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An American National Standard

Standard Practice for Qualification of a Combination of Squeeze Tool, Pipe, and Squeeze-Off Procedures to Avoid Long-Term Damage in Polyethylene (PE) Gas Pipe[1]

This standard is issued under the fixed designation F1734; 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 (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers qualifying a combination of a squeeze tool, a polyethylene gas pipe, and a squeeze-off procedure to avoid long-term damage in polyethylene gas pipe. Qualifying is conducted by examining the inside and outside surfaces of pipe specimens at and near the squeeze to determine the existence of features indicative of long-term damage. If indicative features are absent, sustained pressure testing in accordance with ~~Specification~~ Test Method ~~D2513~~D1598 is conducted to confirm the viability of the squeeze-off process. ~~For assistance with specimen examination, an Adjunct, ADJF1734, is available from ASTM.~~

NOTE 1—This practice may be useful for evaluating the effects of squeeze-off of other piping materials. If applied to other piping materials, research testing to confirm the applicability of this practice to other materials should be conducted.

NOTE 2—Qualification of historic pipe should follow the historic version of F1734 closest to the pipe manufactured data.

1.2 This practice is appropriate for any combination of squeeze tool, PE gas ~~pipe and squeeze-off procedure, and is particularly appropriate for pre-1975 Polyethylene (PE) pipe, and for pipe sizes of 8 in. or above, because of a greater possibility of long-term damage.~~pipe, and squeeze-off procedure.

1.3 This practice is for use by squeeze-tool ~~manufacturers, pipe~~ manufacturers and gas utilities to qualify squeeze tools made in accordance with ~~Specification~~ Test Method F1563; and squeeze-off procedures ~~in accordance~~based on with Guide F1041 with pipe manufactured in accordance with Specification D2513.

1.4 Governing codes and project specifications should be consulted. Nothing in this practice should be construed as recommending practices or systems at variance with governing codes and project specifications.

1.5 Where applicable in this ~~guide,~~practice, "pipe" shall mean "pipe and tubing."

1.6 *Units*—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.

1.7 *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.*

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[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.

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1.8 *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]
D1598 Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure
D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
D2513 Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings
~~D3350 Specification for Polyethylene Plastics Pipe and Fittings Materials~~
F1041 Guide for Squeeze-Off of Polyolefin Gas Pressure Pipe and Tubing
F1563 Specification for Tools to Squeeze-off Polyethylene (PE) Gas Pipe or Tubing
~~2.2 *ASTM Adjuncts:*~~
~~Interpretation Aid for Squeeze-Off Damage[2]~~
2.2 *ISO Standards*[3]
ISO 4437 Plastics piping systems for the supply of gaseous fuels

3. Terminology

3.1 *Definitions:*

3.1.1 *squeeze-off, n*—a technique used to temporarily control the flow ~~of gas~~ in a polyethylene ~~gas~~ pipe by flattening the pipe with a mechanical or hydraulic device.

3.1.1.1 *Discussion*—
Depending on pipe size and wall thickness, stopping flow completely may not be possible. In some cases, attempting to stop flow may over-compress the pipe walls, permanently damage the pipe and lead to premature failure at the squeeze. Some seepage through the squeeze should be expected especially with larger sizes.

3.1.2 *squeeze process, n*—the combination of the squeeze tool, the pipe being squeezed, and the squeeze-off procedure being used.

3.1.3 *wall compression (WC), n*—the percentage extent to which the pipe walls are compressed when the pipe is squeezed. (See Fig. 1.) It is defined as:

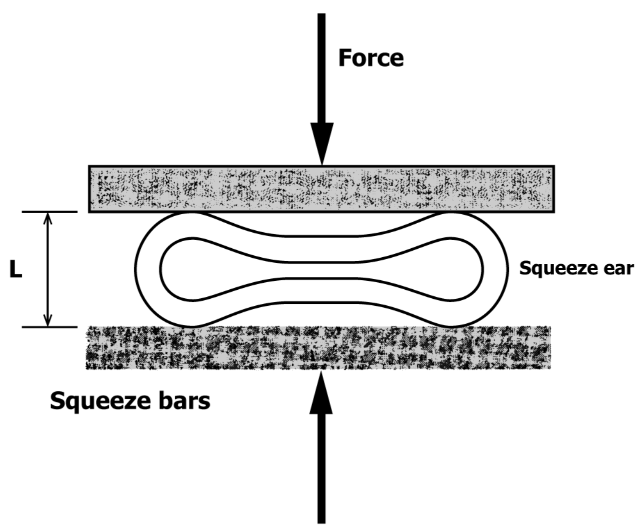

FIG. 1 Definition of Wall Compression

[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 International Organization for Standardization (ISO), ISO Central Secretariat, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, https://www.iso.org.

$$WC, \% = \left(1 - \frac{L}{2t}\right) \times 100 \quad (1)$$

where:

L = distance between the squeeze tool bars as shown in Fig. 1, and
t = uncompressed pipe wall thickness, expressed in the same units as L.

3.1.3.1 *Discussion—*
When the distance between the squeeze tool bars is greater than twice the wall thickness, the pipe walls are not compressed, which yields a negative value for the wall compression percentage. The value becomes positive when the L value is less than the $2t$ value. Typical squeeze tool stops are set for 30 % or less wall compression based on Specification D2513 maximum wall thickness (a distance that is for pipe size and DR combination. This is a distance between the squeeze bars equal to 70 % of twice the maximum wall thickness for pipe size and DR combination when the squeeze tool is closed to the stops).stops. Maximum wall thickness is the minimum wall thickness plus the wall thickness tolerance. tolerance of 12 %.

4. Summary of Practice

4.1 Pipe of the size and material of interest is cut into specimens at least 1 ft long or 3 diameters long whichever is greater, and attached to a supply of pressurized gas. With pressurized gas flowing through the specimen, the specimens are squeezed with the tool of interest, using the procedure of interest, until the desired level of flow control is achieved. Using Eq 1, the wall compression percentage at the desired level of flow control is determined. Let this level of wall compression be called *WCnom*. Additional specimens are squeezed to obtain squeeze levels that are 5 % greater, 10 % greater, 5 % less and 10 % less than *WCnom*. This squeeze range brackets levels of wall compression for flow control.

NOTE 1—For example, if the desired level of flow control were achieved at 25 % wall compression, additional specimens would be prepared at 35 %, 30 %, 20 % and 15 % wall compression. In research tests, a flow of 0.1 ft^3/h was considered equivalent to stopping the flow.[4,5]

4.2 The squeezed samples are split along their length at 90 degrees to the squeeze "ears" (See Fig. 1). The area containing the ears is examined visually using the unaided eye, then magnification. Features such as crazing, small voids, or cracks indicate permanent damage and disqualify the squeeze-off process.

4.3 Where the results of the visual screening do not indicate permanent damage, additional specimens are squeezed at the *WC* level where damage is not indicated, and sustained pressure tests in accordance with Specification D2513 are performed. When sustained pressure test specimens meet the requirements of Specification D2513, the squeeze-off process has been verified.

4.3.1 When damage is identified at *WCnom* less 5 % or *WCnom* less 10 % levels, a wall compression percentage where damage does not occur should be identified. Prepare additional specimens by lessening wall compression in 5 % increments, and then examine the specimens to identify a wall compression percentage that does not indicate damage.

NOTE 2—This practice uses flow through the squeezed-off pipe as a parameter. For some combinations of tool, pipe and procedure, it is not possible to stop flow completely without causing permanent damage to the pipe, particularly for pipes greater than 2 in. nominal size.

4.4 Using a desired squeeze-off procedure, tests conducted at different pipe temperatures with various sizes of tools and pipes can be used to verify a range of temperatures, tool sizes, and pipe sizes for which the squeeze-off process is applicable.

4. Significance and Use

4.1 This practice relies on a screening process using visual inspection followed by 80 °C sustained pressure testing to qualify a squeeze-off process.

4.2 Squeeze-off is widely used to temporarily control the flow of gas in PE pipe. Squeeze tools vary in squeeze bar shape and size, operating method, and available stop gaps depending on the tool manufacturer and the size of the pipe and the design of the tool. Squeeze-off procedures the tool will be used on. Multiple squeeze tools are required for a range of pipe size and DR combinations. Squeeze-off procedures can vary depending on the tool design, pipe material, and pipe size and DR, pipe operating conditions, and pipe environmental conditions.

4.3 Experience indicates that damage leading to gas pipe failure is possible with some combinations of polyethylene material, pipe temperature, tool design, wall compression percentage and procedure can cause damage leading to failure.percentage, and procedure. This practice is useful for determining the suitability of a tool for squeeze-off and for determining acceptable limits for squeeze-off such as acceptable minimum and maximum pipe temperature for squeeze and acceptable line pressure for squeeze. Tests conducted at different pipe temperatures with various sizes of tools and pipes can be used to verify a range of temperatures, tool sizes, and pipe sizes for which the squeeze-off procedure is applicable.

4.4 The area of wrinkling at the ears on the inside diameter (ID) of the pipe and the area on the outside of the pipe opposite the ears are examined. Evidence of any one or a combination of void formation, cracks or extensive localized stress whitening, or failure during sustained pressure testing disqualifies the squeeze-off process.

4.5 Typical unacceptable features implying long-term damage are shown in Appendix X1 photographs.

4.6 Studies of polyethylene pipe extruded in the late 1980s (PE2306 and thereafterPE3408) show that damage typically does not develop when the wall compression percentage is 30 % or less, when temperatures are aboveclosure rates are 2 in. 50 °F (10 °C), and when closure and /minute or less and release rates are typical0.5 in. of field conditions for screw-driven tools./minute or less, With tools meeting Specification F1563, acceptable flow control at typical gas service pressures is achieved at wall compression percentages between 10 and 20 % for pipe diameters less than 6 in.and when . Because damage does not develop in these materials at such squeeze levels, the references cited indicate that squeeze-off flow control practices using tools meeting Specification squeeze bars have radii 4 times or greater than the F1563 and qualified procedures meeting Practice F1041 are effective for smaller pipe sizes.pipe maximum wall– thickness.

NOTE 3—Specification F1563 provides a procedure for evaluating tool flow control performance.

4.7 This practice provides a method to qualify a combination of squeeze tool, pipe size and material, and squeeze-off procedure to ensure that long-term damage does not occur. This practice is useful for all polyethylene gas pipe manufactured before 1975, for new or revised polyolefin gas pipe materials, for pipe diameters of 8 in. or above, for pipe, for all pipe diameters, for new or revised squeeze tool designs, and for new or revised squeeze-off procedures.

6. Interpretation of Results

6.1 This practice relies on a screening process using visual inspection followed by sustained pressure testing as described in Specification D2513 to qualify a squeeze-off process.

6.2 The area of wrinkling at the ears on the inside diameter (ID) of the pipe and the area on the outside of the pipe opposite the ears are examined . Evidence of any one or a combination of void formation, cracks or extensive localized stress whitening, or failure during sustained pressure testing disqualifies the squeeze-off process.

6.3 Unacceptable features implying long-term damage are shown in the photographs in adjunct, ADJF1734[2].

5. Apparatus and Materials

5.1 *Squeeze-off Tools,* meeting Specification F1563 that are to be covered by the squeeze-off process.

5.2 *Pipe Cutters and Saws,* capable of cutting the PE pipe.

5.3 *Jeweler's Loupe or (Stereo) Optical Microscope,* providing 10× or higher magnification.

5.4 *Vernier Caliper or Ball-End Micrometer,* with an accuracy of at least 0.001 in.

5.5 *Stopwatch,* that can indicate time to at least the nearest second.

5.6 Sustained pressure testing apparatus in accordance with Test Method D1598.

5.7 Flow testing apparatus similar to that shown in Fig. 2 or Fig. 3.

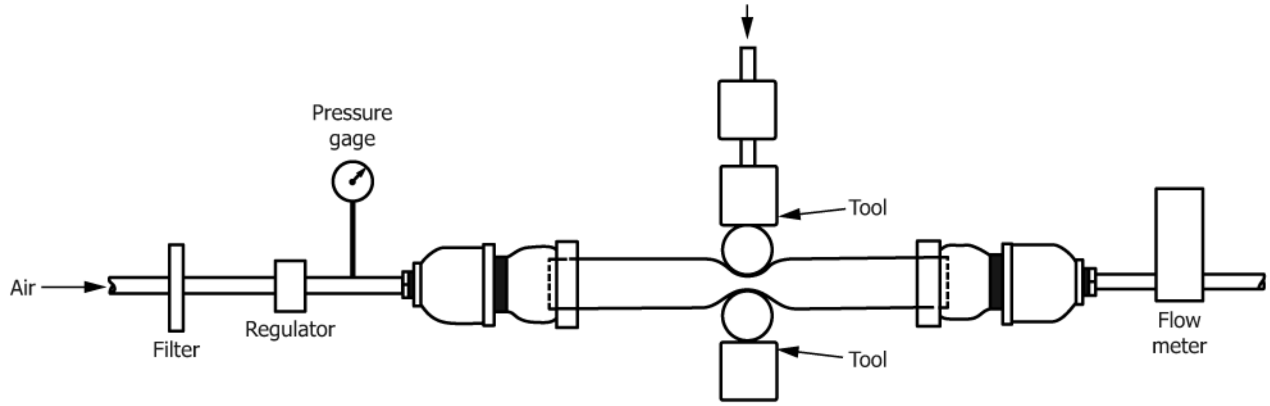

FIG. 2 Typical Flow Testing Apparatus using Flow Meter for Measurement

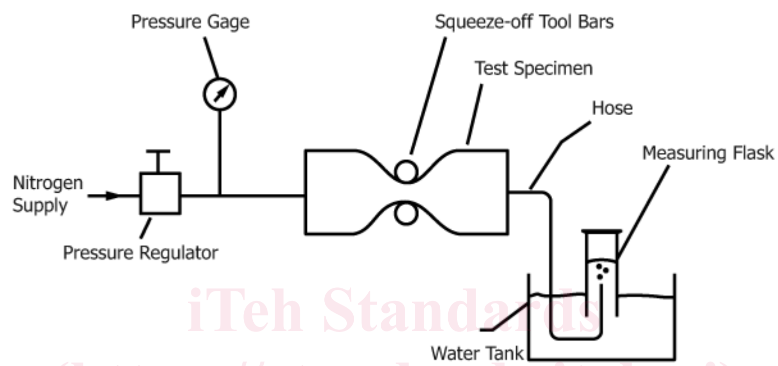

FIG. 3 Typical Flow Testing Apparatus using Water Tank and Flask for Measurement

5.8 Polyethylene pipe meeting Specification D2513.

~~**8. Materials**~~

~~8.1 Polyethylene pipe meeting Specification D2513.~~

6. Safety Precautions

6.1 Care should be taken and appropriate ~~protective equipment for eyes and persons is required~~ personal protective equipment used when working with hydraulic and power tools that may be used in the squeeze-off process. ~~Personal hearing~~ Hearing protection is ~~required~~recommended when compressed gas is discharged from open-ended specimens.

7. Preparation of the Sample and Equipment

7.1 Select nine pipe samples at least ~~3~~6 pipe diameters long but not less than 1 ft long.

NOTE 3—It is recommended that the thickest wall PE pipe in the operator's system that is acceptable for use with the tool of interest be used for squeeze testing.

7.2 ~~Measure the pipe wall thickness~~ Label the samples then measure outside diameter and wall thickness of samples in accordance with Test Method D2122. Record wall thickness measurements at 15° increments around ~~the pipe, and identify~~ each sample. Identify the location of maximum wall ~~thickness.~~ thickness on each sample.

7.3 Condition samples to the temperature of interest. ~~Studies show that at very low temperatures or on thicker-walled pipe significant hold times are necessary to reach thermal equilibrium.~~ Experience with smaller-diameter, lower SDR pipe (for example, 2 to 6-in. SDR 11 pipe) indicates that a minimum of 24 h is required for the sample to reach equilibrium. Thicker wall pipe may take longer time to reach thermal equilibrium at the temperature of interest.

NOTE 4—Several pipe temperatures may need to be investigated to determine the limits for which the squeeze-off procedure is applicable.

8. Procedure

8.1 *Gas Flow Control*—Orient the sample in the squeeze tool so that the thickest portion of the pipe wall forms one of the squeeze-off ears. Locate the squeeze tool at the midpoint of the sample length so that the tool is centered on the sample and square to the centerline of the sample. Perform an experiment to determine the wall compression required to achieve a desired level of flow control on pipe using the desired tool.

NOTE 5—Historic research has shown that the shape and size of the squeeze bar relative to the pipe wall thickness (D/t) influences the amount of flow controlled and the force needed to shut off the flow. For a given wall compression level, the equivalent width of the squeeze tool bar must increase as internal pressure increases and as wall thickness increases to control flow through a squeezed pipe to a given level.

NOTE 6—In research tests on PE2306 and PE3408 material, a flow of 0.1 ft /h was considered equivalent to stopping flow and wall compression over 30% damaged PE3408 material when pipe temperature was -20 °F.[4,5]

8.1.1 Orient a pipe sample in the flow test apparatus so the thickest portion of the pipe wall forms one of the squeeze-off ears. Locate the squeeze tool at the midpoint of the sample length so that the tool is centered on the sample and square to the centerline of the pipe sample. Closure stops may need to be removed or smaller stops or shims may be needed to obtain the closure distance required for the desired flow control level.

8.1.2 Squeeze the pipe at a rate of 2 inches per minute or less as dictated by the procedure of interest, until the pipe walls touch (0% wall compression). Slowly adjust the pressure regulator to increase upstream pressure to the desired line pressure not to exceed the pipes rated pressure. Continue to squeeze pipe until desired flow control is achieved. Record flow rates, distance between squeeze bars, and line pressures in increments up to the desired flow control level for later incorporation into the procedure of interest.

8.1.3 When flow control level is achieved, turn off the supplied gas (air or nitrogen) and allow a minimum squeeze hold time of 30 minutes.

8.1.4 Release the squeeze tool at a rate of 0.5 in. per minute or less as dictated by the procedure of interest.

8.1.5 If re-rounding is included in the procedure of interest, re-round the sample accordingly.

8.1.6 Using Eq 1 and the measured distances between squeeze bars, determine wall compression (*WC*) percentages.

8.1.7 Repeat steps 8.1.1 through 8.1.6 for two additional pipe samples. Determine the average *WC* of all three samples to achieve desired flow control level and call this the nominal level of wall compression, WC_{nom}.

11.2 The squeeze bar shims or stops, or both, must be within 1 % of the target level.

11.3 Operate the tool in accordance with the procedure of interest, close the bars to the distance required for the desired wall compression, and hold for at least 30 min. Closure stops may need to be removed or smaller stops or shims may be needed to obtain the closure distance required.

11.4 Release the squeeze in accordance with the procedure of interest.

11.5 If re-rounding is included in the procedure of interest, re-round the sample accordingly.

11.6 Allow the sample to sit undisturbed without external force at the desired temperature for 24 h.

[4] Stephens,Stephens, D. R., Leis, B. N., Francini, R. B., and CassadyCassady,, M. J., *Volume 1: Users' Guide on Squeeze-Off of Polyethylene Gas Pipes*, Topical Report GRI-92/0147.1, Volume 1: Users' Guide on Squeeze-Off of Polyethylene Gas Pipes, Topical Report GRI- 92/0147.1, NTIS PB93-161032, Battelle Columbus for Gas Research Institute, February 1992.

[5] Stephens,Stephens, D. R., Leis, B. N., Francini, R. B., and CassadyCassady,, M. J., *Volume 2: Technical Reference on Squeeze-Off of Polyethylene Gas Pipes*, Volume 2: Technical Reference on Squeeze-Off of Polyethylene Gas Pipes, Topical Report GRI-92/0147.2, NTIS PB93-161040, Battelle Columbus for Gas Research Institute, October 1992.