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SPECIFICATION FOR THERMOPLASTIC END LOAD RESISTANT MECHANICAL FITTINGS FOR POLYETHYLENE PIPES OF NOMINAL SIZE ≤ 63

FOREWORD

This specification was prepared by WRc plc under the direction of the Sewers and Water Mains Committee in consultation with the Water Industry and Manufacturing Associations to define the properties required of mechanical joints and compression fittings for use with polyethylene pipes in the size range 20 to 63 and manufactured to BS 6572 and BS 6730. It has been updated to take account of the introduction of European Standards, changes in water quality requirements and to reflect current practice with regard to quality assurance.

Throughout this specification, fittings are designated by a size related to the metric nominal outside diameters of the pipe with which the fitting is to be used.

This specification includes a procedure for determining the pressure differential (headloss) at a given rate of flow but does not specify limits.

Attention is drawn to the second edition of the Manual for polyethylene pipe systems for water supply applications which provides guidance on the practical design, installation and operation of PE water pipeline systems.

Attention is also drawn to the following Water Industry Specifications:

WIS 4-32-08
WIS 4-32-14
WIS 4-32-15

It has been assumed in the drafting of this specification that the execution of its provisions is entrusted to appropriately qualified and experienced people.

This specification may call for the use of procedures that may be injurious to health and safety if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

Compliance with this specification does not of itself confer immunity from legal obligations nor does the specification purport to include all the necessary provisions of a contract. Users of this specification are responsible for its correct application.

Reference to a European Standard, British Standard, Water Industry Specification or any other specification applies equally to any equivalent specification.

Information contained in this specification is given in good faith. Neither UK Water Industry Research Ltd, Water UK nor WRc plc can accept any responsibility for actions taken by others as a result.

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1. SCOPE

This specification stipulates the requirements for both blue and black pigmented end-load resistant, mechanical joints and compression fittings, made principally of thermoplastics. They are for use in cold potable water services for sizes 20 to 63 for pressures up to 12 bar at 20° C.

These fittings are designed for use with pipe manufactured to BS 6572 and BS 6730.

NOTE 1 Blue is the preferred colour for thermoplastics fittings for use with blue MDPE pipe for underground potable water use.

NOTE 2 The titles of the publications referred to in this document are listed under clause 10 - REFERENCES.

2. MATERIALS

The fitting shall be made principally from a thermoplastics material or materials which do not suffer from corrosion from potable water (pH range 6 - 8.5) or low resistivity soils (200 ohm.cm).

Any elastomeric sealing ring used in the construction of the fitting shall conform to BS EN 681-1 and BS 7874.

3. DESIGN AND CONSTRUCTION

3.1 The wall thickness of compression fittings shall be such as to enable the fittings to meet all the requirements of this specification.

3.2 The fittings shall be free from internal flash or other irregularities which might restrict the free flow of fluid, and shall be so designed that the resistance to the flow of the fluid through the fittings is minimised.

3.3 Union nuts shall have suitable means for tightening.

3.4 Provision for gripping the body shall be made on all straight fittings with screwed ends.

3.5 Compression fittings shall be supplied with a means for ensuring the correct position of the pipe within the fitting. This requirement does not apply to components designed as repair couplings.

3.6 The external and internal threads of the ends of transition fittings other than for compression ends, shall be threaded with one of the appropriate forms of threads in accordance with BS EN 1254-2. The use of tapered threads in accordance with clause 5.4 of BS 21: 1985 is also permitted.

NOTE: Fittings with tapered threads should be provided with clear jointing instructions including the maximum permitted torque.

3.7 Flanged joints

Flanged joints shall be constructed such that they may be attached to flanges designated PN16 whose dimensions are shown in Table 9 of BS 4504: Part 3: Section 3.3: 1989.

4. DESIGNATION OF SIZE OF FITTING

4.1 The size of fitting shall be designated by the nominal metric outside diameter of the pipe with which the fitting is to be used.

4.2 The method of specifying the nominal size of the ends of the fitting shall be in accordance with Clause 6 of BS EN 1254-3: 1998.

5. EFFECT OF MATERIALS ON WATER QUALITY

When used under the conditions for which they are designed, all materials in contact with, or likely to come into contact with, water for public supply shall be introduced in accordance with the requirements of Regulation 25 of the Water Supply (Water Quality) Regulations 1989. [Water Supply (Water Quality) (Scotland) Regulations 1990 in Scotland].

For products not approved under the former voluntary system, and not eligible for use under regulation 25(1) (b) or 25(1) (c), Secretary of State Approval shall be obtained via submission of the product to the Committee on Chemicals and Materials of Construction for Use in Public Water Supply and Swimming Pools for consideration. Products shall also comply with the requirements of BS 6920: Part 1: 1990; evidence of compliance shall be submitted to the above committee by the manufacturer.

NOTE 1: The Committee, operated by the Drinking Water Inspectorate, undertakes toxicological assessments of products and may require leaching tests for substances of concern. A list of approved substances and products is published annually and is available from: The Drinking Water Inspectorate, Ashdown House, 123 Victoria Street, London, SW1E 6DE.

NOTE 2: Regulation 25 applies only to products used by water companies in the treatment and distribution of public water supplies; it does not apply to use of fixtures and fittings on consumers' own premises. Approval under the Water Byelaws Scheme and listing in the Water Fittings and Materials Directory is desirable.

6. TYPE TEST REQUIREMENTS

6.1 General

The requirements in this section shall be met before compliance with this specification can be claimed. If there is a change in process techniques or a new or modified material is introduced, then it will be necessary to ensure that the conditions of this specification are still satisfied.

Unless otherwise specified, the test samples shall be taken from a production batch which has complied with all the other requirements of this specification.

Details and results for each type test relevant to each material composition and manufacturing process shall be made available to the purchaser or his representative on request.

6.2 Sampling for type testing

Three fittings of size 63, or the largest size of the manufacturer's range complying with this specification shall be tested to the requirements of 6.3.1.

Three fittings of all sizes of the manufacturer's range shall be tested to the requirements of 6.3.2 and 6.3.3 and one fitting for each size and type of the manufacturer's range complying with this specification shall be tested to the requirements of 6.4 to 6.10.

6.3 Pressure tests at 20° C

6.3.1 Pressure test at 5,000 to 10,000 hours

The fitting assembly shall be tested in accordance with the method described in Appendix A at the appropriate pressure specified in Table 1 to cause failure between 5,000 and 10,000 hours.

Table 1 - Test pressures for 5,000 to 10,000 hour test

Nominal size	Test pressure minimum (bar)
20	26
25	20
32	20
50	20
63	20

If after 10,000 hours, the test assembly has not failed, the pressure shall be increased as described in Appendix A.

The pipe shall burst in a ductile manner (see Figure 1) prior to any leakage around the fitting seals or failure of the bond between pipe and fitting. Failure in a brittle manner (see Figure 1) or failure within a distance of less than 0.1L from the fitting (where L = free length of pipe between end caps and fitting) shall be disregarded.

6.3.2 Pressure test at 100 to 1,000 hours

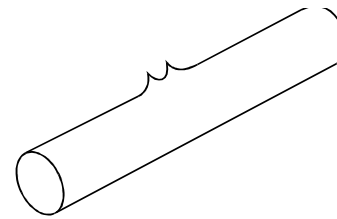
The fitting assembly shall be tested in accordance with the method described in Appendix A at the appropriate pressure specified in Table 2 to cause failure between 100 and 1,000 hours.

Table 2 - Test pressure for 100 to 1,000 hour test

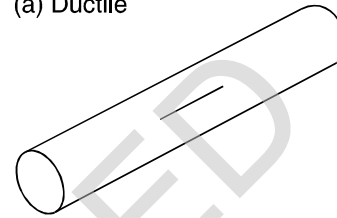
Nominal size	Test pressure minimum (bar)
20	28
25	22
32	22
50	22
63	22

If after 1,000 hours, the test assembly has not failed the pressure shall be increased as described in Appendix A.

The pipe shall burst in a ductile manner (see Figure 1) prior to any leakage around the fitting seals or failure of the bond between pipe and fitting. Failure in a brittle manner (see Figure 1) or failure within a distance of less than 0.1L from the fitting (where L = free length of pipe between end caps and fitting) shall be disregarded.



(a) Ductile



(b) Brittle

Figure 1 - Types of failure

6.3.3 Pressure test at 1 to 10 hours

The fitting assembly shall be tested in accordance with the method described in Appendix A at the appropriate pressure specified in Table 3 to cause failure between 1 and 10 hours.

If after 10 hours, the test assembly has not failed, the pressure shall be increased as described in Appendix A.

The pipe shall burst in a ductile manner (see Figure 1) prior to any leakage around the fitting seals or failure of the bond between pipe and fitting. Failure in a brittle manner (see Figure 1) or failure within a distance of 0.1L from the fitting (where L = free length of pipe between end caps and fitting) shall be disregarded.

Table 3 - Test pressure for 1 to 10 hours test

Nominal size	Test pressure minimum (bar)
20	32
25	25
32	25
50	25
63	25

6.4 Internal pressure resistance when subjected to bending stresses

Using an arrangement as shown in Appendix B with a maximum bend radius of 20 x nominal outside diameter, the test assembly shall be tested in accordance with the procedure specified in BS EN

713 and subjected to a leaktightness test in accordance with BS EN 715. The pressures to be applied are stipulated in Table 4.

Table 4 - Test pressure when subjected to bending stresses

Nominal size	Test pressure minimum (bar)
20	32
25	25
32	25
50	25
63	25

If the test assembly has not failed after 1 hour, the pressure shall be increased as described in Appendix A.

The pipe shall burst in a ductile manner (see Figure 1) prior to any leakage around the fitting seals or failure of the bond between pipe and fitting.

Failure in a brittle manner (see Figure 1) or failure within a distance of less than 0.1L from the fitting (where L = free length of pipe between end caps and fitting) shall be disregarded.

6.5 External pressure resistance

When tested in accordance with the method given in BS EN 911, a test assembly shall withstand an external pressure of 0.1 bar above atmospheric pressure for 1 hour followed by a pressure of 0.8 bar above atmospheric pressure for a further 1 hour without leakage at any time during the 2 hour test duration.

6.6 Resistance to pull-out of a test assembly at 20° C

The test assembly shall be evaluated in accordance with and meet the requirements of Appendix C.

NOTE: Reference is made to BS EN 712 which permits specification of parameters by the product specification.

6.7 Resistance to freezing

The test assembly as specified in A.2 of Appendix A shall be filled with water and left in a freezer at a

temperature below -15° C for 24 hours. The test assembly shall be removed from the freezer and conditioned for a period of not less than 24 hours at a temperature of (20 ±2)° C.

One test assembly shall then be tested to the requirement of 6.3.3 and one to that of 6.6.

6.8 Impact resistance at 0° C

When tested by the method described in Appendix D, the fitting shall neither crack nor break.

If the fitting does not crack or break, it shall then be conditioned for a period of not less than 24 hours at a temperature of (20 ±2)° C.

One test assembly shall be tested to, and meet, the requirement of 6.3.3 and one to that of 6.5.

6.9 Resistance to external bending - male and female adaptors

When tested by the method described in Appendix E and applying the forces specified in Table 5 for 1 hour, the fitting shall neither crack nor break. For evidence of cracking, the test piece shall be viewed under an optical microscope at 40 x magnification.

6.10 Determination of head loss against size

The pressure differential (head loss) at a given flow rate shall be determined by the method described in Appendix F and shall be recorded.

Table 5 - Applied bending moment for external bending test

Nominal size	Applied bending moment - minimum (Nm)
20	80
25	110
32	150
50	250
63	300

7. QUALITY CONTROL TEST REQUIREMENTS

7.1 Sampling frequency

Production quality control activities shall be carried out in accordance with an appropriate sampling plan drawn from BS 6001: Part 1. Guidance on the use of BS 6001 and sampling procedures for inspection by attributes is given in BS 6000.

The manufacturer shall not knowingly supply a defective unit in any batch.

7.2 Voids and defects

None of the fitting samples evaluated shall show blisters, excessive delamination or cracking, or signs of weld line splitting.

For fittings moulded by conventional techniques, care shall be taken in examining the area around the point of injection, where no cracks or delamination shall penetrate to a depth greater than 20% of the wall thickness. For fittings moulded by end-gating techniques, e.g. ring or diaphragm methods, any cracks or delamination in the wall of the fitting adjacent to the injection area shall be parallel to the axis and shall not penetrate to a depth of more than 20% of the socket length.

The assessment of the depth of penetration of cracks or delamination shall be carried out by sectioning the specimen at the point of injection and measuring the depth to which these defects penetrate the wall thickness of the fitting.

NOTE Non-destructive test methods may be used as an alternative if approved under a quality assurance scheme.

7.3 Pressure test at 1 hour

The fitting assembly shall be tested in accordance with the method described in Appendix A at the appropriate pressure specified in Table 3. If, after 6 hours the test assembly has not failed, the test may be discontinued.

Failure of the test assembly is defined as rupture of the fittings or leakage or weepage of the joint. Premature rupture of the pipe does not constitute failure but the test shall be repeated on an assembly made from the same batch of fittings.

7.4 Resistance to pull-out of a test assembly

Fittings shall be tested to, and meet, the requirements of 6.6.

7.5 Resistance to external bending - male and female adaptors

Fittings shall be tested to, and meet, the requirements of 6.9.

8. SPECIMEN CONDITIONING DURING TYPE TESTING OR IN ANY CASE OF DISAGREEMENT

Unless otherwise specified, fittings and test assemblies shall be conditioned for not less than 24 hours at $(20 \pm 2)^\circ\text{C}$.

9. MARKING

Fittings manufactured to this specification shall be clearly and legibly marked. No method of marking shall prejudice the performance of a fitting when tested to the requirements of this specification.

The marking shall give the following information:

- (a) Manufacturer's identification;
- (b) Reference to this Water Industry Specification, i.e. WIS 4-32-11. (The use of this mark is a claim by the manufacturer that the product has been manufactured in accordance with the requirements of this specification and the claim is his sole responsibility);
- (c) Batch identification code;
- (d) The letters PE;
- (e) The nominal size and pressure rating in bar as given in 1 - Scope.

Additional information shall be provided as specified in Appendix G.

10. REFERENCES

British Standards

- BS 21 Specification for pipe threads for tubes and fittings where pressure-tight joints are made on the threads (metric dimensions).
- BS 4504 Circular flanges for pipes, valves and fittings. (PN designated).
Part 3 Steel, cast iron and copper alloy flanges.
Section 3.3 Copper alloy and composite flanges.
- BS 5728 Measurement of flow of cold potable water in closed conduits.
Part 3: Methods of determining principal characteristics of single meters.
- BS 6000 Guide for the selection of an acceptance sampling system, scheme or plan for inspection of discrete items in lots.
- BS 6001 Sampling procedures for inspection by attributes.
Part 1 specification for sampling plans indexed by acceptable quality level (AQL) for lot-by-lot inspection.
- BS 6572 Specification for blue polyethylene pipes up to nominal size 63 for below ground use for cold potable water.
- BS 6730 Specification for black polyethylene pipes up to nominal size 63 for above ground use for cold potable water.
- BS 6920 Suitability of non-metallic products for use in contact with potable water intended for human consumption.
Part 1 - Specification
Part 2 - Methods of test.
- BS 7874 Method of test for microbiological deterioration of elastomeric seals for joints in pipework and pipelines.
- BS EN 681-1 Elastomeric seals - Materials requirements for pipe joint seals used in water and drainage applications.
Part 1: Vulcanised rubber.
- BS EN 712 Thermoplastics piping systems - End-load bearing mechanical joints between pressure pipes and fittings - Test method for resistance to pull-out under constant longitudinal force.
- BS EN 713 Plastics piping systems - Mechanical joints between fittings and polyolefin pressure pipes - Test method for leaktightness under internal pressure of assemblies subjected to bending.
- BS EN 715 Thermoplastics piping systems - End-load bearing joints between small diameter pressure pipes and fittings - Test method for leaktightness under internal water pressure, including end thrust.
- BS EN 911 Plastics piping systems - Elastomeric sealing ring type joints and mechanical joints for thermoplastics pressure piping - Test method for leaktightness under external hydrostatic pressure.
- BS EN 921 Plastic piping systems - Thermoplastics pipes - Determination of resistance to internal pressure at constant temperature.
- BS EN 1254-2 Copper and copper alloys - Plumbing fittings. Part 2: Fittings with compression ends for use with copper tubes.
- BS EN 1254-3 Copper and copper alloys - Plumbing fittings. Part 3: Fittings with compression ends for use with plastic pipes.

Water Industry Specifications

4-32-08	Specification for site fusion jointing of MDPE pipes and fittings.
4-32-14	Specification for PE80 and PE100 electrofusion fittings for nominal sizes up to and including 630.
4-32-15	Specification for PE80 and PE100 spigot fittings and drawn bends for nominal sizes up to and including 1000.

Manual for polyethylene pipe systems for water supply applications, second edition, July 1994, published by WRc plc.

APPENDIX A - PRESSURE TESTS AT 20°C

A.1 Apparatus

The apparatus shall be that described in BS EN 921.

A.2 Test assembly

The test assembly shall be a fitting with a minimum free length of pipe of 300 mm fitted in each outlet. The type a) end caps shown in Figure 1 of BS EN 921 shall be used.

A.3 Procedure

The test assembly shall be tested in accordance with the procedure given in BS EN 921 at a temperature of $(20 \pm 2)^\circ\text{C}$ at the specified pressure and time. If the assembly has not failed after the stipulated time, the pressure shall then be increased at a steady rate so that failure occurs in a period of not less than 15 seconds.

A.4 Report

The report shall include the following:

- Identification of the test (e.g. delayed burst test, external pressure resistance test, etc.);
- Identification of the test assembly;
- Type of failure (e.g. ductile, brittle, etc.);
- Hold pressure and failure pressure;
- Test duration;

- Date of test.

APPENDIX B - APPARATUS FOR HYDROSTATIC PRESSURE TEST OF FITTINGS WHEN SUBJECTED TO BENDING STRESSES

A diagram of suitable apparatus is shown in Figure 2.

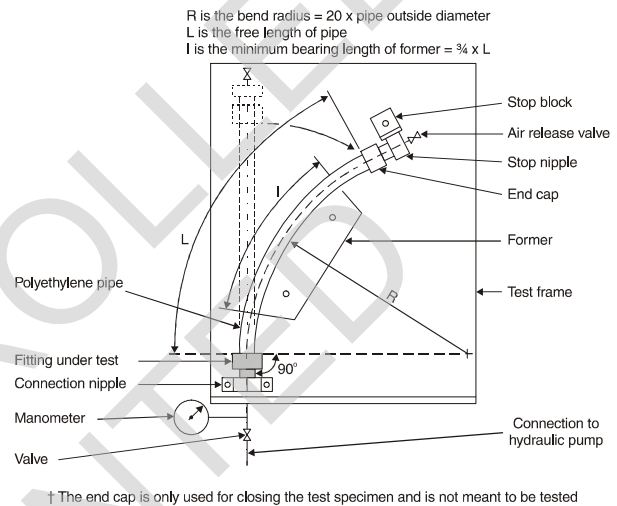


Figure 2 - Diagram of suitable apparatus for hydrostatic pressure test when subjected to bending stresses

APPENDIX C - RESISTANCE TO PULL-OUT OF A TEST ASSEMBLY AT 20°C

C.1 Test under constant force

C1.1 Form of test pieces

The test pieces shall comply with the requirements of BS EN 712 and consist of the fitting or fittings to be tested, assembled with one or more pieces of polyethylene pipe of the size and quality for which the fitting is designed. Each piece of pipe shall be at least 300 mm in length. The pipes and fittings shall be conditioned for at least 1 hour at $23 \pm 2^\circ\text{C}$ prior to assembly in accordance with the fittings manufacturer's instructions.

At least 3 test pieces from a production batch shall be evaluated to the requirements of this test.

C1.2 Apparatus

The apparatus shall consist of a tensile testing machine capable of applying a constant force to the test piece. Alternatively, the force may be applied by means of weights, in which case the test piece shall be suspended in a frame with a suitable fixture to hold the weights. A suitable apparatus of the latter type is shown in Figure 3.

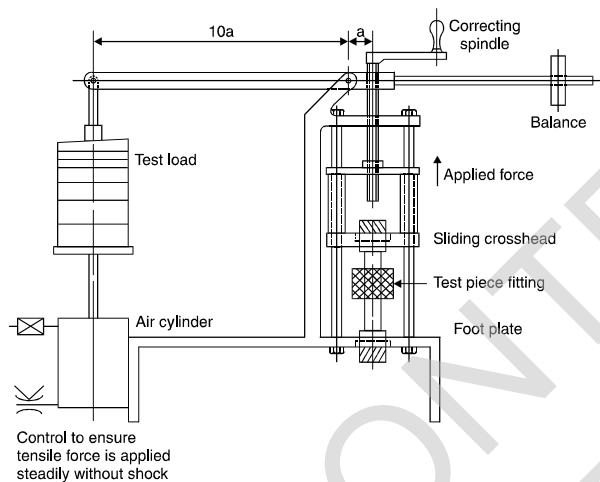


Figure 3 - Diagram of suitable apparatus for test for resistance to pull-out of assembled joint

C2.3 Procedure

Mount the test piece securely in the apparatus and apply the appropriate force given in Table 8 gradually over a period of 15 to 30s. Hold the test piece in constant tension for a period of 5 minutes (+30s - 0s) at a temperature of $(23 \pm 2)^\circ\text{C}$. After removal examine the test piece for pull-out from the compression ring and/or fracture/tearing of the pipe. If appropriate, the cap nut shall be removed to permit examination.

C.3 Report

The report shall include the following:

- (a) The full identification of the specimens;
- (b) Description of assembly instructions;

- (c) The test carried out i.e. under tensile force or under constant force;
- (d) The force applied;
- (e) Comments on ring position on the pipe and pipe condition after test;
- (f) The date of the test.

Table 8 - Test forces for test under constant load

Nominal pipe size	20	25	32	50	63
Test force (kN)	1.9	2.5	4.1	9.8	15.6

APPENDIX D - IMPACT RESISTANCE AT 0°C

For each test, 10 test specimens shall be evaluated. The test specimens shall be pre-conditioned at $(0 \pm 2)^\circ\text{C}$ for 3 hours prior to testing. The tests shall be conducted within 30 sec of removal from the conditioning chamber/bath.

Each test specimen shall be dropped from a height of $(2 \pm 0.05)\text{m}$ in random positions, onto a flat concrete floor.

Visually examine the test specimens for breaks or cracks. Condition them for 24 hours at $(20 \pm 2)^\circ\text{C}$. One test specimen selected at random shall then be tested to the requirement of 6.3.3 and one to that of 6.5.

APPENDIX E - RESISTANCE TO EXTERNAL BENDING

Male and female adaptors shall be screwed into metal support plates, so arranged to allow the fitting to be loaded with a constant force.

The fittings shall be screwed hand tight into the supports and a bending moment applied to the fitting via a circular metal bar. The bar shall have a diameter equal to the nominal size of the fitting.

The test load for the appropriate size of fitting as given in Table 5 shall then be applied and the bending moment imposed for 1 hour. At the end of this period, the pressure is released and the fittings removed for inspection.

The fittings shall be examined under an optical microscope at 40 x magnification.

A typical assembly is illustrated in Figure 4.

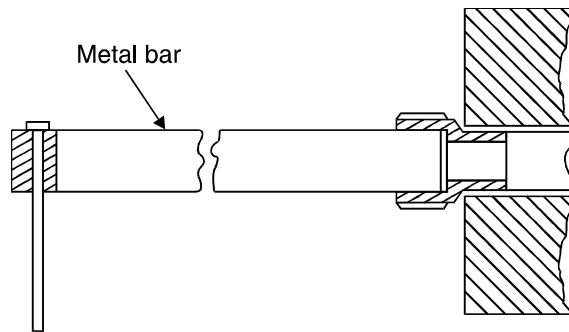


Figure 4 - Typical apparatus for external bending

APPENDIX F - TEST METHOD FOR THE DETERMINATION OF HEAD LOSS AGAINST SIZE

F.1 Procedure

F1.1 The test shall be conducted in accordance with the procedure described in BS 5728: Part 3 using suitably accredited equipment.

F1.2 Measure the static differential pressure (ΔP_1) at flow rates of 10 and 25 L/min along a straight section of pipe of a size and quality for which the fitting is designed.

F1.3 Install the fitting to be tested in the test rig and repeat the measurements (ΔP_2) at the same flow rates. The actual head loss (ΔP) due to the fitting is given by:

$$\Delta P = \Delta P_2 - \Delta P_1 \quad \text{L/min}$$

F2 Test Report

The report shall include the following information:

- (a) Full identification of the sample under test;
- (b) The recorded head loss (ΔP) at flow rates of 10 and 25 L/min;

- (c) The date of the test;
- (d) Observations and test conditions.

APPENDIX G - ADDITIONAL MARKING REQUIREMENTS

All fittings shall be accompanied by clear instructions giving:

- (a) Minimum pipe penetration depth needed to effect a seal to allow the fitting to meet the performance requirements;
- (b) If required, the chamfer angle necessary on the end of the MDPE pipe to allow the pipe to seal correctly in the fitting without disturbing any seal or clamping rings which might affect the performance of the joint;
- (c) Details of the type of insert, if any, needed to allow the fitting to meet the performance requirements;
- (d) The maximum out-of-square tolerance on the cut pipe end which can be tolerated;
- (e) Clear assembly instructions shall be provided. Where fittings rely on the tightening of an external nut to compress grip rings or seals, the degree to which the nut needs tightening to effect full performance shall be clearly indicated.