



Designation: F1606 – 19

Standard Practice for Rehabilitation of Existing Sewers and Conduits with Deformed Polyethylene (PE) Liner¹

This standard is issued under the fixed designation F1606; 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 the requirements for the installation of deformed polyethylene (PE) liner for pipeline rehabilitation.

1.2 This practice describes a method by which the PE liner may be installed with little or no excavation.

1.3 This practice applies to the rehabilitation of 3 to 18 in. (76 to 457 mm) diameter pipe in terms of installation. The specifier determines what DR is used based on conditions of the specific application.

1.4 *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.*

1.5 *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

[D638 Test Method for Tensile Properties of Plastics](#)

[D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials](#)

[D1600 Terminology for Abbreviated Terms Relating to Plastics](#)

[D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings](#)

[D3350 Specification for Polyethylene Plastics Pipe and Fittings Materials](#)

[F412 Terminology Relating to Plastic Piping Systems](#)

[F1417 Practice for Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air](#)

[F1533 Specification for Deformed Polyethylene \(PE\) Liner](#)

2.2 *NASSCO Standard:*

[Recommended Specifications for Sewer Collection System Rehabilitation](#)³

3. Terminology

3.1 *General*—Abbreviations used in this practice are in accordance with Terminology [D1600](#), and definitions are in accordance with Terminology [F412](#), unless otherwise indicated.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *deformed pipe*—HDPE or MDPE pipe manufactured in deformed shape with a reduced cross-sectional area that includes the most common u-geometric form for use in existing sewer and conduit rehabilitation. (See [Fig. 1.](#))

3.2.2 *dimpling*—a localized deformation resulting from expansion, during rounding of a thermoplastic deformed PE pipe, into space where a side connector meets an existing conduit and where there is no support for the deformed PE pipe.

3.2.3 *insertion point*—an existing manhole, existing access shaft or an excavated pit that serves as the point of entrance for the deformed pipe into the existing pipe.

3.2.4 *liner*—PE reformed pipe fully functional as pipe within a rehabilitated pipe.

3.2.5 *manifolds*—set of the equipment required for heat and pressure processing of the deformed pipe.

3.2.6 *pipeline*—existing sewer to be rehabilitated.

3.2.7 *reformed pipe*—PE deformed pipe processed by heat and pressure after insertion into the pipeline and reformed to a fit conforming to the existing pipe (See [Fig. 1.](#))

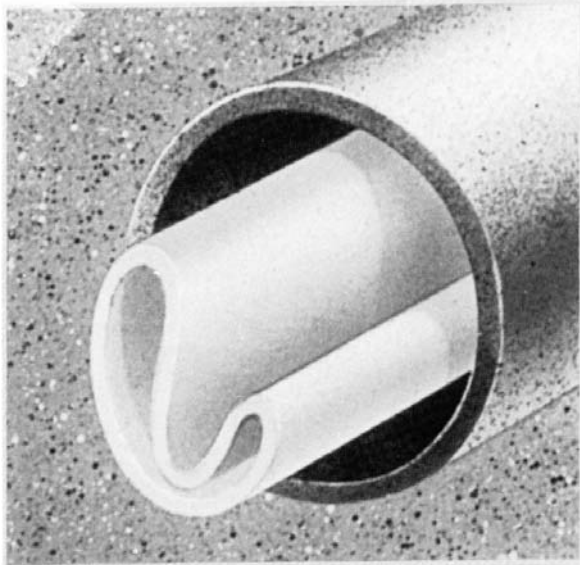
¹ This practice is under the jurisdiction of ASTM Committee [F17](#) on Plastic Piping Systems and is the direct responsibility of Subcommittee [F17.67](#) on Trenchless Plastic Pipeline Technology.

Current edition approved Nov. 1, 2019. Published December 2019. Originally approved in 1995. Last previous edition approved in 2014 as F1606–05(2014). DOI: 10.1520/F1606-19.

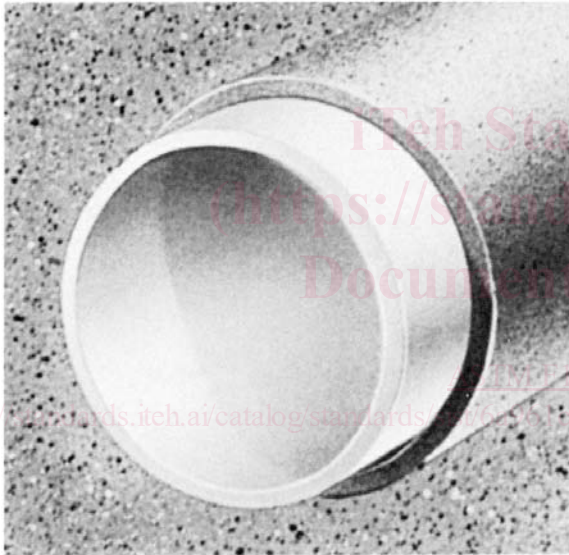
² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ NASSCO, Inc. 2470 Longstone Lane, Suite M, Marriottsville, MD 21104. <http://nassco.org/>

*A Summary of Changes section appears at the end of this standard



(a) Deformed Pipe



(b) Reformed Pipe

NOTE 1—This figure is intended only for clarification of terms specific to this practice and shows representative deformed and reformed pipe shapes. Other deformed pipe shapes may meet the general requirements of this practice.

FIG. 1 Deformed Pipe and Reformed Pipe—Clarification of Terms

3.2.8 *termination point*—an existing manhole, existing access shaft or an excavated pit that serves as the point of exit of the deformed pipe from the existing pipe.

4. Significance and Use

4.1 This practice is to provide guidance for designers and specifiers, regulatory agencies, owners, and inspection organizations who are involved in the rehabilitation of conduits. Modifications may be required depending on specific job conditions to establish a project specification. The manufac-

turer of the product should be consulted for design and installation information.

5. Materials

5.1 The deformed PE liner should be in accordance with Specification F1533.

5.2 The following are minimum cell classification numbers for HDPE polyethylene pipe based on Specification D3350. Specification D3350 should be consulted for property value limits based on these cells.

Type	PE 4710
Density	4
Melt	4
Flexural Modulus	5
Tensile Strength	5
ESCR	7
HDB	4
Color and UV Stabilizer	C, D, or E

5.3 The deformed pipe should be spooled in a continuous length for storage and shipping to the job site. Handling and storage should be in accordance with the manufacturer's published recommendations.

5.4 There should be no evidence of splits, cracks, crazing or breaks in the deformed pipe on the spool. If any of these conditions are evident, the damaged material should be replaced.

6. Installation Recommendations

6.1 *Cleaning and Inspection:*

6.1.1 Prior to entering access areas, such as manholes, and performing inspection or cleaning operations, an evaluation of the atmosphere to determine the presence of toxic or flammable vapors or lack of oxygen shall be undertaken in accordance with local, state, or federal safety regulations.

6.1.2 *Cleaning of Pipeline*—Internal debris should be removed from the existing pipeline. Gravity pipes should be cleaned with hydraulically powered equipment, high-velocity jet cleaners, or mechanically powered equipment, in accordance with NASSCO Recommended Specifications for Sewer Collection System Rehabilitation.

6.1.3 *Inspection of Pipelines*—Inspection of pipelines should be performed by experienced personnel trained in locating breaks, obstacles, and service connections by closed circuit television. The interior of the pipeline should be carefully inspected to determine the location of any conditions that may prevent proper insertion of the deformed pipe, such as protruding service taps, collapsed or crushed pipe, out-of-roundness, significant line sags, and deflected joints. All such conditions should be noted in the plans so that they can be corrected prior to liner installation. If a user desires to ignore any of the obstacles with PE liner pipe, the contractor should inform the user about expected results.

6.1.4 *Line Obstructions*—The inside of the existing pipeline should be clear of obstructions that will prevent the proper insertion and full expansion of the deformed pipe. Obstructions could include dropped or offset joints of more than 12.5 % of inside pipe diameter; service connections that protrude into the pipe more than 12.5 % of the inside diameter or 1 in. (25 mm), whichever is less; and other obstructions in cross-sectional area

of more than 14 % based on the inside diameter of the existing pipe. If inspection reveals an obstruction that cannot be removed by cleaning or rodding, then a point repair excavation should be made to uncover and remove or repair the obstruction. Typically, bends along the pipe length in excess of 30° and changes in pipe size cannot be accommodated. Such conditions require access at these points for termination and start of a new insertion.

6.2 Bypassing—If flow cannot be interrupted for the necessary duration, bypassing of flow is required around the sections of the existing pipeline designated for rehabilitation. The bypass should be made by plugging the line at the point upstream of the pipe to be reconstructed and bypassing the flow to a downstream point or adjacent system. The bypass lines, pump, and pump-sump pit dimensions, if required, should be of adequate capacity and size to handle the flow during the installation period. Services within this work area will be temporarily out of service.

NOTE 1—Public advisory services will be required to notify all parties whose service laterals will be out of commission and to advise against water usage until the main line is back in service.

6.3 Insertion:

6.3.1 The spool of deformed pipe should be positioned near the insertion point. A cable should be strung through the existing conduit and attached to the deformed pipe. The deformed pipe should be pulled (with a power winch and the cable) directly through the insertion point to the termination point. Pulling forces should be limited so as not to exceed the axial strain limits of the deformed pipe. The measured pulling operation limits pulling force to allowable tensile stress (1500 psi or 50 % of the yield) times the pipe wall cross sectional area.

6.3.2 After the insertion is complete, the tension from the winch should be relieved and the deformed pipe should be cutoff at the insertion point and restrained at the termination point. Allowances for pipe length normalization should be made to attain correct length.

6.4 Reforming:

6.4.1 Temperatures and pressures should be monitored and recorded throughout the installation process to ensure that each phase of the process is achieved at the required levels. Temperature gages should be placed near the upstream and downstream manholes to measure the liner's outside temperature.

6.4.2 Steam and air pressure are applied through the inlet manifold and the deformed pipe should be reformed to conform to the existing pipe wall. The deformed pipe shall be pressurized up to 14.5 psig (100 kPa) max, at a steam temperature in excess of 235 °F (112.8 °C), and less than 260 °F (126.7 °C), while the termination point valves, located at the outlet manifold, are kept open to provide heat flow. The minimum temperature needed at the outside of the HDPE pipe should be 185 ± 9 °F (85 ± 5 °C). The pressure should then be increased in increments up to a maximum of 26 psig (179.4 kPa). Maximum pressure may be lower, depending on DR and condition of the pipeline.

6.4.3 The reforming pressure should be maintained to ensure complete expansion of the pipe and to allow for dimpling at side connections.

6.5 Cool Down—The reformed pipe should be cooled to a temperature of 100 °F (38 °C). The pressure should then be slowly increased to approximately 33 psig (227.7 kPa), while applying air or water for continued cooling. The equipment should be disconnected after ambient temperature is attained.

6.6 After the reformed pipe has cooled down, the terminating ends should be trimmed to a minimum of 3 in. (76.2 mm) beyond the existing pipe to account for possible shrinkage during cooling to ground temperatures.

6.7 Service Connections—After the liner has been reformed and stabilized, the existing active service connections should be reconnected. This should be done without excavation from the interior of the pipeline by means of a television camera and a remote control cutting device unless otherwise specified by the owner.

NOTE 2—In many cases, a good seal is provided where the formed pipe dimples at service connections. However, this practice should not be construed to provide a 100 % watertight seal at all service connections. If total elimination of infiltration and inflow is desired, other means, which are beyond the scope of this practice, may be necessary to seal service connections and to rehabilitate service lines and manholes.

6.8 The numeric information given for the processing of the liner are the standard practical information. Where the specific cases require, such as long pipelines, unusually difficult conditions, extremely fragile pipelines and unique jobs, the processing parameters may vary. The final outcome of the processing should comply with this practice. The design engineer should determine the applicable processing parameters in accordance with the manufacturer's specific specifications and instructions.

7. Inspection and Acceptance

7.1 The installation may be inspected by closed-circuit television. The reformed pipe should be continuous over the entire length of the insertion and conform to the walls of the existing pipe evidenced by visible joint deformation and mirroring of existing pipe irregularities. Variations from true line and grade may be inherent because of the conditions of the original piping. No infiltration of groundwater through the reformed wall should be observed. All service entrances should be accounted for and unobstructed.

7.2 Leakage Testing—If required by the owner or designated in the contract documents or purchase order, or both, gravity pipes should be tested for leakage. This test should take place after the reformed pipe has cooled down to ambient temperature. This test is limited to pipe lengths with no service laterals. One of the following two methods should be used:

7.2.1 Exfiltration Test Method—This test involves plugging the reformed pipe at both ends and filling it with water. The allowable water exfiltration for any length of pipe between termination points should not exceed 50 gal/in. of internal pipe diameter per mile per day, providing that all air has been bled from the line. The leakage quantity should be gauged by the water level in a temporary standpipe placed in the upstream