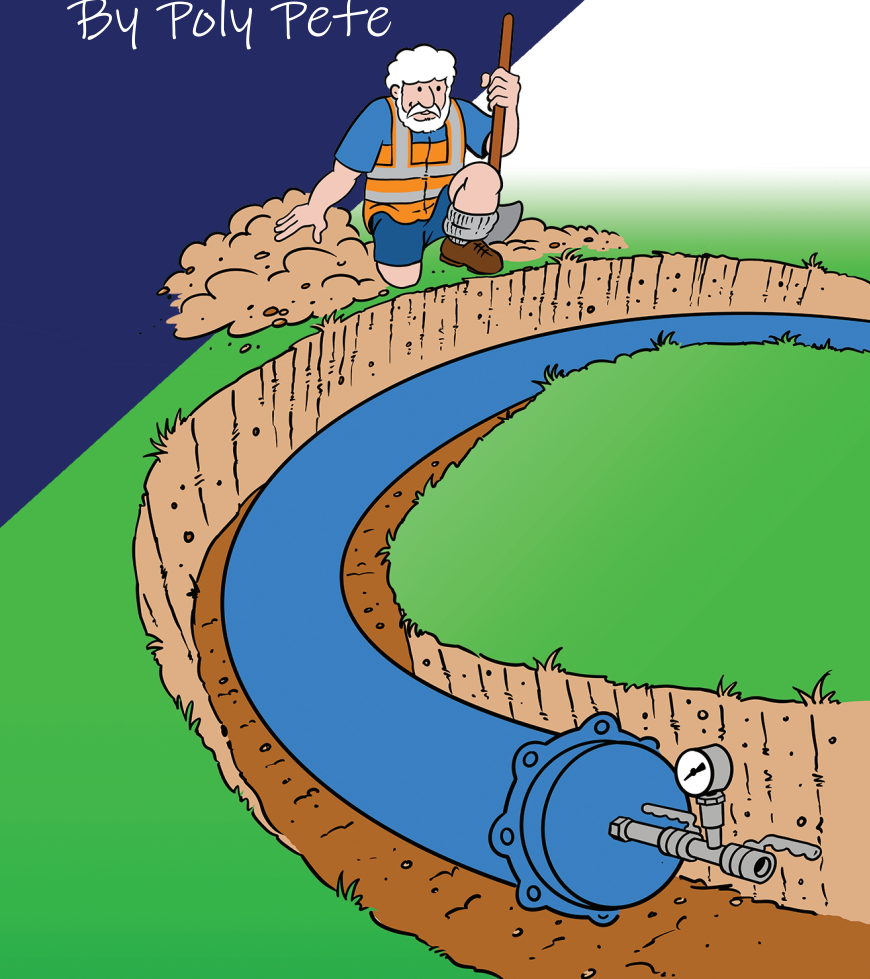
iPLEX Pipelines

How To

Field Test Polyethylene Pressure Pipes

By Poly Pete



Contents

Introduction

Hi, all my friends call me Poly Pete, cos I've been installing Polyethylene pipes since I was a wee fella.

Iplex asked me to write a booklet on how to Pressure Test Polyethylene pipes. I'll draw some sketches as I go and share how to do it right first time!

Please treat this booklet as a guide only. For full procedures you might need to get a copy of New Zealand's Land Development and Subdivision Infrastructure Standard NZS4404:2010. Go to Appendix C3 (page 227).

Follow these steps, and you will;

- Get it right first time,
- Get the job done faster,
- Avoid those expensive mistakes!

I know I can call on the guys at Iplex Pipelines –they'll answer any problems that might stump you. Don't you be afraid to contact Iplex. Their website is www.iplex.co.nz or you can call them free on 0800 800 262 and ask for the Iplex Technical Advisory Team.

You can also see my other booklet called "How I install PE Pipes,"

I hope this helps you.

Poly Pete

Why do we test PE pipelines?

To uncover any faults in the pipeline joints - for example, electrofusion, butt fusion or mechanical joints.

To reveal any faults in the assembly of fittings, including valves, hydrants, bends, tees, branch saddles, and flanges.

To check that the pipeline will handle pressure greater than its design pressure without leaks.

A fully fused pipe string for installation by a trenchless method such as Horizontal Directional Drilling, may have a pre-commissioning test, above ground.

Generally check that the complete pipeline has no leaks and is 'good to go" into service.

But... A test may not uncover damage to pipes, that's your job...you must check for damage during construction.

Pre-commissioning testing is not intended to supplement or replace the test requirements of the pipeline product Standards.

What you need to know

You'll need to choose an appropriate Test Method, with consideration for:

(a) Pipe diameter, PN class and length to be tested.

(b) Length of time for the pressure test itself.

(c) Magnitude of the test pressure and rate of pressurisation.

(d) Removing all air from the pipeline during filling with water

(e) Prevent movement of thrust restraints, and have in place all permanent or temporary anchor block supports.

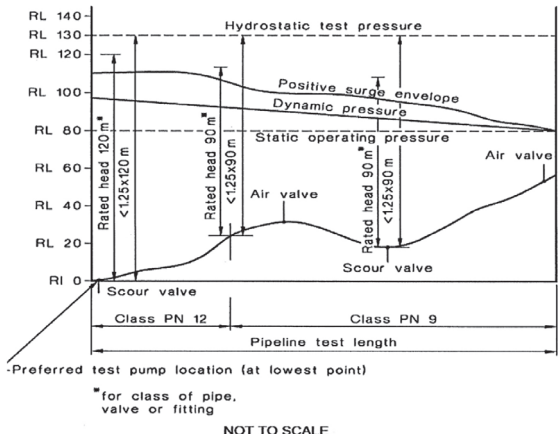
(f) Be sure your test gauges are accurate.

(g) Be aware of ambient temperature changes during testing.

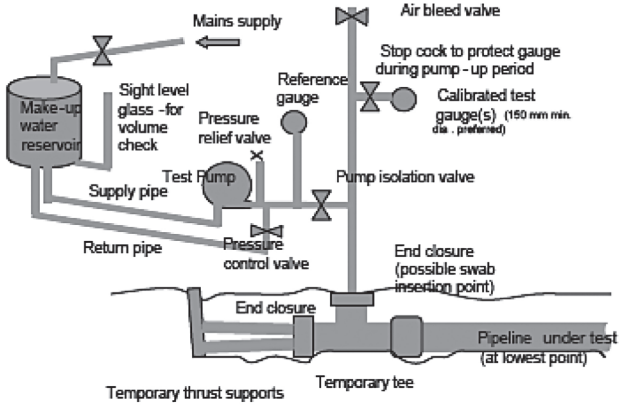
(h) Prevent leaks in all test equipment and the pipeline.

During any pipeline construction I recommend you begin testing the pipeline sections early in the project, to prove how good your pipe jointing skills are. A simple half-daily or daily low pressure air test of no more than 35 kPa, can help you to know that you are "doin' it right", before beginning the main pressure test procedure. I've drawn a sketch below of typical pressure test layouts and equipment. Their locations are shown in S1 and S2.

Sketch S1 - Typical pressure pipeline under field hydrostatic test.



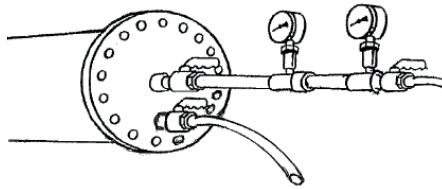
Sketch S2 - Typical field pressure test equipment layout.



YOUR TEST EQUIPMENT

Test Manifold

This sketch shows how a typical Test Manifold should be set up. There are two calibrated gauges (one to check that the other is accurate). It has a valve to draw off air as the pipe section fills with water. There is a filling pipe with valve at the bottom which can also be used to drain the pipe after the test.



Test Pump

I usually use a water blaster pump as the pressure source. It needs to be big enough to raise and maintain the test pressure during the pressure test.

PRE-TEST PROCEDURES

Before you begin testing...

- Be sure that all concrete thrust blocks or thrust restraints installed are secure and fully cured..... Concrete can take up to 28 days to cure and reach its full strength.
- Install blank flanges and/or temporary end-load-restraint end caps (if used) at the beginning and end of the pipeline test section.

When the pipe is pressurised, visually inspect all the exposed joints to be sure they have no leaks. Avoid testing against any closed isolation valves as these can leak slightly and upset the test.

- Leave all bolted or flanged joints exposed, to allow for re-tensioning during or after testing.
- Leave all fusion joints, service connections and valves exposed, wherever possible to check for leaks.

Filling the pipe...

- Always, slowly fill the pipeline with water from the lowest point – this will allow for air to migrate to the high point and allow it to bleed off through an air valve, hydrant or service connection located at a high point.
- Be sure to remove all air out of the line during filling, and before you apply the test pressure. Air trapped in the line, can make the test appear like you have a leak, (when there actually is no physical leak) and give a false result.
- You may use a firm foam swap ahead of the fill water to help remove the air, especially where the pipeline indulates – be sure to remove the swab at a high point washout before testing begins.
- The availability of water for testing is important.... you'll need a clean acceptable supply and don't forget you'll need an approved location to discharge it after the test.

- As the pipe slowly fills with water, allow a stabilization time-period for the air to escape and water temperature in the pipe to stabilise. The length of the stabilisation time period will depend on the pipe diameter, and ground gradients or profile - over night is preferred but should be at least 3 hours. Any trapped air must be bled off before you start your pressure test.
- The recommended rate of filling the pipe is based on a slow flow velocity of 0.05 m/s, to help allow the air to escape. You can calculate the filling rate using the following equation:

$$Q_f \leq 12.5\ \pi\ D^2$$

where... Q_f = filling rate, litres per seconds

D = pipe diameter in metres

π = 3.14

The pressure pump must be big enough to raise the pressure in your pipeline up to the test pressure within no more than 45 minutes, otherwise the elastic response in the pipe, needed for some PE pressure test procedures, may not occur at the right time.

SELECTING THE TEST PRESSURE (STP)

The maximum hydrostatic test pressure (STP) at any point in the pipeline needs to be

- Not less than the maximum operating or design pressure in the pipeline
- Not more than 25% above the rated PN pressure class (eg PN class) of any component in the pipeline, allowing for any rerating due to temperature. *(Refer to Table below)*
- If you are planning to pressure test the pipeline above ground, be sure to allow for the pipe becoming heated by the sun, which temporarily reduces the pressure strength of the heated pipe. Heated exposed pipes can fail if the test pressure is not rerated.
- You can choose the **maximum allowable test pressure (in Bar)** for PE pipe from this table. Do not attempt pressure testing on any PE pipe heated to more than 40°C

Pipe Wall Temperature °C	Pipe Class PN 6.3	Pipe Class PN 8	Pipe Class PN 10	Pipe Class PN 12.5	Pipe Class PN 16
5 - 20	7.8	10	12.5	15.6	20
25 - 30	7.2	9.1	11.3	14.3	18.1
35 - 40	6.6	8.3	10.3	13.2	16.6

SELECTING THE TEST LENGTHS

The length of PE pipeline you're going to test can be the whole pipeline, or you can test a smaller isolated section.

(But... long length pipelines may need to be tested in several sections). This will depend on the pipe, diameter and where the fittings are located, such as; isolation valves, hydrants and dead-end caps etc.

Long test sections with fused and mechanical joints fitted must be checked for leaks. The longer the pipeline test section, the harder it is to remove all the air, and later, to locate a leak or loss of pressure.

SELECTING THE TEST METHOD

Polyethylene pipe requires special test methods that are different from those used with other pressure pipe materials such as PVC, Ductile Iron or Steel.

NZS 4404:2010 includes three alternative pressure test methods for PE pressure pipe -these are the methods I will talk about in this Field Testing Guide.

1. **Visual Test Method for small pressure pipelines**
   Recommended for small diameter pipes including service laterals and small rider mains or short length pipelines (less than 200m long), and for pipe lines where all the pipe joints have been left exposed for the test operation.

2. **Constant Pressure Test (Water Loss Method)**
   May be used for long test lengths of up to several kilometres in length.

3. **Pressure Rebound Test Method**
   May be used for pipes sizes up to DN 315 where a short test time is required.

Note: The test rig for this method must include a recently calibrated pressure transducer, data logger, and check pressure gauge with a dial of at least 100 mm diameter and a pressure range that places the Test Pressure (STP) within the range of 35% to 70% of the gauge's full scale. The transducer and the check gauge must read within ±5% of each other. If they do not agree within this tolerance, the equipment must be recalibrated or replaced.

Other approved test methods for PE pipe may be used, such as in City or Council construction Standards, or the AS /NZS 4404:2010 Standard.

1 - VISUAL PRESSURE TEST

Procedure

Step 1 Select the Test Pressure using the Table on page 9

Step 2 Apply the Test Pressure and isolate your pipeline by closing the high point air release valves and the pump feed valve.

Step 3 Visually inspect the pipeline for leakage at all joints (especially bolted joints), fittings, service connections, and valves.

Step 4 Check the pressure gauges to ensure that pressure has not fallen significantly, indicating a possible leak you'll need to repair any leaks found and re-test.

Step 5 When no leaks are found, open the high point air release valves. Slowly depressurise the pipeline, drain to an approved location, and reinstate all connections.

The test length is acceptable where there is:

1. No failure of any thrust block, or pipeline component
2. No physical leakage
3. No pressure loss indicative of a leak

2 - CONSTANT PRESSURE TEST

Procedure

Step 1 Purge all the air from the pipeline.

Step 2 Select and apply the Test Pressure, using the guidelines found on page 9.

Step 3 Shut off the pipe section and allow pressure to settle for 12 hours - (the pressure will drop significantly).

Step 4 Re-apply and maintain the test pressure for 5 hours by successively pumping a sufficient amount of water to maintain the Test Pressure.

Step 5 Measure and record the water volume ($\mathbf{V_1}$ in litres) required to maintain the pressure between Hour 2 and Hour 3.

Step 6 Measure and record the water volume ($\mathbf{V_2}$ in litres) required to maintain the pressure between Hour 4 and Hour 5.

The quantity of make-up water necessary to maintain the test pressure shall comply with the following equation:

$Q \leq 0.14\ LDH$

Where... Q = allowable make-up water, in litres per hour

L = length of the test length, in kilometres

D = nominal diameter of the test length, in metres

H = average test head over length of pipeine under test, in metres

Note: The make-up water is not a leakage allowance, but is an allowance to cover the effects of the test head forcing small quantities of entrapped air into solution. Normally the test should last for a minimum of 2 hours and be concluded within 5 hours to 8 hours. The make up water requirement should reduce with time as air goes into solution. Where, after 12 hours the make up water still exceeds the allowable limit, testing should cease and the cause of loss investigated.

Step 7 Calculate:

$0.55\ V_1 + Q$

where Q is the allowable make-up volume obtained from Step 6 above.

The test length is acceptable where there is:

- No failure is found on any pipe, fitting, joint, or any other pipeline component.
- There are no physical leaks anywhere, and $V_2 \leq 0.55\ V_1 + Q$

3 - PRESSURE REBOUND METHOD

Summary of the Procedure

Note: The test rig requirements for this method on page 10

The test procedure has the following three phases:

1. **Preliminary phase** in which the pipeline is
   - (i) depressurised and allowed to relax after the pre-test procedure, refer page 6
   - (ii) pressurized quickly to the test pressure and maintained at this pressure for a period of time without further water being added
   - (iii) the pressure is allowed to decay by normal visco-elastic creep in the pipe, and
   - (iv) provided the pressure drop does not exceed a specified maximum, the pressure test can proceed to the second phase;
2. **Air volume assessment phase** where the volume of air remaining in the pipeline is assessed against an allowable maximum.
3. **Main test phase** in which the pipeline is maintained at the test pressure for a period of time, and pressure decay due to normal viscoelastic creep in the pipe is commenced. The creep is interrupted by a rapid reduction of the pressure in the pipeline to a specified level. This rapid reduction in pressure results in contraction of the pipeline with an increase **(rebound)** in pressure. If, during the rebound period,

the pressure versus time record shows a fall in pressure, (which indicates a physical leak) the pipeline fails the test.

Preliminary phase procedure

Step 1 Reduce pressure to just above atmospheric at the highest point of the test length, and let stand for 60 minutes. Ensure no air enters the line;

Step 2 Raise the pressure smoothly to the Test Pressure in less than 10 minutes. Hold the pressure at Test Pressure for 30 minutes by pumping continuously, or at short intervals as needed. Do not exceed the Test Pressure.

Step 3 Inspect for leaks during the 30 minute period, then shut off the pressure supply;

Step 4 Allow the pressure to decay for 60 minutes

Step 5 Measure the pressure remaining at 60 minutes (**P_{60}**);

Step 6 If $P_{60} \leq 70\%$ of Test Pressure, the test is failed. The cause must be located and fixed. Steps (1) to (6) must be repeated. If $P_{60} > 70\%$ of STP, then proceed to the *air volume assessment phase*.

Air volume assessment phase

Step 1 Quickly (< 5 Min) bleed out water to reduce pressure by ΔP (10% to 15% of Test Pressure)

Step 2 Measure the water volume bled out (ΔV)

Step 3 Calculate $\Delta V_{\text{max allowable}}$ as follows

$$\Delta V_{\text{max allowable}} = 1.2 \times V \times \Delta P \left(\frac{1}{E_W} + \frac{D}{e \times E_R} \right)$$

Where... 1.2 = air allowance

V = pipe internal volume (litres)

ΔP = measured pressure drop (KPa)

D = pipe internal diameter (metres)

E_R = pipe material modulus (KPa)
(Refer table C2)

E_W = bulk modulus of water (KPa)
(Refer table C3)

e = wall thickness of the pipe (metres)

If $\Delta V > \Delta V_{\text{max allowable}}$, the test has failed. Locate and fix the cause. Repeat the preliminary phase.

If $\Delta V \leq \Delta V_{\text{max allowable}}$, proceed to the main text phase.

Note: ΔV and ΔP must be very accurately measured, especially where the pipe length & volume is small.

MAIN TEST PHASE

Observe and record the pressure rise for 30 minutes.

In the event of failure, locate and repair leaks. If failure is marginal or doubtful, or if it is necessary to determine leakage rate, use an alternative reference test method such as the Constant Pressure Test above.

Note: Figure C3 gives an example of a full pressure test with the main test phase extended to 90 minutes.

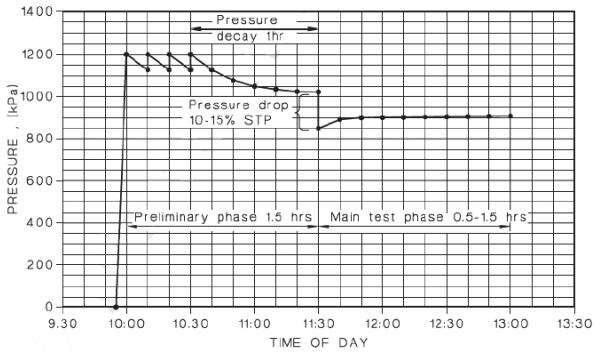
Table C2 - Pipe E_R material modulus for PE 80 and PE 100

Temp °C	PE 80B - *E* Modulus (kPa x 10^3)			PE 100 - *E* Modulus (kPa x 10^3)		
	1h	2h	3h	1h	2h	3h
5	740	700	680	990	930	900
10	670	630	610	900	850	820
15	600	570	550	820	780	750
20	550	520	510	750	710	680
25	510	490	470	690	650	630
30	470	450	430	640	610	600

Table C3 - Bulk modulus E_W - Water

Temperature °C	Bulk Modulus (kPa x 10^3)
5	2080
10	2110
15	2140
20	2170
25	2210
30	2230

Figure C3 - Typical successful modified rebound test for a PE pipeline



The test length is acceptable where

(a) There is no failure of any thrust block, pipe, fitting, joint or any other pipeline component;

(b) There is no physical leakage;

(c) The pressure rises or remains static in the 30 minute period;

Note: If there is any doubt about the pressure recovery, the monitoring period may be increased to 90 minutes, and any pressure drop that does occur, must not exceed 20KPa over the 90 minute period;

- If the pressure drops by more than 20 KPa during the 90 minute extended period, the test fails, and
- Repetition of the main test phase may only be done by repeating the whole test procedure, including the relaxation period of 60 minutes described in the preliminary phase.

Well that's it. It's easy when you know how! Always do it right the first time—she's all good to go!

I hope this helps you,

Poly Pete

Disclaimer:
The information, opinions, advice and recommendations contained in this publication are put forward with the main object of providing a better understanding of technical matters associated with pipeline and component design using Iplex Pipelines. Whilst all reasonable care has been made in ensuring that the information contained in this publication is accurate, this publication should not be used as the only source of information by the reader. Reference should also be made to establish textbooks and other published material, and readers should not rely on the information contained in this publication without taking appropriate professional advice for their particular circumstances. Fittings have been shown as typical configurations, however, in some cases product dimensions or installations may vary or be changed without notice. In all instances, the reader should contact Iplex Pipelines for clarification that the specific product is appropriate for their circumstances.

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