Plastics Industry Pipe Association of Australia Limited ACN 086 511 686

Notes on Field Pressure Testing

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It has long been recognised that for field pressure testing of PE pipelines it may be necessary to provide allowance for the fact that polyethylene pipes expand under pressure and are subject to creep. Recommendations such as found in Oy Wiik & Hoglund published literature, were developed in Scandinavia over twenty years ago to account for the pressure variations, especially with pipes up to one metre diameter.

In Australia, large diameter pressure pipelines were being field pressure tested as long ago as the 1960's. AS 2033, Installation of Polyethylene Pipe Systems, first published in 1977, acknowledged the phenomenon, but did not provide specific guidance for making allowance. The main emphasis was on visual inspection of joints for leakage, still the most effective method if practicable.

In the period since, various national and industry specifications have been developed, including WRc (U.K.), ASTM (U.SA.), PPI (U.S.A.) VAV P78 (Sweden), CEN. In addition, the advent of PE materials with higher stress ratings and lower modulus values has necessitated more detailed consideration of the procedures.

Where pipe expansion is a consideration, the method should either account for effects such as soil support or be independent of them. Two methods that are independent of soil support are the modified rebound method, based on work within CEN, and the Swedish Water Works Association VAV P78 method, originally developed by Prof. Lars-Eric Janson. This latter method has been successfully used over a range of pipe sizes since 1989, and described in various publications. The modified rebound method has the advantage that it is a quick test, but it cannot quantify a leak in the event of failure. This method is suitable for all pipe diameters. Where it may be necessary to quantify a leak, or for referee purposes (eg to resolve an inconclusive test result), the method of Prof. Lars-Eric Janson should be used.

Regarding other methods, ASTM rely heavily upon visual inspection, PPI recommendations are similar to rebound and Swedish Water Works Association (but material specific), and the WRc (pressure decay) method is complex and requires an estimate of the support given by the soil.

For pipelines where visual inspection of joints is not practicable, for long pipelines, or for larger diameters, the following are the recommended procedures for field pressure testing.

The Reference Test (Prof. Lars-Eric Janson) method has been adopted by Standards Australia in AS/NZS 2566.2:2002 Buried flexible pipelines Part 2: Installation, and by the Water Services Association of Australia (WSAA) in their Polyethylene Pipeline Code WSA 01 - 2004.

REBOUND TEST SUMMARY

- Water entry at lowest point in line
- Flush/swab/vent all air from line.

MAXIMUM SYSTEM TEST PRESSURE (STP) at least 1.25 times maximum working pressure of pipeline but not to exceed 1.25 times MAOP of lowest rated pipe/fitting in line.

PRELIMINARY PHASE

- Reduce pressure to atmospheric, let stand for 60 minutes.
- Raise to STP in less than 10 minutes and hold for 30 minutes, pumping as needed.
- Inspect for leaks, shut off pressure, let stand for 60 minutes.
- Measure pressure reading P_{60} > 70% STP.

MAIN TEST PHASE

- Quickly (<5 minutes) reduce pressure by 10 -15% of STP - ΔP.
- Measure water volume bled out - ΔV
- Calculate $\Delta V_{max\ allowable}$ if not already done.

  $\Delta V_{max\ allowable} = 1.2V \Delta P \{1/E_W + D/eE_R\}$

  where:-

  1.2 = air allowance

  V = pipe volume in litres

  ΔP = pressure drop in kPa

  D = pipe internal diameter in metres

  e = pipe wall thickness in metres

  E_R = pipe material modulus kPa (see Table 1)

  E_W = Bulk modulus of water (see Table 2)
- Observe and record pressure rise for 30 minutes.

PASS IF

- No leaks
- No components break
- Pressure reading rises / remains static over 30 minutes. If in doubt, leave for 90 minutes, maximum allowable pressure drop in 90 minutes = 20 kPa.

FAIL

- Locate and repair leaks
- If failure is marginal or doubtful, or if it's necessary to determine leakage rate, use Reference Test.

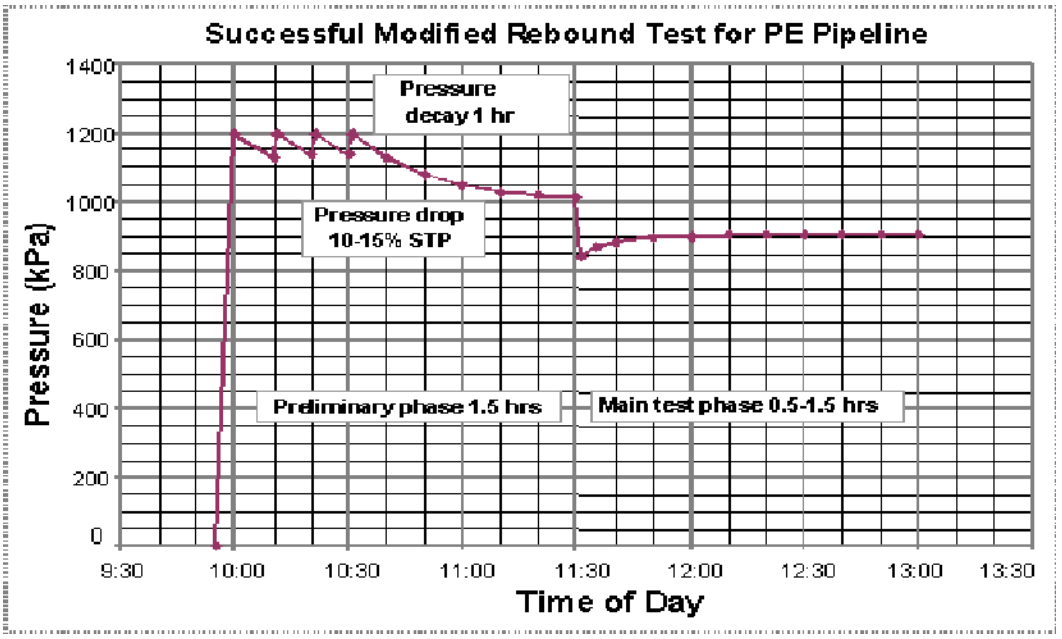
Table 1 PE MATERIAL MODULUS E_R

TEMP. ° C	PE 80B - E Modulus ($kPax10^{-3}$)			PE 100 - E Modulus ($kPax10^{-3}$)		
	1 hour	2 hours	3 hours	1 hour	2 hours	3 hours
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

Note: Table assumes MDPE for PE 80B and HDPE for PE 100.

Table 2 BULK MODULUS Ew – WATER

TEMPERATURE	BULK MODULUS ($kPax10^{-3}$)
5	2080
10	2110
15	2140
20	2170
25	2210
30	2230


Successful Modified Rebound Test for PE Pipeline
Pressure decay 1 hr
Pressure drop 10-15% STP
Preliminary phase 1.5 hrs
Main test phase 0.5-1.5 hrs
Pressure (kPa)
1400
1200
1000
800
600
400
200
0
9:30
10:00
10:30
11:00
11:30
12:00
12:30
13:00
13:30
Time of Day

REFERENCE TEST SUMMARY

- Water entry at lowest point in line
- Flush/swab/vent all air from line.

MAXIMUM SYSTEM TEST PRESSURE (STP) at least 1.25 times maximum working pressure of pipeline but not to exceed 1.25 times MAOP of lowest rated pipe/fitting in line.

PRELIMINARY PHASE

- Raise pressure to STP, close off main, allow to settle for at least 12 hours. The pressure gauge will show a drop.
- Inspect for leaks.

MAIN TEST PHASE

- Raise pressure to STP and maintain for 5 hours.
- Measure water volume to keep constant pressure between 2 hours and 3 hours after test start.
- Measure water volume to keep constant pressure between 4 hours and 5 hours after test start.

PASS IF

- $\Delta V_{(5h-4h)} \leq 0.55 \Delta V_{(3h-2h)} + V_{all}$

  where:-

  $V_{all} = 0.14 L D H$

  D = Pipe internal diameter in metres

  L = Test pipe length in km

  H = Average test head in metres

  V_{all} is a make-up allowance to cover the effects of entrapped air being forced into solution.
- No visible leaks
- No components break

FAIL

- Repair / reinstate pipeline

For Further information please contact
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