



Standard Practice for Determining Allowable Tensile Load for Polyamide-12 (PA12) Gas Pipe During Pull-In Installation¹

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1. Scope

1.1 This practice provides a means to determine an allowable tensile load (ATL) value for a polyamide-12 (PA12) gas pipe that is to be installed underground using methods that pull the pipe into a trench (cut or plowed), bore hole, casing pipe, or the like. The ATL value takes into account pipe size, tensile yield strength, pipe temperature, and pulling load duration.

1.2 The ATL is used to set the break-away strength for a “weak-link” device, or as a limit setting for other devices that control the maximum pulling force exerted by equipment used to pull PA12 gas pipe into an underground location, or to determine if pulling equipment can exert pulling force greater than the ATL value for the gas pipe being installed. A weak-link device is installed where the pipe pulling equipment is connected to the PA12 gas pipe. If pulling load exceeds the ATL limit, the device de-couples the pipe from the pulling equipment. Other measures or equipment that limit the pulling force on the pipe are also used. When the ATL value is compared to the pulling force developed by the pull-in installation equipment, and the equipment cannot exert a pulling force greater than the ATL value, a weak-link or other device for limiting the pulling force is not necessary.

1.3 This practice does not address weak-link device design or requirements, nor does it address the design or requirements for other equipment or procedures used to limit the pulling force applied to PA12 gas pipe during pull-in installation.

1.4 This practice does not address installation methods or procedures employed for pull-in of PA12 gas pipe.

1.5 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate*

safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*²

D1600 Terminology for Abbreviated Terms Relating to Plastics

F412 Terminology Relating to Plastic Piping Systems

F2785 Specification for Polyamide 12 Gas Pressure Pipe, Tubing, and Fittings

2.2 *ASME Standards:*³

NM.3.3-2020 Nonmetallic Materials Part 3 - Properties

3. Terminology

3.1 Unless otherwise indicated, abbreviations are in accordance with Terminology **D1600**, and terms are in accordance with Terminology **F412**.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *allowable tensile load (ATL), n*—The maximum tensile load applied to a PA12 gas pipe during pull-in installation that does not result in an unrecoverable tensile elongation of the pipe.

3.2.1.1 *Discussion*—Polyamide-12 (PA12) gas pipe materials are viscoelastic, that is, they exhibit properties associated with both elastic materials such as rubber, and viscous materials such as wax or clay. When subjected to a tensile load that is significant, but less than the yield strength, PA12 will elongate or stretch. If the load is then removed, PA12 will, over time, recover all or part of the elongation, depending upon the

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

¹ This practice is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.60 on Gas. Current edition approved April 1, 2022. Published May 2022. DOI: 10.1520/F3564-22

TABLE 1 Allowable Tensile Stress During Pull-In

Load Duration, hours	Allowable Tensile Stress σ_t , psi (MPa)							
	73 °F (23 °C) and lower	>73 °F to 80 °F (>23 °C to 27 °C)	>80 °F to 90 °F (>27 °C to 32 °C)	>90 °F to 100 °F (>32 °C to 38 °C)	>100 °F to 110 °F (>38 °C to 43 °C)	>110 °F to 120 °F (>43 °C to 49 °C)	>120 °F to 130 °F (>49 °C to 54 °C)	>130 °F to 140 °F (>54 °C to 60 °C)
0.5	4150 (28.6)	3450 (23.8)	2700 (18.6)	2100 (14.5)	1700 (11.7)	1400 (9.9)	1200 (8.3)	1050 (7.2)
1.0	4100 (28.3)	3400 (23.4)	2600 (17.9)	2050 (14.1)	1650 (11.4)	1350 (9.3)	1150 (7.9)	1000 (6.9)
10	3750 (25.9)	3050 (21.0)	2350 (16.2)	1800 (12.4)	1450 (10.0)	1200 (8.3)	1000 (6.9)	900 (6.2)
24	3550 (23.1)	2900 (20.0)	2200 (15.2)	1700 (11.7)	1400 (9.9)	1150 (7.9)	950 (6.6)	850 (5.9)

magnitude of the load, and the length of time the load was applied. For the purposes of this practice, elongation that is not completely recovered within 24 h after the load is released is considered unrecoverable.

4. Significance and Use

4.1 The ATL value is used to set the break-away strength of a weak-link device, or to set other equipment used to limit pulling force during pull-in installation of PA12 gas pipe, or to determine if pulling equipment can exert pulling force greater than the ATL value for the PA12 gas pipe being installed.

4.2 The ATL value is determined before gas pipe installation.

5. Procedure

5.1 The following information about the PA12 gas pipe is required: size (outside diameter), dimension ratio, the approximate temperature of the pipe at the time of installation, and the approximate time under tension during installation.

5.1.1 Pipe size, dimension ratio, and material shall be in accordance with Specification **F2785**.

5.1.2 The temperature of the pipe at the time of installation is measured at the time of installation using appropriate temperature measuring equipment, or is estimated using installer experience.

5.1.3 The time under tension during installation is estimated using factors including the size and length of pipe being installed, the method of installation, and the nature of the underground location such as in a casing, or a cut or plowed trench, or a directionally bored hole.

5.2 Calculate the allowable tensile load (ATL) using the following formula:

$$ATL = \sigma_t \pi D^2 \left[\frac{1}{R} - \frac{1}{R^2} \right] \quad (1)$$

where:

ATL = allowable tensile load, lb. (kg)

NOTE 1—The ATL value may be rounded to the nearest 50 lb. (20 kg).

σ_t = Allowable tensile stress, psi (MPa), in the PA12 pipe material at the pipe installation temperature. See **Table 1**. If the installation conditions cause the pipe temperature to be greater than 140 °F (60 °C), consult the manufacturer for guidance on the maximum stress value. For load durations between two listed durations (for example, between 1 h and 10 h), use the longer duration values.

D = Pipe outside diameter, in. (m)

R = Pipe dimension ratio (D/wall thickness)

NOTE 2—The allowable tensile stress values in **Table 1** were calculated by multiplying the apparent tensile modulus of the material at the indicated load duration time by 3 %, and further adjusting by a factor of 0.6 to account for potential transient high stress levels during pull-back. The apparent tensile modulus values are taken from ASME NPPS NM.3.3-2020.

6. Report

6.1 Report the calculated ATL in pounds (kg).

6.2 Report the pipe dimensions or dimension ratio, temperature range, and load duration used for the calculation.

7. Keywords

7.1 gas pipe; PA12; polyamide-12; pull-in installation

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