and Coverage

(a) This Standard addresses pipe and piping components that are produced as standard products, as well as custom products that are designed for a specific application. It covers FRP pipe and piping components manufactured by contact molding, centrifugal casting, filament winding, and other methods. Its intent is to provide a uniform set of requirements for FRP pipe and piping components that can be adopted by reference in the various piping codes, including sections of the ASME B31 Code for Pressure Piping. This Standard is published as a separate document to reduce duplication between piping codes.

(b) Requirements of this Standard apply to FRP piping systems typically used within the scope of the various sections of the ASME B31 Code for Pressure Piping (ASME B31.1, ASME B31.3, ASME B31.4, ASME B31.5, ASME B31.8, and ASME B31.9) and selected piping systems designed to the ASME Boiler and Pressure Vessel Code (BPVC), Section III, Division 1, Subsection ND.

1-1.2 Exclusions

This Standard does not provide requirements for the following:

- (a) metallic pipe
- (b) thermoplastics, ceramics, and other nonmetallic materials used to fabricate pipe and piping components
- (c) dual laminate construction that combines thermoplastic linings with FRP pipe and fittings
- (d) reinforced polymer mortar pipe

(e) products with fiber-reinforcement materials that are not made from glass

(f) nonmetallic pressure vessels, valves, and specialty components covered by other ASME codes and standards, such as ASME BPVC, Section X and ASME RTP-1

(g) piping for which the maximum internal pressure exceeds 1700 kPa (250 psi)

(h) piping for which the algebraic product of internal pressure [in kilopascals gauge (pounds per square inch gauge)] and internal diameter [in meters (inches)] exceeds 1262 kPag-m (7,200 psig-in.)

(i) piping used as ductwork conveying air or other gases at pressures within 6.89 kPag (1 psig) of the pressure of the surrounding atmosphere

1-2 TERMS AND DEFINITIONS

(20)

Commonly used terms relating to FRP piping are defined below. Some terms are defined with specific reference to piping. The definitions generally agree with those in ASME BPVC, Section X; ASME RTP-1; ASTM D883; and ASTM F412. Definitions taken unchanged from other standards are indicated by a footnote.

adhesive: a material designed to join together two other component materials by surface attachment (bonding).

adhesive joint: a bonded joint made using an adhesive on the surfaces to be joined.

assembly: synonymous with fabrication.

*binder*¹: in a reinforced plastic, the continuous phase that holds together the reinforcement.

*bloom*¹: a visible exudation or efflorescence on the surface of a material.

*bonder*²: one who performs a manual or semiautomatic bonding operation.

*bonding procedure*²: the detailed methods and practices involved in the production of a bonded joint.

Bonding Procedure Specification (BPS): a document providing in detail the required variables and procedures for the bonding process to ensure repeatability in the bonding procedure.

¹This definition is from ASTM D883.

²This definition is from ASME B31.3.