iPLEX Pipelines

How To
Field Test PVC Pipelines

By Pipeline Percy

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Introduction

G'day I'm, Pipeline Percy,

I've written a couple of "How I" booklets for the good ol' folk at Iplex Pipelines. They've been so well received I've been asked to write this one on *"How to Field Test PVC Pipelines".*

Over recent years I've been called onto lots of failed pre-commissioning tests to help get contractors back on track. A couple of jobs stick in my mind as the WORST cases I've ever seen. The oldest … a project back in the'90's in central North Island where a contractor kept blowing his pipe to bits! When I got to site and checked things out I used my calibrated pressure gauge I found his was way out of synch. His read 9 bar and mine read 31 bar. WOW - no wonder! The other project was where a contractor was testing a 150mm water main using compressed air, there is a low air pressure test but that's a 25KPa test procedure, he was testing his main way beyond 700KPa, and….that pipe blew to bits as well!

Both of these cases could have caused injury, or in the compressed air case could have caused ***SERIOUS HARM***.

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 C (page 223).

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 to assist – they'll answer any problems that will stump you. Don't be afraid to phone Iplex. They have a call free number, call them on **0800 800 262** and ask for the Iplex Technical Support Team.

I hope this helps you.

Pipeline Percy

Why do we test pipelines?

We should test all pipelines to uncover any faults during pipeline construction, for example…

To check that…

All pipe-joints have been made correctly. 

All pipeline components… valves, hydrants, bends, tees, tapping bands and any other mechanical fittings have been installed correctly. 

For pressure pipes… to determine that the pipeline will handle pressure greater than its design pressure - without leaking! 

For gravity pipes… to determine that the pipeline can hold water/sewer in and keep ground water **out!** Water tight joints will prevent ground water getting' into our Waste Water treatment plants! 

Generally, test that the pipe is "good to go" into service. 

But….
A test may or 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 product standards.

How I Leak Test Gravity Pipes

Leak testing is used to find potential infiltration and exfiltration caused by poor install practices. On any new pipe installation you should carry out at least one of the following tests: **a low pressure air test (LPAT)** or a **hydrostatic pressure test (HPT).**

What you need to know….

Air tests only tell you … that you've installed everything properly. Because air pressure losses can't be related directly to water leakage.

When pipeline sections are installed below the water table, the test pressure used for hydrostatic pressure testing and for the air test, should be increased to maintain the required differential between internal and external water height pressure above the pipeline.

A pipeline that fails the air test should be checked for leaks, the leaks fixed and re-tested using the hydrostatic method.

Visual Test

This is a test that can be used for small diameter or short length pipelines of (less than 200 m in length) all materials. I also use it for pipelines where joints have been left exposed for the test operation.

Visual Test Procedure (VTP)

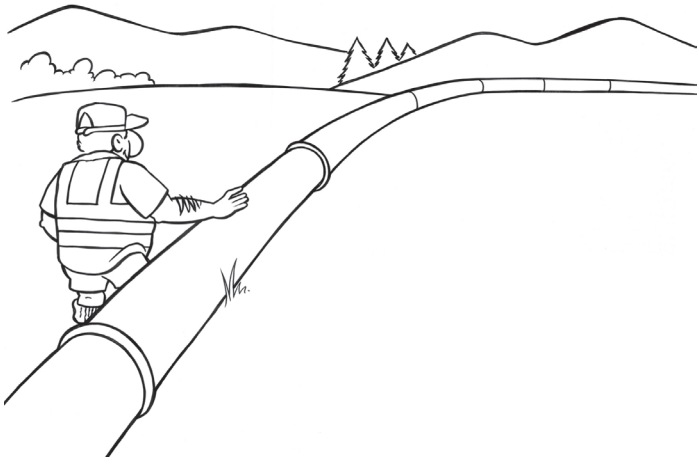
Step 1 Select your Test Pressure using the notes I've made on page 13 under the heading of STP. Apply the TP, test your pipeline by closing the high point air release valves and the pump feed valve.

Step 2 Inspect the pipeline visually for leakage at all joints, especially bolted joints, all fittings, service connections, and valves.

Step 3 Check the pressure gauges to ensure that pressure has not fallen significantly. If you've lost pressure this might indicate an undetected leak.

Step 4 You'll need to repair any detected leaks and re-test the pipeline.

Step 5 When no leaks have been detected, open the valve at the high point of the pipeline. This is usually at an isolation valve attached to an air relief valve, depressurise the pipeline slowly and drain the pipeline. Reinstate all connections.

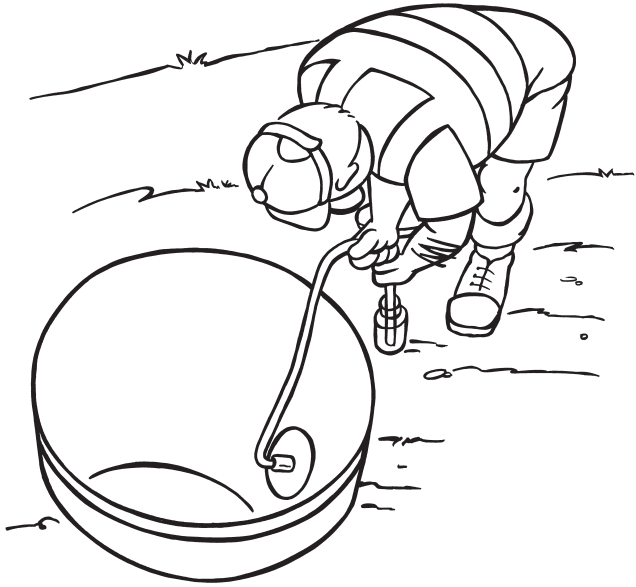


Gravity Pipes – Low Pressure Air Test Procedure (LPATP)

A low pressure – air test shall pass where the pressure gauge reading exceeds 18 KPa, or not more than 7 KPa less than the pressure at the start of the test. The period of time shown in Table 1 below is based on an air test pressure (in excess of any external hydrostatic pressure due to groundwater) and on this basis, the air volume losses shall not exceed:

(A) A rate of 0.0009m^3/(min x m^2) of pipe wall area; and

(B) A rate of 0.056m^3/min, which is regarded as the lowest detectable individual air leak. Column 2 and 3 of Table 1 will give you the times and lengths up to which (**B**) prevails over (**A**).



NOTE – For safety reasons… do not apply air pressure above 50 kPa.

Low Pressure Air and Vacuum Tests
– Minimum time intervals for 7 kPa pressure change in pipeline

Table 1

The Pipe DN or Ø	Minimum time in minutes	Maximum pipeline length for minimum time to apply in metres	Test length in metres				
			50	100	150	200	250
			Minimum test duration in minutes				
80	1.5	231	1.5	1.5	1.5	1.5	1.6
100	2	185	2	2	2	2	3
150	3	123	3	3	3	5	6
225	4	82	4	5	8	10	13
300	6	62	6	9	14	18	23
375	7	49	7	14	22	29	36
450	9	41	10	21	31	41	52
525	10	35	14	28	42	56	70
600	11	31	18	37	55	73	92
675	13	27	23	46	70	93	116
750	14	25	29	57	86	115	143
900	17	21	41	83	124	165	207
1000	19	19	51	102	153	204	255
1050	20	18.8	56	112	169	225	281
1200	23	15	73	147	220	294	367
1500	28	12	115	230	344	459	574

NOTE –
The time interval may be reduced for a proportionate reduction in the allowable pressure drop. Where there is no detectable change in pressure after 1 hour of testing, the section under test has passed this test.
If you are a mathematician….this table is based on the following equation:

$$T = 1.02 D_i k L q,$$

Where, Time: T = time for a 7 kPa pressure drop, in seconds.
Diameter: D_i = pipeline internal diameter, in metres.
Flow: q = allowable volume loss in cubic metre/minute/square metre taken as 0.0009 $m^3/min.m^2$.
Coefficient loss: $k = 0.054DL$ but not less than 1.
Length: L = length of test section, in metres.
Columns 2 and 3 have been calculated with $k = 1.0$.
The air or vacuum test/pressure method for pipes larger than 750Ø should be established by the designer.

Low Pressure Air Test Procedure (LPATP)

Step 1 Pump in air **slowly** until a pressure of 25 kPa is reached. Remember…where the pipeline is below the water table the pressure should be increased to achieve a differential pressure of 25 kPa but the pressure should NEVER exceed 50 kPa.
Rapid pressurisation may cause significant air temperature changes, which will affect the test accuracy – **build pressure slowly!**

Step 2 Maintain the pressure for at least 3 minutes and if there are no leaks shut off the air supply.

Step 3 If the pipeline fails the test, re-pressurise to 25 kPa and check for leaks by pouring a concentrated solution of soft soap and water over any accessible joints or fittings.

Step 4 Repair any leaks and repeat steps 1 & 2.

Step 5 With the air supply shut off, monitor the pressure for the time intervals given in **Table 1**.

Step 6 The test should be considered a pass where the pressure drops less than 7 kPa from your start pressure of 25 kPa over the required test period shown in **Table 1**.

Some things to remember….

The test length of pipeline should be restricted to pipeline sections between manholes or exposed fittings that test plugs can be inserted into. This method should not be used to test lengths longer than 250m or pipe diameters larger than 1500mm.

Low pressure air test of large diameter pipelines is potentially **DANGEROUS** because of the very large forces to be resisted by temporary plugs or bulkheads and the serious consequences of accidental bulkhead blow-out! **A relief valve with a 50kPa maximum setting should be installed on all pressurising equipment.**

Gravity Pipes – Hydrostatic Pressure Test (HPT)

The test length passes the test where the specified allowable make up water is not exceeded. Where not specified, the allowable make up water shall be 0.5 litres per hour per metre length, per metre diameter.

The test pressure should not be less than 20 kPa, or 20 kPa above the groundwater pressure at the bottom of pipe (that's the top) at its highest point, whichever is the greater, and not exceed 60 kPa at the lowest point of the test section.

Steeply graded pipelines might need to be divided into sections and tested separately in stages if the maximum pressure that I've listed above is exceeded.

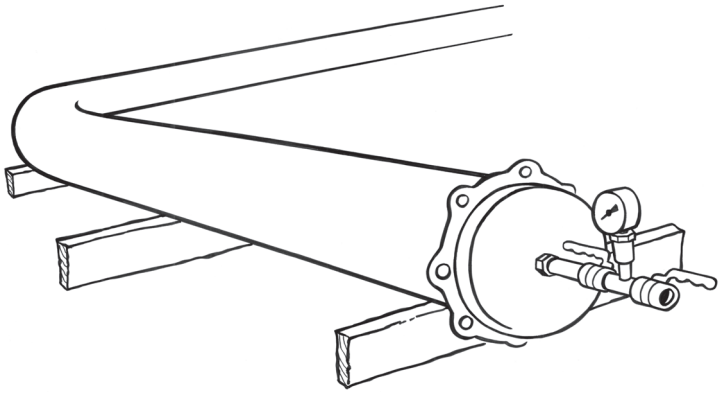
Gravity Pipes – Hydrostatic Pressure Test Procedure (HPTP)

Step 1 Pump in water **slowly** until a pressure of 20KPa is reached. Bleed all the air off during filling. Remember…where the pipeline is below the water table the pressure should be increased to allow for the ground water height. (Do not exceed 50 kPa).

Step 2 Maintain the pressure for at least 2 hours by adding measured volumes of water where necessary. If there are no visible leaks you've passed the hydro test.

Step 3 If you have any leaks these need to be repaired and repeat Steps 1 & 2.

How I Test Pressure Pipe



What you need to know

You'll need to select an appropriate test method, pressure, and length of test section.

(a) Pipe material, diameter and length to be tested.
(b) Length of time of the pressure test itself.
(c) Magnitude of the test pressure and rate of pressurisation.
(d) Air in the pipeline must be removed.
(e) Prevent movement of thrust restraints, and permanent or temporary anchor block supports.
(f) Be sure your test gauges are accurate.
(g) Ambient temperature changes during testing.
(h) Prevent leaks in all test equipment and the pipeline.

When you begin any long pipeline construction I recommend you begin testing the pipeline as early as you can to prove how good your pipe laying skills are. You should only lengthen the test period progressively until you are confident that you are "doin' it right". A simple half daily or daily low pressure air test of no more than 35 kPa.

Selection of the Test Pressure (STP)

The hydrostatic test pressure at any point in the pipeline needs to be:

(a) Not less than the design pressure; and

(b) Not more than 25% above the rated pressure of any pipeline component.

The design pressure is the maximum system pressure taking into consideration any future growth which needs to include the static pressure, dynamic pressure, and an allowance for short-term surge pressure or water hammer. High pressure compressed air testing **IS NOT** allowed for pressure pipe testing as you could cause serious harm to your pipeline and you!

Selecting Test Lengths (STL)

The length of the pipeline you're going to test can be the whole pipeline, or if you can isolate a section, just a small section. (But… pipelines longer than 1000m may need to be tested in several sections.) This will depend on the length, diameter and where fittings are located, such as; isolation valves, hydrants and dead-end caps etc. Long test sections may have a large number of mechanical joints fitted which should be checked for leaks. The longer the pipeline test section the harder it is to locate a leak or loss of pressure. Get all the air out of the line during filling. Air trapped in the line will make the test look like you have a leak.

Be sure that the hydrostatic test pressure at any point in the pipeline is:

- Not less than the design or operating pressure.
- Not more than 1.25 times (25%) the PN or pressure rating of the pipeline and **ALL**… of its components.

The availability of water is important…. you need a good clean supply and don't forget you might need to get rid of it after the test. You'll need to make sure you have somewhere to put it if it's not wanted later or things don't go quite to plan!

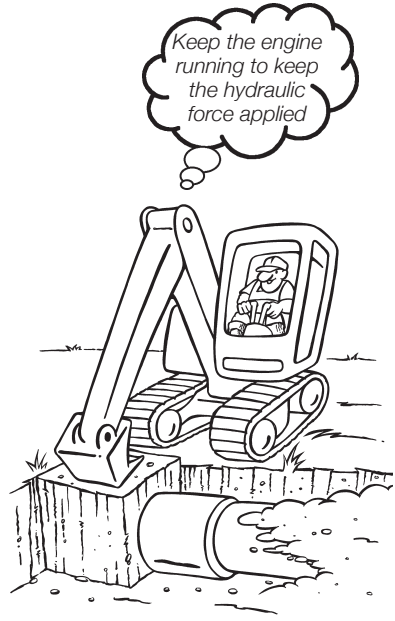
Pre-Test Procedures (PTP)

Ensure all thrust blocks, restraints including integral restraint joint systems, are securely in place. Did you know concrete can take up to 28 days to cure. In some cases the pipeline can be pressurised after a minimum of 7 days of pouring the concrete anchor blocks.

Blank flanges or dead-end caps should be installed at the beginning and end of the pipeline test section. **Never** test against closed isolation valves - I've had new ones leak fresh from the factory.

Make sure all mechanical joints, bends or dead-end caps in exposed open test pits are temporarily and **securely** anchored to hold without any movement. Concrete waste blocks like this one work - spot on!

….Believe me, I've seen poorly anchored pipelines climb out of the ground and **erupt!!!!!** – this can be caused by not

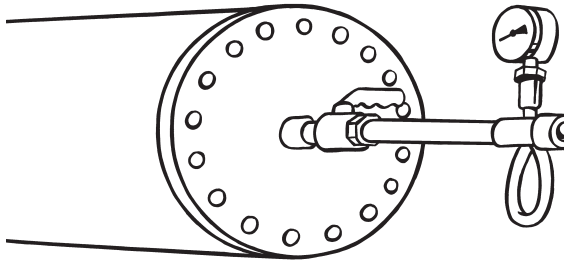


supporting temporary anchors during pressure tests. If you're using a digger to absorb the pressure force you'll need to keep the engine running to keep the hydraulic pressure force applied to temporary supports.
Don't remove any temporary supports until the pipeline has been depressurised!

Carefully place compacted fill to leave all joints, service connections and isolation valves exposed (wherever possible) - you must **securely** restrain all exposed mechanical couplings!

In isolated locations I usually use a water blaster as the pressure-pump source. It needs to be big enough to raise and maintain the test pressure during the pressure test.
I reckon it's a good idea to have two calibrated pressure gauges in my test equipment to cross check each gauge from time-to-time.

I always slowly fill the pipeline with water from the lowest point of the pipeline – this will allow for air to migrate to the high point of the pipeline and be vented out at the high



point, usually through an open valve. Allow a stabilization time-period… somewhere in the range of 3 hours to 24 hours, for the temperature of the pipe and water to equalise. The length of the stabilisation period will depend on the pipe diameter gradients or ground profile. Any trapped air will need to be bled off before your pressure test.

The recommended rate for filling pipe is based on a low flow velocity of 0.05 m/s, calculated from the following equation:

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

Where

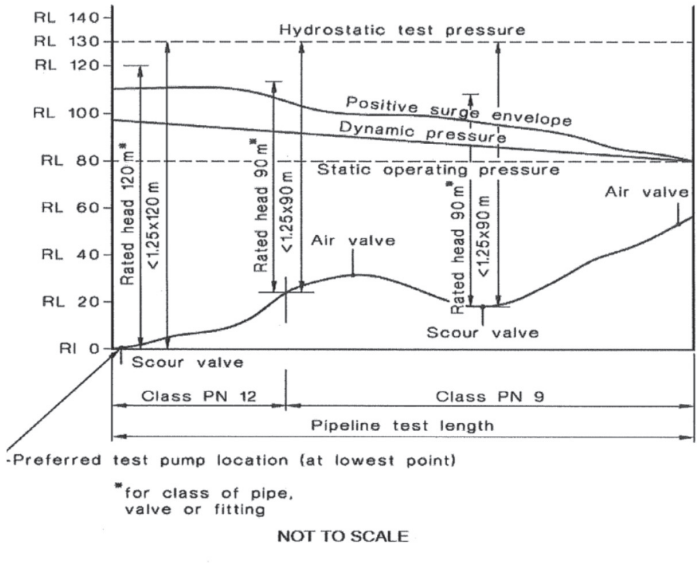
Qf = filling rate (litres per seconds)

D = pipe diameter (m)

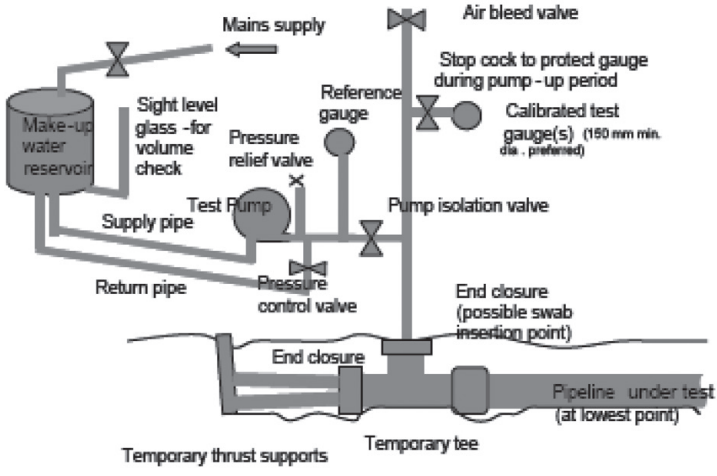
The low filling rate reduces air entrapment when your filling water is cascading through downward gradients along the pipeline.

You might want to use a firm foam swab ahead of the fill water to assist air removal especially where the pipeline gradient levels change. You must extract the swab at a high-wash-out point.

I've drawn a sketch on the next page of typical pressure test layouts, equipment and their locations are shown in sketches **S1** and **S2**.



Sketch **S1** – Typical pressure pipeline under field hydrostatic test



Sketch **S2** – Typical field pressure test equipment layout

Pressure Pipe – Constant Pressure Test (CPT) (water loss method)

This test can be used for PVC or Glass Reinforced Polymer (GRP) pipe systems.
The pipeline test length may be several kilometres in length (see STP - Selecting Test Lengths on page 13.

Procedure

The procedure to follow is:

Step 1 Close all valves except the test pump input and pressurise your pipeline to the specified test pressure.(STP) – (Refer page 13 Selection of Test Pressure).

Step 2 Apply and maintain the test pressure by the addition of measured and recorded quantities of makeup water at regular intervals over a period, in the range of 1 hour to 12 hours.

Step 3 Where pressure measurements are not made at the lowest part of the test length, make an allowance for the static head, between the lowest point of the pipeline and the point of measurement, to ensure that the test pressure is not exceeded at the lowest point. The quantity of make-up water necessary to maintain the test pressure can be calculated using the following equation:

$Q \leq 0.14LDH$

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 pipeline under test, in metres

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 finished within 5 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, stop testing and find the cause.

Post Test Procedure

After testing depressurise the pipelines slowly. When emptying the pipeline open all vents and valves to allow air back in and prevent a vacuum occurring.

Acceptance

The test is a pass where there is:

- No failure of any thrust block, pipe, fitting, joint or any other pipeline component.
- There is no physical leaks in the pipeline anywhere.
- The quantity of make-up water necessary to maintain the test pressure complies with the procedure.

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

Pipeline Percy

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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