



## Standard Practice for Determining Allowable Tensile Load for Polyethylene (PE) Gas Pipe During Pull-In Installation <sup>1</sup>

This standard is issued under the fixed designation F 1804; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This practice provides a means to determine an allowable tensile load (ATL) value for a polyethylene 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 yeild 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 polyethylene gas pipe into an underground location, or to determine if pulling equipment can extert 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 polyethylene 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 equipment cannot extert 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 polyethylene gas pipe during pull-in installation.

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

1.5 Throughout this practice, inch-pound units shall be regarded as standard with SI units in parentheses for informational purposes.

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 and health practices and determine the applicability of regulatory limitations prior to use.*

### 2. Referenced Documents

2.1 *ASTM Standards:*

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- D 638 Test Method for Tensile Properties of Plastics<sup>2</sup>  
 D 1600 Terminology for Abbreviated Terms Relating to Plastics<sup>2</sup>  
 D 2513 Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings<sup>3</sup>  
 F 412 Terminology Relating to Plastic Piping Systems<sup>3</sup>

### 3. Terminology

3.1 Unless otherwise indicated, abbreviations are in accordance with Terminology D 1600, and terms are in accordance with Terminology F 412.

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

NOTE 1—Polyethylene gas pipe materials are visco-elastic, 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, polyethylene will elongate or stretch. If the load is then removed, polyethylene will, over time, recover all or part of the elongation, depending upon the 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 in about 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 polyethylene gas pipe, or to determine if pulling equipment can exert pulling force greater than the ATL value for the polyethylene gas pipe being installed.

4.2 The ATL value is determined before gas pipe installation.

### 5. Procedure

5.1 The following information about the polyethylene gas pipe is required: size (outside diameter), dimension ratio, material tensile yield strength, 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 D 2513.

5.1.2 The pipe material tensile yield strength per Test Method D 638 at 2 in./min (50.8 mm/min) and  $73 \pm 3^\circ\text{F}$  ( $23 \pm 1.8^\circ\text{C}$ ) is obtained from the pipe manufacturer, or is determined by testing representative samples of the pipe material in accordance with Test Method D 638.

5.1.3 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 or information from the pipe manufacturer.

5.1.4 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:

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

where:

$ATL$  = allowable tensile load, lb (N)

NOTE 2—The ATL value may be rounded to the nearest 50 lb (0.35 MPa).

$f_y$  = tensile yield design (safety) factor

NOTE 3—The tensile yield design (safety) factor is usually 0.5 or less. If a design (safety) factor is not available from the pipe manufacturer, a value of 0.4 is used.

$f_t$  = time under tension design (safety) factor

NOTE 4—Based on 5 % strain, suggested time under tension design (safety) factors are 1.00 for times to 1 h, 0.95 for times to 12 h, and 0.91 for times to 24 h.

$T_y$  = Tensile yield strength, psi (MPa), of the polyethylene pipe material at the pipe installation temperature.

<sup>2</sup> Annual Book of ASTM Standards, Vol 08.01.

<sup>3</sup> Annual Book of ASTM Standards, Vol 08.04.

NOTE 5—For installation temperatures of 100°F (38°C) or less, use tensile yield strengths of 2600 psi (18 MPa) for PE2406, 3000 psi (21 MPa) for PE3408, or a value from the pipe manufacturer, or from pipe material sample testing. For installation where pipe temperatures are above 100°F (38°C), use an elevated temperature tensile yield strength from the pipe manufacturer for the polyethylene pipe material being installed.

$D$  = Pipe outside diameter, in. (m)

$R$  = Pipe dimension ratio

## 6. Report

6.1 Report the calculated ATL in pounds (N).

## 7. Keywords

7.1 gas pipe; polyethylene; pull-in installation

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