Technical Note 802 – Leak Testing of Polyethylene Pipe For Municipal and Industrial Applications

Part 1 – Pre-Test Considerations

Leak testing may be used to find leaks in a newly constructed or newly modified piping system or in an established system where an apparent loss of integrity has been experienced. If they exist, leaks typically occur at joints or connections in the system.

Leak testing does not verify pressure rating or potential long-term performance, nor is it intended to supplement or replace product standard test requirements. The system design and the pressure ratings of the installed components are the sole determinants of system pressure rating and long-term performance.

For M&I applications, leak testing of pressure piping systems is done by filling the piping system or a section of the piping system with a liquid and applying a pressure. Pneumatic (air) testing of pressure piping systems is not within the scope of this technical note. Information on testing with a compressible fluid such as air is discussed in ASTM F2786.

The common hydrostatic leak test used for polyethylene pipe is a "modified pressure rebound method." In this testing method, the test section is filled with water and pressurized to a specified test pressure. The pressure is maintained for a certain duration, then slightly reduced and observed for one hour to assure the pressure remains essentially constant (within 5% variation) to achieve an acceptable test. Slightly reducing the test pressure suspends expansion of the PE piping, allowing a leak-free PE system to maintain a steady test pressure. This leak testing method and procedure is described in ASTM F2164, "Standard Practice for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure." Additional information on leak testing can be found in PPI TN-46 "Guidance for Field Hydrostatic Testing of High Density Polyethylene Pressure Pipelines: Owner's Considerations, Planning, Procedures, and Checklists."

Safety

Safety is of paramount importance when performing leak tests. Leak tests can apply high stress to untried joints and parts in the system. Failure can occur by leaking or by catastrophic rupture that can cause sudden, violent movement. In some cases, leakage may immediately precede catastrophic rupture.

WARNING – Death or serious injury and property damage can result from failure at a joint or connection during pressure leak testing. Keep all persons a safe distance away during testing. The test section is to be supervised at all times during the test.

Ensure that all piping is restrained against possible movement from catastrophic failure at a joint or connection. When pressurized, faulty joints or connections may separate suddenly, causing violent and dangerous movement of piping or parts. Correctly made joints do not leak. Leakage at a joint or connection may immediately precede catastrophic failure. Never approach or attempt to repair or stop leaks while the test section is pressurized. Always depressurize the test section before making repairs.

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Restrain Against Movement

Before applying pressure, all piping and all components in the test section must be restrained. This means that if piping or parts move or separate during the test, any movement of components or parts is sufficiently constrained such that it will not result in damage or injury. Common restraints include backfill, anchors, external clamps and tie rods, pipe guides, etc. ***Never conduct leak tests on unrestrained piping.***

Additional guidance for preparing connections and joints for leak tests include:

- Heat fusion joints must be properly cooled before testing.
- Mechanical connections must be completely installed and tightened per manufacturer's instructions.
- If backfill provides restraint, it must be properly placed and compacted. Joints and connections may be exposed for inspection.
- End closures must be suitable for pressure service and pressure-rated for the test pressure.
- Ensure that all connections to test equipment are secure. Disconnect or isolate all low-pressure filling lines and all other parts that are not to be subjected to test pressure. Restrain, isolate or remove expansion joints before leak testing.
- Testing against closed valves is not recommended due to the potential for leakage and/or trapped air. Best practice is to blind-flange before the closed valve.

Test Section

Testing may be conducted on the full piping system or in sections. Test section length is generally limited by the capacity of the testing equipment. Lower capacity pressurizing or filling equipment may not be capable of completing the test within permissible time limits. In addition, the test section should be filled at a slow rate (typically less than 10-feet per minute) to minimize air entrapment. Considering test time limits and fill rate, pipelines longer than 3000 feet may need to be tested in several sections (see PPI TN-46).

Before applying test pressure, allow time for the test fluid and the test section to equalize to a common temperature.

Test Pressure

The maximum test pressure should be measured at the lowest elevation in the test section. For pressure piping systems that include polyethylene pipe or fittings, the maximum permissible test pressure is the lower of:

a) 150% of the PE pipe system's design pressure rating for the application and application service temperature, provided that all components in the test section are rated for the test pressure.
b) The pressure rating of the lowest pressure rated component in the test section. Lower pressure-rated components or devices may include pipe or fittings made from other plastics or metals, appurtenances such as valves, hydrants, regulators, and pressure relief devices, or some types of mechanical connections such as lower pressure-rated compression couplings or flanges with lower pressure-rated back-up rings.

Do not subject lower pressure rated, non-polyethylene parts or devices to pressures above their pressure rating. Lower pressure rated parts may be removed or isolated from the test section to avoid damage or failure. Vent isolated parts or equipment to atmosphere.

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Test Temperature

The pipe should be allowed to thermally stabilize and equalize before pressurizing the pipe to test pressure. All thermoplastic pipes have reduced strength at elevated temperature. Test pressure must be reduced when the test section is at elevated temperature either from service conditions or from environmental conditions such as being warmed by the sun. Multiply the test pressure by the Table 1 multiplier to determine the allowable elevated temperature test pressure.

Table 1 Elevated Temperature Multiplier

Test Section Temperature °F (°C)	≤ 80 (≤ 27)†	≤ 90 (≤ 32)	≤100 (≤ 38)	≤110 (≤ 43)	≤ 120 (≤ 49)	≤ 130 (≤ 54)	≤ 140 (≤ 60)‡
Multiplier	1.00	0.90	0.80	0.71	0.63	0.57	0.50

† Use the 80°F (27°C) multiplier for 80°F (27°C) and lower temperatures.
‡ The maximum service temperature for Performance Pipe PE pressure piping is 140°F (60°C).

Test Duration

When testing at pressures above the system design pressure up to 150% of the system design pressure, the maximum test duration is eight (8) hours including time to pressurize, time for initial expansion, time at test pressure, and time to depressurize the test section. If the test is not completed due to leakage, equipment failure, or for any other reason, depressurize the test section completely, and allow it to relax for at least eight (8) hours before pressurizing the test section again. *CAUTION – Testing at excessive pressure or for excessive time may damage the piping system.*

When testing at the system design pressure or less, test duration including time to pressurize, time for initial expansion, time at test pressure, and time to depressurize should be limited to a practical time period (72 hours or less is suggested) given that the test section is not to be left unsupervised at any time during leak testing.

Test Fluid

Hydrostatic Testing

The test liquid should meet appropriate industry standards for safety and quality so that the environment, system, test equipment and disposal (if necessary) are not adversely affected. The recommended test liquid is water.

Pneumatic Testing

WARNING – Failure during a pneumatic (compressed gas) leak test can be explosive and result in death or serious bodily injury.

If failure occurs when using compressed gas as the test fluid, both the pressure stress on the system and the energy used to compress the gas are released. Such failure can be explosive and dangerous. Compared to hydrostatic testing, pneumatic testing can be more dangerous because failure during pneumatic testing releases more energy. For safety reasons, pneumatic testing is not within the scope of this technical note. Refer to ASTM F2786.

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Part 2 – Hydrostatic Leak Testing Procedure

Read all of this publication and observe all safety precautions before conducting any leak test.

Hydrostatic Leak Testing

This hydrostatic leak test procedure consists of filling, an initial expansion phase, a test phase, and depressurizing.

Filling

Fill the restrained test section completely with test liquid. The test section is usually filled from the lowest point of the pipeline and at a slow fill rate to minimize air entrainment. A fill rate of 10-feet per minute axial velocity or less is suggested in PPI TN-46. After filling, allow time for the system to reach thermal equilibrium and allow for any dissolved air to exit the system air vents.

WARNING – Ensure that there is no air trapped in the test section. Failure with entrapped air can result in explosive release and result in death or serious bodily injury. Use equipment vents at high points to remove air. A firm urethane foam pig or swap, pushed by the fill water, may be used to assist in air removal.

Initial Expansion Phase

Gradually pressurize the test section to test pressure, and add make-up water as necessary to maintain maximum test pressure for four (4) hours. During the initial expansion phase, polyethylene pipe will expand slightly due to elasticity and Poisson effects. Additional test liquid will be required to maintain pressure. The amount of additional test liquid will vary because expansion in the PE pipe is not linear. It is not necessary to monitor the amount of water added during the initial expansion phase.

If test pressure cannot be attained, or if it takes an unreasonably long time to reach test pressure, there may be faults such as excessive leakage, entrapped air, or open valving, or the pressurizing equipment may be inadequate for the size of the test section. If such faults exist, discontinue pressurizing and correct them before continuing.

Test Phase

Immediately following the initial expansion phase, reduce test pressure by 10 psi and stop adding test liquid. Monitor the pressure for 1 hour.

If no visual leakage is observed and test pressure remains steady (within 5% of the target value) for one (1) hour, no leakage is indicated.

Depressurization

Depressurize the test section by reducing pressure or releasing test liquid at a controlled rate. Sudden depressurization can cause water hammer.

Part 3 – Additional Leak Testing Procedures

Low Pressure Air Testing of Gravity Flow Systems

For gravity flow and low or intermittent pressure applications such as sewer and odor control, leak testing in accordance with ASTM F1417 is recommended.

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High Pressure Air Testing

For applications requiring high pressure air (pneumatic) testing, leak testing in accordance with ASTM F2786 is recommended.

Initial Service Leak Testing

An initial service leak test may be acceptable when other types of tests are not practical, when leak tightness can be demonstrated by normal service, or when an opportunity is afforded by performing initial service tests of other equipment. An initial service leak test may apply to systems where isolation or temporary closures are impractical, or where checking out pumps and other equipment allows the system to be examined for leakage prior to full-scale operations.

The piping system should be gradually brought up to normal operating pressure, and held at normal operating pressure for at least ten (10) minutes. During this time, joints and connections may be examined for leakage.

At the conclusion of the test, depressurize the test section by the controlled release of fluid from the test section. Controlled release avoids the potential for pressure surge.

Systems that are Not Suitable for Pressure Leak Testing

Some systems may not be suitable for pressure leak testing. These systems may not be designed or intended for internal pressure such as vacuum systems, or they may contain parts that cannot be isolated, or temporary closures to isolate the test section may not be practical.

Systems that are not suitable for pressure leak testing should not be pressure tested, but should be carefully inspected during and after installation. Inspections such as visual examination of joint appearance, mechanical checks of bolts and joint tightness, and other relevant examinations should be performed.

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