ASME NM.3.3-2018

Nonmetallic Materials

Part 3 — Properties

ASME Standards for Nonmetallic Pressure Piping Systems

AN AMERICAN NATIONAL STANDARD

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

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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 construction[1] 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.

The first edition of ASME NM.3.3 contains stress tables and physical properties tables for thermoplastic materials as well as data sheets for six reinforced thermoset plastic material constructions. ASME NM.3.3-2018 was approved by the American National Standards Institute (ANSI) on August 16, 2018.

[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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General. ASME Standards are developed and maintained with the intent to represent the consensus of concerned interests. As such, users of this Standard may interact with the Committee by requesting interpretations, proposing revisions or a case, and attending Committee meetings. Correspondence should be addressed to:

Secretary, NPPS Standards Committee
The American Society of Mechanical Engineers
Two Park Avenue
New York, NY 10016-5990
http://go.asme.org/Inquiry

Proposing Revisions. Revisions are made periodically to the Standard to incorporate changes that appear necessary or desirable, as demonstrated by the experience gained from the application of the Standard. Approved revisions will be published periodically.

The Committee welcomes proposals for revisions to this Standard. Such proposals should be as specific as possible, citing the paragraph number(s), the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent documentation.

Proposing a Case. Cases may be issued to provide alternative rules when justified, to permit early implementation of an approved revision when the need is urgent, or to provide rules not covered by existing provisions. Cases are effective immediately upon ASME approval and shall be posted on the ASME Committee web page.

Requests for Cases shall provide a Statement of Need and Background Information. The request should identify the Standard and the paragraph, figure, or table number(s), and be written as a Question and Reply in the same format as existing Cases. Requests for Cases should also indicate the applicable edition(s) of the Standard to which the proposed Case applies.

Interpretations. Upon request, the NPPS Standards Committee will render an interpretation of any requirement of the Standard. Interpretations can only be rendered in response to a written request sent to the Secretary of the NPPS Standards Committee.

Requests for interpretation should preferably be submitted through the online Interpretation Submittal Form. The form is accessible at http://go.asme.org/InterpretationRequest. Upon submittal of the form, the Inquirer will receive an automatic e-mail confirming receipt.

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

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

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.

SUBPART 1
STRESS TABLES

STATEMENT OF POLICY ON INFORMATION PROVIDED IN THE STRESS TABLES

The purpose of this Statement of Policy is to clarify which information in the stress tables is mandatory and which is not. The information and restrictions provided in the Notes found throughout the various stress tables provided in this Subpart are mandatory. It is vital to recognize that lines of information in Tables 1-1-1, 1-1-2, and 1-1-3 (Tables 1-1-1M, 1-1-2M, and 1-1-3M) frequently have essential information referenced in the Notes column. These Notes are organized as follows:

(a) General Notes. These notes are applicable to all materials presented in the specific table.

(b) MXX — Material Notes. These notes are applicable to materials of a specific material nominal composition (e.g., polyethylene), product form (e.g., extruded pipe), and/or type/grade (e.g., PE4710).

(c) CXX — Construction Standard Notes. These notes are applicable to requirements for a specific construction standard (e.g., ASME NM.1).

The specifications and grades or types, coupled with the assigned Notes for each line, provide the complete description of material in the context of the allowable stresses or allowable stress ranges. Additional requirements for particular types of construction must also be obtained from the requirements governing the construction.

In Tables 1-1-1, 1-1-2, and 1-1-3 (Tables 1-1-1M, 1-1-2M, and 1-1-3M), the information in the nominal composition column is nonmandatory and is for information only. However, these nominal compositions are the primary sorting used in these tables.

Where provided, the information in the columns for product form, specification number, type/grade, size/thickness, and external pressure chart number is mandatory. The information in the material grouping column is also mandatory; however, the primary source for this information is ASME BPVC, Section IX, Table QF-422. When there is a conflict between the material grouping information in these stress tables and that in ASME BPVC, Section IX, the numbers in Section IX shall govern.

The information in the minimum tensile strength and minimum yield strength columns is nonmandatory. These values, as well as the temperature-dependent values provided in Table 1-1-Y (Table 1-1-YM) may be invoked by the construction standard in the determination of some form of allowable stress values (e.g., a short-duration load) but do not typically form the basis for long-term allowable stress values for nonmetallic materials. When there is a conflict between the tensile and yield strength values in the stress tables and those in the material specifications in ASME NM.3.1 and ASME NM.3.2, the values in ASME NM.3.1 and ASME NM.3.2 shall govern.

The information in the applicability and maximum temperature limits columns is mandatory. Different construction standards often have different use-temperature limits for the same material and condition. Where a material is permitted for use in the construction code or standard, and is in the SI units version of these tables, the maximum use-temperature limit in these columns is critical. Further, in the SI units version of the stress tables, values may be listed in the table at temperatures above the maximum use-temperature limit. These stress values are provided solely to permit interpolation to be used to determine the allowable stress or allowable stress range at temperatures between the next lowest temperature for which stress values are listed and the maximum use-temperature limit listed in these columns.

GUIDELINE ON LOCATING MATERIALS IN STRESS TABLES, AND IN TABLES OF MECHANICAL AND PHYSICAL PROPERTIES

1 INTRODUCTION

The goal of this Guideline is to assist the users of ASME NM.3.3 in locating materials in the thermoplastic stress tables, tables of thermoplastic mechanical properties, tables of thermoplastic physical properties, and thermoset data sheets. This Guideline defines the logic used to place materials within these tables.

Tables and data sheets whose designators have a prefix of "1-" or "2-" can be found in Subpart 1 or Subpart 2, respectively. Stress tables and mechanical property tables have prefixes of "1-1-," data sheets have prefixes of "1-2-," and physical property tables have prefixes of "2-." The suffix "M" indicates that SI units (metric) are used.

2 STRESS TABLES

Tables 1-1-1 and 1-1-2 (Tables 1-1-1M and 1-1-2M) cover allowable stresses, while Table 1-1-3 (Table 1-1-3M) covers allowable stress ranges. Although Subpart 1 also covers (where applicable based on material type) yield strength, the organization of those mechanical property tables is discussed separately in section 3. A table-by-table explanation of the materials-organization logic used to place materials within the designated tables follows.

2.1 Table 1-1-1 (Table 1-1-1M)

Table 1-1-1 (Table 1-1-1M) provides allowable stresses for thermoplastic[1] materials used in ASME NM.1 construction. Within these tables, the first step in ordering materials is to use their nominal compositions. These nominal compositions are nothing more than widely recognized designators for each thermoplastic material. These nominal compositions are arranged as follows:

(a) chlorinated poly(vinyl chlorides) (CPVCs)
(b) polyamides (PAs)
(c) polyethylenes (PEs)
(d) polyethylenes of raised temperatures (PE-RTs)
(e) poly(vinyl chlorides) (PVCs)
(f) poly(vinylidene fluorides) (PVDFs)

For a given nominal composition, these tables are arranged by increasing yield strength. For a given nominal composition and yield strength, stress listings are provided in order of increasing specification number.

Sometimes, for a given nominal composition, yield strength, specification number, and grade or type, there may be more than one line of stresses. At this point, the Notes referenced will define why there are two or more lines of stresses and when each applies.

2.2 Table 1-1-2 (Table 1-1-2M)

Table 1-1-2 (Table 1-1-2M) provides allowable compressive stresses for thermoplastic materials used in ASME NM.1 construction. This table is organized in the same manner as Table 1-1-1 (Table 1-1-1M); see para. 2.1.

2.3 Table 1-1-3 (Table 1-1-3M)

Table 1-1-3 (Table 1-1-3M) provides allowable secondary stress ranges for thermoplastic materials used in ASME NM.1 construction. These tables are organized in the same manner as the preceding tables; see para. 2.1.

3 MECHANICAL PROPERTY TABLES

Yield strength values (where applicable based on material type) are to be used in design calculations according to the requirements of the construction standards. However, they are not to be construed as minimum strength values at temperature. This is explained in the General Notes to these tables. Paragraph 3.1 explains the materials-organization logic.

3.1 Table 1-1-Y (Table 1-1-YM)

Table 1-1-Y (Table 1-1-YM) provides yield strength values for thermoplastic materials. The ordering of yield strength lines parallels the logic described for thermoplastic materials in para. 2.1. It is important to note that yield strength typically does not form the basis for long-term allowable stress values for thermoplastic materials; values of yield strength should therefore only be used in design where allowed by the construction standard.

[1] ASME uses the current ASTM definition of *thermoplastic* — a plastic that repeatedly can be softened by heating and hardened by cooling through a temperature range characteristic of the plastic, and that in the softened state can be shaped by flow into articles by molding or extrusion.