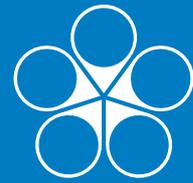


# Field Testing of Concrete Pipelines and Joints



**Concrete Pipe  
Association  
of Australasia**

ACN 007 067 656

**TECHNICAL  
BULLETIN**



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Test Procedure for Air Testing of Concrete Non Pressure Pipelines

**CONCRETE PIPE ASSOCIATION OF AUSTRALASIA  
FIELD TESTING OF CONCRETE PIPELINES AND JOINTS  
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### **ABSTRACT**

Although rigorous tests are specified in Australian and New Zealand Standards for client acceptance of pipes before delivery, the development and establishment of standard test procedures for checking the integrity of an installed pipeline have often been neglected.

New Zealand practice for non-pressure pipelines is covered by New Zealand Standard NZS 4452:1986 "Code of Practice for the Construction of Underground Sewers and Drains".

In this document four separate test methods are outlined in an attempt to standardise the application of field testing in Australia and ensure a high quality pipeline.

## 1 INTRODUCTION

Australian and New Zealand Standards for precast concrete pipe make provision for hydrostatic pressure testing for rubber-ring jointed pipes.

Routine **factory** hydrostatic pressure testing is undertaken for drainage and sewerage pipes only where specified by the purchaser at the time of order. It is, however, mandatory for pressure pipes.

**Field testing of concrete pipelines and joints is applicable only to pipes which have been subject to routine factory hydrostatic pressure testing by the manufacturer.**

Within Australia and New Zealand, and elsewhere the world Authorities, Consultants and others have from time to time produced recommended procedures for checking the integrity of a pipeline subsequent to laying. These have differed markedly in certain aspects.

It is the aim of this document to rectify this situation for concrete pipelines and standardise the application of these tests within Australia.

New Zealand practice is covered by New Zealand Standard NZS 4452:1986 "Code of Practice for the Construction of Underground Sewers and Drains".

## 2 OVERVIEW OF TEST METHODS

Various field tests are in use to ensure the integrity of concrete pipelines. These, together with their correct application are discussed in the following sections and summarised in Table 1 as it is important that these tests are used for the correct reasons and in the correct manner. The various tests are:

- *Field testing of rubber ring joint non-pressure pipelines by application of a hydrostatic test (Section 3)*

The purpose of this test is to check that the jointing has been performed correctly and the rubber ring properly located. It is intended to pick up any fault that has occurred during the laying process.

- *Field testing of reinforced concrete pressure pipelines by the application of a hydrostatic test (Section 4)*

This test may be applied to any diameter of pressure pipeline for the purpose of:

- (a) revealing the occurrence of faults in the laying procedure, eg incorrect jointing methods or pipes damaged.

- (b) ensuring that the pipeline will resist the sustained service pressure.

- *Field testing of individual rubber ring joints in installed reinforced concrete pipelines (Section 5)*

This test is used to establish that each jointing operation has been performed correctly and the rubber ring is in position. It is not appropriate for use on small pipes and is recommended for diameters over 1200 mm.

- *Field testing of non-pressure concrete pipelines by the application of an air test (Section 6)*

This test uses low pressure air and is only applicable where it is more convenient than using the hydrostatic test. It can provide the criteria for acceptance of a pipeline but not for its rejection.

**Table 1  
Summary of Test Methods and Their Application**

Field test for	Test medium	This test demonstrates				Comments and limitations
		A	B	C	D	
Non pressure pipeline	Water	Yes	Yes	Yes	Yes	
Pressure pipeline	Water	Yes	Yes	Yes	Yes	
Pipeline joint	Water	Yes	Yes	No	No	See Note 1
Non pressure pipeline	Air	Yes	Yes	Yes	No	See Note 2

Key: A – jointing performed correctly  
 B – rubber ring positioned correctly  
 C – no damage to line during laying  
 D – line will resist the pressure for which it was designed

Notes:

- 1 The joint test is not in any way equivalent to a line test at the specified test pressure and must not be used as such.
- 2 When unacceptable leakage rates occur during the air test the contractor has the option to revert to the hydrostatic (water) test, ie air testing provides criteria for acceptance of a line but not for rejection.

### **3 HYDROSTATIC TESTING NON PRESSURE PIPELINES**

#### **3.1 Introduction**

Concrete drainage and sewer pipes are manufactured to meet the requirements of Australian and New Zealand Standards. For rubber ring jointed pipe these Standards provide an option for the purchaser to specify a hydrostatic test on each pipe before it leaves the factory.

To ensure that the pipes are still in good condition and have been correctly laid a low pressure hydrostatic test can also be applied to the pipeline after it has been laid. The test is a good indicator of the integrity of the line because it simulates service conditions. It is relatively simple to perform and can be applied to the full range of diameters of rubber ring joint drainage and sewer pipelines. It should not be applied in the same manner to pressure pipelines, eg water supply or irrigation installations, for which the equivalent test procedures and acceptance criteria must be more strict.

It should be noted that this field test is not intended to reassess general pipe permeability as the original factory test is designed to do.

#### **3.2 Purpose of Test**

When so determined by the owner or principal that a hydrostatic test is to be carried out, this should be done after laying the pipes and placing anchors, but before completing back-filling or placing surround concrete. The test is designed to reveal the occurrence of damaged pipes, joints incorrectly installed, or other laying deficiencies.

#### **3.3 Test Criteria**

The pipe when tested under a minimum head of 1.2 metres and a maximum head of 6 metres shall not show any leakage in excess of 0.5 litre per hour per linear metre per metre of nominal internal diameter. The minimum and maximum heads specified shall be measured above the internal crown of the pipe.

#### **3.4 Preparation and Procedure**

By fitting temporary bulkheads the test can be applied to the completed pipeline or progressively to sections as laid. Depending on the grade some pipelines must be tested in stages otherwise maximum head could be exceeded. All bulkheads must be suitably strutted and restrained, and plugs must be similarly fitted at any inlet/outlet connections.

Whenever possible testing should be carried out from manhole to manhole. Short branch drains connected to a pipeline between manholes should be tested as one system with the main pipeline. Long branches and manholes should be separately tested.

For the purpose of filling the line and obtaining the required 1.2 metres head above the crown at the high point of the test section, a water entry point must be provided through the temporary bulkhead. It is suggested that a flexible hose be attached to this fitting.

To obtain the correct head level and also to enable the leakage rate to be simply estimated, a drum or container should be attached to this hose. The drum which should be calibrated by marking with a litre scale is then supported so that the top mark of the scale is at 1.2 metres above the crown of the pipe. This is the reference mark and by noting the time and rate of fall an estimate of the leakage rate can be quickly obtained.

When filling there must be provision for air to bleed out or escape from high points. After filling, the water level will initially fall due to:

- absorption into the pipe wall
- air which is trapped at joints needs time to escape.

Allowance should be made for this by adding water to maintain some head on the pipe for an appropriate stabilising period before the measuring time commences. This stabilising time will depend on factors such as the age of the pipes, their moisture condition, ambient conditions, etc. It will usually be of the order of 24 hours. Whilst the aim is to commence the test proper as soon as possible, the appropriate period will best be determined by conferring with the pipe suppliers.

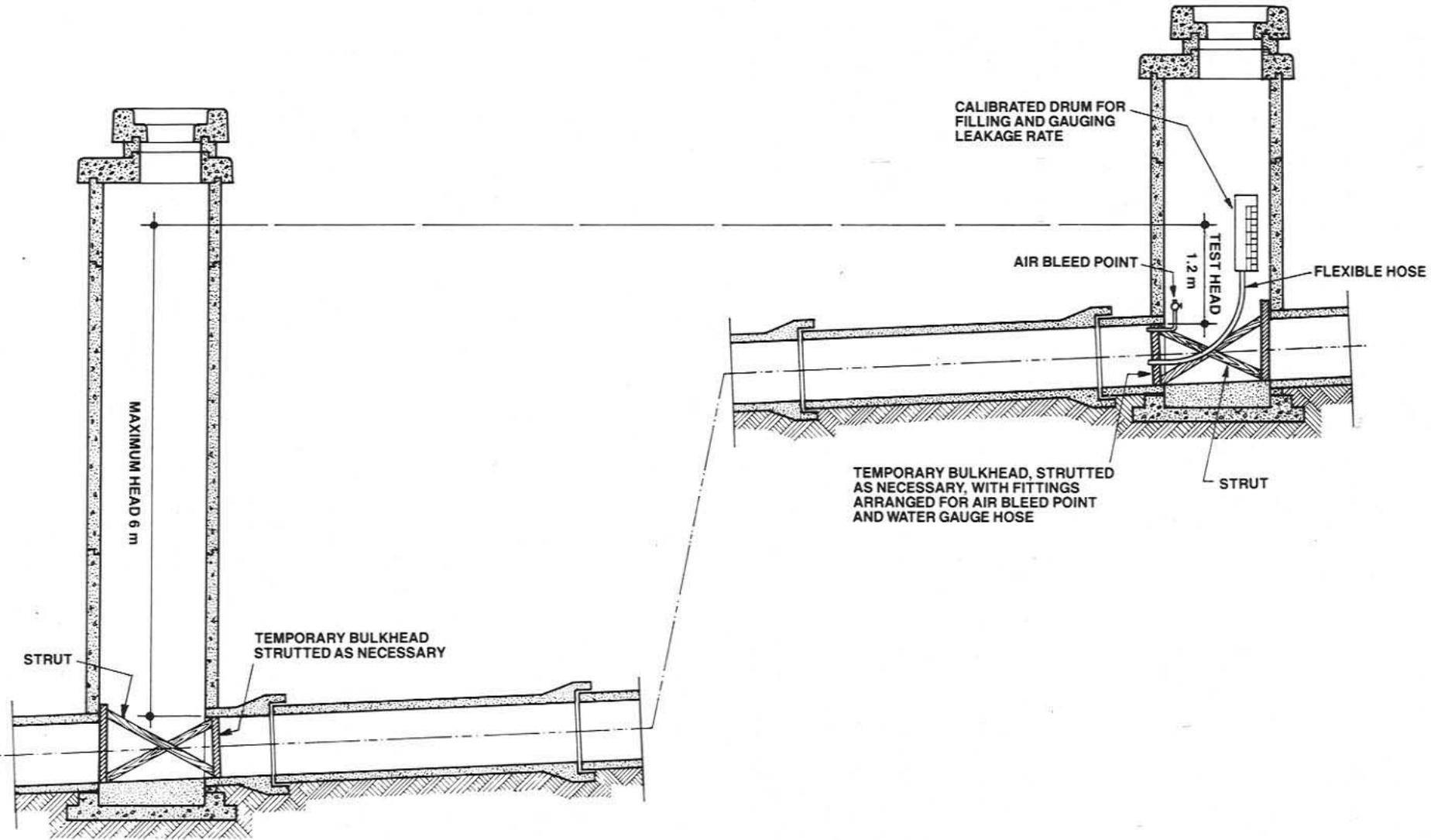
At the end of the stabilising period the head of water is adjusted back to the correct level. The loss of water over a period of 30 minutes is then measured by adding water and noting the quantity required to maintain the correct water level. The average quantity added should not exceed the equivalent leakage rate as specified under the test criteria in Section 3.3. above.

#### **3.5 Test Assessment**

Water loss in excess of the specified rate may be due to a defect. The line should be inspected and if a defect is detected by visible signs of leakage then remedial action is to be taken.

If no defect is found then it may be that the stabilising period was insufficient and after a further waiting period the test should be re-run.

DIAGRAM OF HYDROSTATIC TESTING BETWEEN MANHOLES



## 4 HYDROSTATIC TESTING PRESSURE PIPELINES

### 4.1 Introduction

Australian and New Zealand Standards require routine factory hydrostatic pressure testing of concrete pressure pipe.

To ensure pipes are being correctly laid and jointed, a field hydrostatic test can be applied. Temporary bulkheads will have to be installed at the ends of the pipeline or section of pipeline to be tested.

This field test is not to be applied for the purpose of reassessing individual pipe performance. The manner in which the pipes have been treated and the conditions to which they have been subjected prior to and during laying may have affected the performance of the pipeline. It is well recognised that initial leakage may occur through sound concrete pipes if they have been stored on-site for an extended period. Desirably such storage should be minimised by installing pipes as soon as possible, preferably before they dry out.

Pipes may show initial damp spots or weeps which will gradually diminish with time. This may not be the case if the damp spots are the result of damage.

### 4.2 Purpose of Test

The purpose of a hydrostatic test is to:

- reveal the occurrence of faults in the laying procedure, eg joints incorrectly installed or pipes damaged.
- ensure that the pipeline will resist the sustained internal service pressure to which it will be subjected.

### 4.3 Precautions

It is recommended that backfilling be partly completed before the test is applied, to minimise the chance that pipes will 'float' in trenches which become accidentally filled with water.

It is important that a pipeline to be tested be properly restrained to prevent movement of pipes, bends, tees, junctions, adaptors, and reducers. It is recommended that straight sections of pipeline be prevented from moving out of alignment by placing adequate sidefill to restrain the pipe. Excessive deflection of any pipe due to internal pressure may result in a failure at a joint.

### 4.4 Test Procedure

It is desirable to conduct an initial test as soon as possible after the first 500 metres of line has been laid and jointed, as an early check on the standard of pipelaying. The feasibility of doing this will depend on the rate of laying and whether the delay to pipelaying can be accommodated.

Considerable care and attention must be given to the provision and fixing of adequate bulkheads, which must be properly designed to prevent blow out and leakage. Such leakage unless monitored, can confuse the final test result.

The preconditioning of the line is important. It should be allowed to stand under some hydrostatic pressure say, up to 50 kPa at the highest point on the line for as long a period of time as necessary to allow absorption of water by the concrete. Time taken will depend on the age, moisture condition of the pipes and the ambient site conditions. Some lines will need no more than 24 hours before pressurisation commences, others may need longer.

Pressurisation should be carried out slowly and can begin at 50 kPa per hour. A guide to the rate of pressure increase can be obtained at any stage by measuring the rate of loss, ie the leakage per hour, and checking how this compares with the rate given by

the formula below. If the rate is substantially above this there is little point in raising the pressure further at this stage. Further preconditioning should be applied if there are no obvious leaks occurring anywhere along the line.

Once the pressure has reached the specified test pressure for the line and provided no major faults have appeared the loss of water should be measured at hourly intervals, over a period of three hours. If these measurements show a steadily decreasing rate of leakage it indicates that the test section of line has not yet reached equilibrium. In this event it may be necessary to allow a further period of preconditioning and then repeat the measurement. The test result may be considered satisfactory when the amount of water lost in one hour does not exceed the amount defined by the formula expressed under test acceptance.

### 4.5 Test Acceptance

At the specified site test pressure the line shall not show any leakage greater than that given by the formula:

$$Q_L = \frac{Nd\sqrt{P}}{70}$$

Where

$Q_L$	litres/hour	– leakage
$N$		– number of joints in the section of line under test
$d$	metres	– diameter of pipe
$P$	kPa	– specified site test pressure

It is strongly recommended that the specified site test pressure be not greater than the sustained working pressure to which the pipeline will be subjected in service.

## 5 INDIVIDUAL JOINT TESTING

### 5.1 Introduction

Joint testing is generally limited to internal diameter 1200 mm and upwards. Access to smaller diameters makes testing impracticable.

The purpose of a joint test is to establish the integrity of the joint. It is not equivalent in any way to a performance test for the line at full pressure. However, it requires very little water and the equipment is simple and safe to use.

### 5.2 Test Criteria

Under a test pressure of 90 kPa visual assessment of moisture in the form of water dripping or running from the external joint surfaces is the accepted criterion of joint failure.

Assessment by pressure loss versus time is not practical because of the small volumes of water involved and the initial absorption of water into the concrete surfaces.

### 5.3 Preparation, Precautions and Procedure

The testing equipment consists of a short internal annular ring, smaller in diameter than the minimum pipe bore. There are rubber sealing rings at each end of the cylinder, so that the joint is effectively isolated.

The Concrete Pipe Association can advise on the general arrangement of this equipment.

The test is performed by positioning the mobile test equipment so that it seals across the joint to be tested. For maximum benefit this joint should be as close behind the laying as is practical. Because of the end thrust transmitted by pressure on the vertical end surfaces of the pipe joints the test needs to be at least three pipes behind the laying face of the line.

Water is pumped into the space between the joint and the seals until a pressure of 90 kPa is reached.

### 5.4 Test Acceptance

As previously outlined the assessment of the joint integrity is based on a visual inspection of the external joint surfaces for moisture dripping or running whilst the pressure is maintained.

Although there is necessarily some small pressure drop with time (ie absorption into the concrete surfaces under test) the test is still sufficiently sensitive for an experienced operator to distinguish between a sound joint and a defective joint.



*Joint test rig being prepared.*



*Joint test rig in-situ.*

## 6 AIR TESTING NON PRESSURE PIPELINES

### 6.1 Introduction

The most reliable proof test of the workmanship in a laid concrete pipeline is by the application of a hydrostatic test but it is not always convenient to carry this out. There can be problems or excessive cost in obtaining water at some locations, and then in disposing of it afterwards.

Instead of the hydrostatic test it may be possible to apply a low pressure air test. However, pipelines will tend to show greater and more variable permeability to air than to water, so care is needed in applying the air test and in interpreting results. Although results of air tests and water tests do not correlate very well a satisfactory air test can serve as a useful indication that a line will pass a water test.

### 6.2 Features of Air Testing

The test procedure recommended by the Concrete Pipe Association of Australasia is given in Appendix A

Points to note in the application of air tests are as follows:

- Pipes are more permeable to air than they are to water. They will always show a basic but small amount of air leakage per unit of area of the pipe wall. This leakage, which is called the basic permissible leakage rate, as measured by a pressure drop, might vary considerably (possibly by a factor of five times) in different pipelines, which would all be quite satisfactory in a water test.
- The basic air leakage is considerably affected by the degree of dampness in the pipe walls, probably the main reason for the poor correlation with water test results.

- With a pipeline exposed to varying ambient conditions, especially sunshine, the air temperature within the pipe can be subject to wide and rapid fluctuations. Being inversely proportional to the temperature, the internal air pressure can be similarly affected and as it is this pressure which is the measure of air leakage the resultant fluctuations can be wrongly interpreted. It is possible to largely overcome the effects of varying temperature by having the applied average pressure sufficiently high.
- Care is needed in making air tight seals at plugs, joints and pipes of the air test equipment. Again loss of air pressure at such points, often difficult to detect, can be wrongly interpreted as being due to faults in the pipeline.
- As pipe diameters increase the air test becomes more hazardous because of the danger of end seals (which can have imposed loads of several tonnes) blowing out.
- Defects may not be easy to locate with air tests.
- The test can be much too sensitive to leaks in short lengths of small diameter pipelines and have too little sensitivity to leaks in long lengths of large diameter pipelines.

Various air test procedures are used in overseas countries with notable differences between them in the manner of application. These procedures were considered when drafting the procedure recommended by the Concrete Pipe Association of Australasia (see Appendix A), although most reliance was placed on data from American sources.

The recommendation is not intended to be an unqualified endorsement of air testing which is not an accurate guide to performance under hydrostatic head, but is intended to standardise and avoid misapplication of the test.

It can provide the criteria for acceptance of a pipeline but not for its rejection.

The option to carry out a water test if the pipeline fails the air test must always be available to the installer.

### 6.3 Special Requirements

In fixing the permissible holding times for the air test (Refer Appendix A) two limiting conditions need consideration:

- For long lengths of larger diameter pipes the pipe wall area and hence the basic permissible leakage rate is high. A defect in the pipeline might be masked by the slow pressure drop.

To overcome this disadvantage it is proposed that for larger pipe diameters the allowable test length should be generally restricted to lengths between manholes (the most convenient places for fixing temporary bulkheads), and should not apply to lengths in excess of 100 metres nor to pipes larger than 1200 mm in diameter.

- For small pipe wall areas, ie small diameters and short lengths the calculated volume leakage rate is small and the permissible holding time is very low. If the average pipe wall permeability is a little higher than allowed for, then this combined with the experimental error means that the test is too sensitive.

To overcome this a minimum leakage rate has been set which will permit a reasonably accurate measure.

## 6.4 Safety Aspects

The procedure for air testing large diameter pipelines is hazardous because of the very large forces to be resisted by temporary bulkheads and the serious consequences of accidental bulkhead blow out.

The bulkhead force increases as the square of the socket diameter and the cost of maintaining safe working conditions increases rapidly with increasing pipe diameter.

The American Concrete Pipe Association advocates that air testing is not practical in pipes of diameter greater than 1000 mm diameter and beyond this it is recommended to apply a water pressure test to the joints only. Because the Concrete Pipe Association of Australasia recommended procedure uses a reduced applied pressure it is considered that pipes up to 1200 mm diameter can be safely air tested, but beyond that diameter either a separate joint test or a hydrostatic test should be adopted.

## APPENDIX A

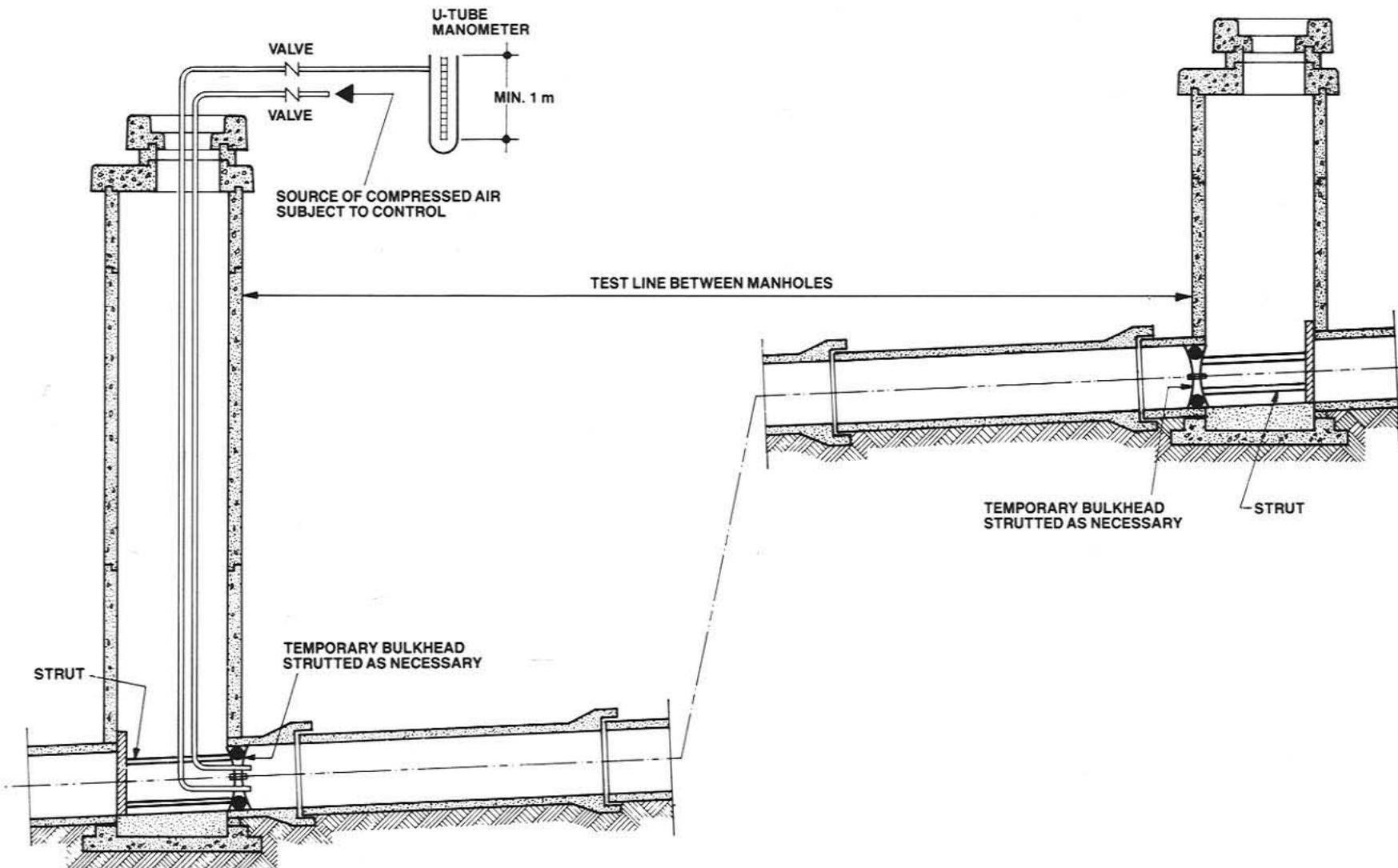
### TEST PROCEDURE FOR AIR TESTING OF CONCRETE NON PRESSURE PIPELINES

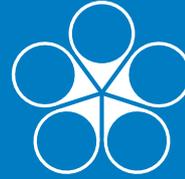
- 1 The section of line to be tested should be flushed and cleaned. This serves to clean out any debris and wet the pipe.
- 2 Isolate the section of line to be tested by means of inflatable stoppers or other suitable test plugs. The ends of all branches, laterals, tees or wyes to be included in the test should be plugged to prevent possible blowout due to internal pressure. One of the plugs should have an inlet valve for connection to a source of air under pressure.
- 3 Prior to setting up the air test, ensure that ground water is not leaking into the isolated section of the line.
- 4 Connect the air hose to the inlet tap and a portable air control source. The air equipment should consist of necessary valves and pressure gauges to control the rate at which air flows into the test section and to enable monitoring of the air pressure within the test section. Also, the testing apparatus should be equipped with a pressure relief device to prevent the possibility of loading the test section with the full capacity of the compressor.
- 5 Add air slowly to the test section until the pressure is just over 1000 mm of water. Regulate the air supply to maintain the pressure between 1000 and 1100 mm head whilst checking all plugs, bulkheads and fittings, with soap solution if necessary, to ensure there is no stray leakage. This period, which should be a minimum of two minutes, also allows the air temperature to stabilise with the temperature of the pipe walls.
- 6 After the stabilisation period ensure that the pressure is just above 1000 mm head. Commence measuring time as the pressure falls to 1000 mm and note the time taken for it to drop another 200 to 800 mm head. For the pipe to pass the test this time should not be less than the holding time given in Table A.1 appropriate to the diameter and length of line under test.
- 7 If the pipeline fails the test the cause of the failure must be detected by audible or visual means and rectified and the test repeated. If no defect can be detected the installer can either:
  - apply water to the pipeline internally and/or externally and then repeat the air test, or
  - apply a hydrostatic test to prove that the pipeline is sound.

**Table A.1 Air Test Holding Times (mins–secs) for an Average Applied Pressure of 900 mm Head of Water (ie falling from 1000 to 800 mm head)**

Pipe dia. (mm)	Length of test section (metres)											
	15	20	25	30	35	40	50	60	70	80	90	100
150	0-13	0-17	0-22	0-25	0-30	0-35	0-45	0-50	1-00	1-10	1-20	1-30
225	0-30	0-40	0-50	1-00	1-10	1-20	1-40	2-00	2-10	2-10	2-10	2-10
300	0-50	1-10	1-30	1-40	2-00	2-20	3-00	3-00	3-00	3-00	3-00	3-00
375	1-20	1-50	2-20	2-40	3-10	3-40	3-40	3-40	3-40	3-40	3-40	3-40
450	2-00	2-30	3-10	3-50	4-20	4-20	4-20	4-20	4-20	4-20	4-20	4-20
525	2-40	3-30	4-20	5-10	5-10	5-10	5-10	5-10	5-10	5-10	5-10	5-10
600	3-30	4-30	5-50	5-50	5-50	5-50	5-50	5-50	5-50	5-50	5-50	5-50
750	5-20	7-10	7-10	7-10	7-10	7-10	7-10	7-10	7-10	7-10	7-10	7-10
900	7-40	8-50	8-50	8-50	8-50	8-50	8-50	8-50	8-50	8-50	8-50	8-50
1050	10-10	10-10	10-10	10-10	10-10	10-10	10-10	10-10	10-10	10-10	10-10	10-10
1200	11-40	11-40	11-40	11-40	11-40	11-40	11-40	11-40	11-40	11-40	11-40	11-40

DIAGRAM OF AIR TEST ARRANGEMENT





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### **DISCLAIMER**

The Concrete Pipe Association of Australasia believes the information given within this brochure is the most up-to-date and correct on the subject. Beyond this statement, no guarantee is given nor is any responsibility assumed by the Association and its members.

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