BRITISH STANDARD

BS 7892:2000

Incorporating Corrigendum No. 1

Specification for seal coats on cement mortar lined ductile iron pipes and fittings

ICS 23.040.10; 25.220.60

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee PSE/10, Iron pipes and fittings, upon which the following bodies were represented:

Adhesive Tape Manufacturers' Association
British Compressed Gases Association
British Foundry Association
Ductile Iron Pipe Committee
Institute of British Foundrymen
Institution of Mechanical Engineers
Society of British Water Industries

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The following BSI references relate to the work on this standard:
Committee reference PSE/10
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Contents

Foreword

This British Standard has been prepared by Technical Committee PSE/10, Iron pipes and fittings and is a revision of BS 7892:1997 which is withdrawn.

WARNING This specification calls for the use of substances and/or procedures that may be injurious to health 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.

Product certification

Users of this British Standard are advised to consider the desirability of third-party certification of product conformity with this British Standard based on testing and continuing surveillance, which may be coupled with assessment of a supplier's quality systems against the appropriate part of BS EN ISO 9000.

Enquiries as to the availability of third-party certification schemes will be forwarded by BSI to the Association of Certification Bodies. If a third-party certification scheme does not already exist, users should consider approaching an appropriate body from the list of association members.

Annexes A to F are normative.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations. Attention is drawn to the following statutory regulations.

— Water Supply (Water Quality) Regulations 1989 as amended by the Water Supply (Water Quality) (Amendment) Regulations 1991 [1] (in particular Regulation 25).

— The Water Supply (Water Quality) (Scotland) Regulations 1990 [2] (in particular Regulation 25).

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 11 and a back cover.

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Introduction

The intended purpose of the seal coat is to control leaching of lime ($CaOH_2$) and other hydroxides from the cement into the water supply such that the pH of conveyed water is maintained below 9.5 during normal use. A pH of 9.5 is the maximum prescribed value permitted by the Water Supply (Water Quality) Regulations 1989 as amended by the Water Supply (Water Quality) (Amendment) Regulations 1991 [1] and the Water Supply (Water Quality) (Scotland) Regulations 1990 [2]. The seal coat is also intended to control leaching of other deleterious materials which could cause their maximum permitted concentration or value to be exceeded.

Attention is drawn to the fact that National or International Water Supply or Water Quality Regulations, effective within the region, may apply when seal coated surfaces come into contact with, or are likely to come into contact with, potable water, when used:

a) in accordance with the product manufacturer's instructions for use; and

b) under any other appropriate conditions defined for that product within any published list of substances, products and processes approved to those Water Supply or Water Quality Regulations.

Seal coatings are usually specified where the pipeline is to convey soft water, and/or where water residence times are very long. Supply water quality data for such pipelines should be discussed between the prospective client and the manufacturer of the product so as to ensure the suitability of the product for use.

1 Scope

This British Standard is issued to satisfy the requirements of both users and suppliers for a standard specification for seal coats on cement mortar linings in ductile iron pipes and fittings. It specifies requirements for seal coatings for factory application to the surface of cement mortar linings which are factory applied to the interior of ductile iron pipes and fittings.

This standard is applicable to products for potable and other water applications.

This standard gives requirements for routine testing for visual appearance, coating thickness, adhesion and odour; it also gives type test requirements for water quality effects (pH), durability, and abrasion resistance.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this British Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the publication referred to applies.

BS 3887:1991, *Specification for pressure sensitive adhesive closing and sealing tapes.*

BS 3900-C.5:1997, *Methods of test for paints — Group C: Tests associated with paint film formation — Part C5: Determination of film thickness.*

BS 6068-2.50:1995, *Water quality — Part 2: Physical, chemical and biochemical methods — Section 2.50: Determination of pH.*

3 Terms and definitions

For the purposes of this British Standard the following terms and definitions apply:

3.1

ductile iron

cast iron in which graphite is present substantially in spheroidal form

3.2

fitting

casting other than a pipe which allows pipeline deviation or change of direction or bore

NOTE Flanged-socket pieces, flanged-spigot pieces and collars are classified as fittings.

3.3

test film

film of consistent thickness and density, morphologically stable at the temperature of the substrate during seal coat application, used as a surrogate surface for the measurement of coating thicknesses

3.4

pipe

casting of uniform bore, straight in axis, having either spigot, socket, flange or plain ends

NOTE This does not include flanged socket pieces, flanged spigot pieces and collars, which are classified as fittings.

3.5

product

seal coated, cement mortar lined iron pipe or fitting

3.6

seal coat

coating applied over a cement mortar lining to control the interactions between the lining and the contents of the main

3.7

type test

proof of design test which is done once and only repeated after change of design

4 Type test requirements

4.1 Water quality (pH)

When tested in accordance with annex A, the pH of the test water shall not exceed 9.5.

4.2 Durability

When tested for a period of six months in accordance with annex B the pH of the test water shall not exceed 9.5 after a 24 hour contact time.

4.3 Abrasion resistance

When tested in accordance with annex C, the pH of the test water shall not exceed 9.5.

5 Routine test requirements

5.1 General

Coating and re-work procedures (e.g. drying regimes for solvent based coatings and mixing and curing regimes for multi-component materials) shall be defined by the manufacturer of the product in agreement with the seal coat supplier, where necessary, such as to enable the product to conform to the requirements of this standard.

The tests specified in **5.2** to **5.5** shall be carried out on factory seal coated pipes or fittings as opposed to separately prepared test pieces.

Sampling plans for the tests specified in **5.2** to **5.5**, specific to the seal coating material used, the size of the batch and the storage conditions, shall be specified by the coater for each batch of product.

Where a non-conforming product is identified, the product shall be re-worked such that it meets the requirements of this standard, or rejected.

5.2 Visual appearance

When examined visually, the seal coat shall be free of any defects likely to be detrimental to coating performance. The manufacturer of the product shall define those defects taking into account the nature of the seal coat material.

5.3 Coating thickness

When tested in accordance with BS 3900-C.5:1997, method 1A, or annex D of this standard, the wet or dry coating thickness shall be within the limits specified by the manufacturer of the product in conjunction with the seal coat supplier, where necessary.

5.4 Adhesion

When tested in accordance with annex E, the adhesive strength shall fall within the range of 1 to 3.

Adhesive failure of the seal coat to substrate bond shall be considered a fail. A cohesive failure within the seal coat or within the mortar (evidenced by a white/grey layer on the underside of the detached coating) shall not be considered as a fail in this test.

The area damaged during testing shall be repaired in accordance with a procedure defined by the manufacturer of the product in agreement with the seal coat supplier, where necessary.

5.5 Odour

When tested in accordance with annex F, no significant difference in odour shall be detectable, by inhalation, between test water and tap water.

NOTE 1 It is not normally considered necessary to test fittings for odour as they generally only constitute a minor proportion of a main; however, some installations are fittings intensive (for instance pumping stations) and odour tests should therefore be carried out on seal coated fittings by agreement between the manufacturer and the customer.

NOTE 2 Some seal coat materials (for instance solvent-based single pack coatings) which dry by solvent evaporation will exhibit odour levels which diminish with increased storage time. In these cases the pipe batches should be stored and released by the coater only when they exhibit an acceptable level of odour. Other seal coat materials (e.g. multi-component solvent-free epoxy coatings) which harden and cure by chemical reaction may not improve with increased storage time. Failure of the odour test of such materials probably results from a process abnormality which should be investigated. All pipes in the batch from which the test sample was taken should be considered suspect and quarantined pending investigation of the process records etc.

NOTE 3 This test is a production quality control test to be undertaken by the manufacturer of the product as part of his Quality Assurance procedures. It is not a test of conformance with the requirements of statutory regulations. Attention is drawn to the fact that statutory regulations may apply when seal coat materials are used in contact with potable water. See the Foreword and Introduction of this standard.

The manufacturer of the product shall define a procedure for the investigation and resolution of repeated failures of the odour test within a batch, taking into account the nature of the seal coat material and the process abnormalities which might cause repeated failure of the test.

6 Marking

Each seal coated pipe or fitting shall be identified with the pipe manufacturer's name or mark.

In addition, seal coated pipes shall be indelibly and legibly marked on the external surface with the following:

a) either the batch number or code, or the date of manufacture (effectively date of seal coat application);

b) the number and year of this standard[1)].

NOTE Where pipes are bundled, the markings required by a) and/or b) may be applied to the bundle rather than to individual pipes.

[1)] Marking BS 7892:2000 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third-party certification of conformity.

Annex A (normative)
Water quality (pH)

A.1 Principle

The effect of a seal coated cement lined surface upon the water quality (pH) of a given test water is determined by measuring the pH of test water after three successive 24 h periods of exposure within a seal coated pipe sample.

A.2 Apparatus and materials

A.2.1 *DN 100 seal coated and cement lined pipe*, with double spigot and at least 150 mm long.

A.2.2 *Paraffin wax*, solvent-less epoxy, silicone resin or other suitable sealing material.

A.2.3 *Test water*, having bicarbonate alkalinity of approximately 26 mg/l as $CaCO_3$, at equilibrium with the atmosphere (i.e. no artificially induced carbon dioxide level) and with a pH of 8 ± 0.1.

This water shall be produced by dissolving (0.0278 ± 0.0005)g of $CaC1_2$ (calcium chloride) and (0.0420 ± 0.0005)g of $NaHCO_3$ (sodium bicarbonate) in 1 l of distilled water.

NOTE It should be noted that such a soft, poorly buffered water would be considered to represent the worst case for UK waters.

A.2.4 *Petroleum jelly*

A.2.5 *pH meter*, having capacity to measure pH 0 to pH 14, with discrimination of a pH of 0.01 or better.

A.3 Procedure

A.3.1 Seal the pipe (**A.2.1**) at its lower end in molten paraffin wax, uncured liquid epoxy, uncured silicone resin or other suitable sealing material (**A.2.2**). Allow the sealant to cool or harden.

A.3.2 Fill the pipe with test water (**A.2.3**) at room temperature.

A.3.3 Cover the top of the pipe with a glass plate and seal it with petroleum jelly (**A.2.4**).

A.3.4 After (24 ± 1) h, dispose of the water and refill with test water (**A.2.3**).

A.3.5 Repeat **A.3.4** twice, sampling the water after the third fill period.

A.3.6 Determine the pH of the water supply with the pH meter (**A.2.5**) in accordance with BS 6068-2.50.

Annex B (normative)
Durability type test for seal coats

B.1 Principle

The ability of a seal coat to maintain its sealing efficiency for an extended period is determined by measuring the performance of the seal coated surface after exposure to flowing water for six months.

B.2 Materials

B.2.1 *Test water*, as defined in annex A.

B.3 Apparatus

B.3.1 *Pump*, capable of a pumping rate in accordance with **B.5.2**.

B.3.2 *pH meter*, having capacity to measure pH 0 to pH 14, with discrimination of a pH of 0.01 or better.

B.4 Preparation of test samples

The test shall be carried out using nominally 500 mm long, DN 100, sections of seal coated, cement lined, ductile iron pipe samples. These samples shall be cut from pipes taken from normal production batches.

B.5 Procedure

B.5.1 Seal both pipe ends to allow water to be recirculated through the pipe sample and set up apparatus in accordance with Figure B.1. Ensure that the test water does not come into direct contact with the cement lining which can be exposed at the pipe ends.

B.5.2 Using a peristaltic pump (**B.3.1**), recirculate a total volume of 40 l of test water (**B.2.1**) through the pipe sample. The retention time of water in the test pipe shall be approximately 1 h. The test water shall be replaced every seven days.

B.5.3 After a minimum of 26 weeks, assess the lime leaching potential by replacing the test water and measuring its pH using the pH meter (**B.3.2**), in accordance with BS 6068-2.50, under static flow conditions after a minimum 24 h contact time.

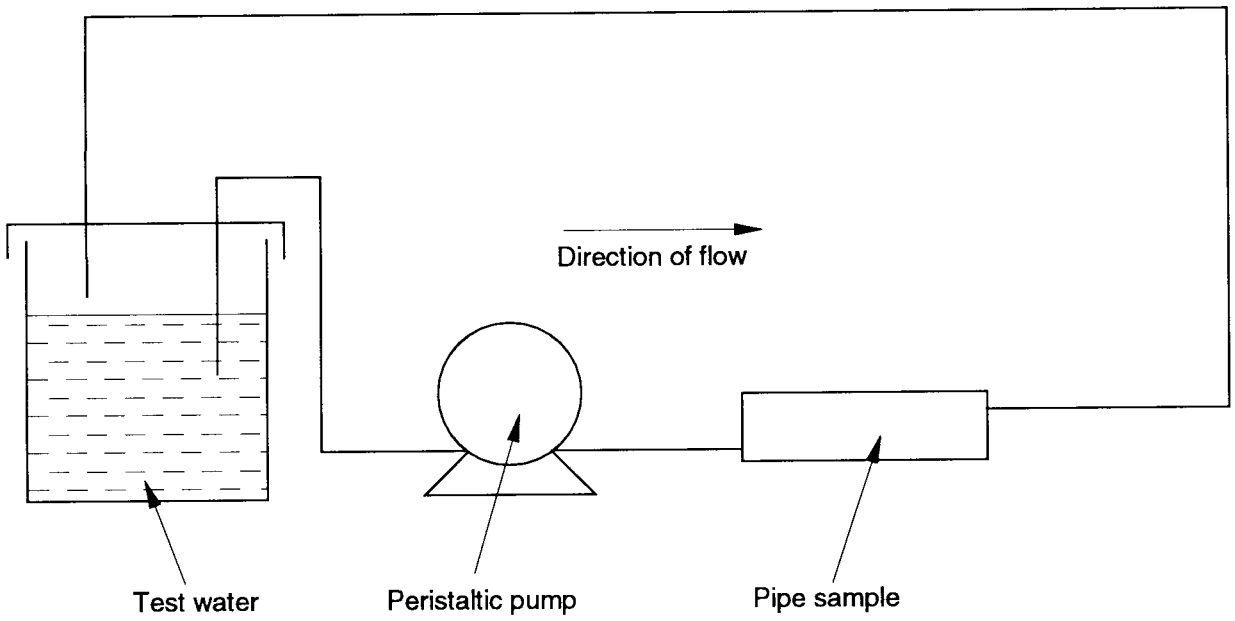

Figure B.1 — Schematic diagram of durability rig

Annex C (normative)
Abrasion type test for seal coats

C.1 Principle

The resistance of a seal coated, cement lined surface to withstand the abrasion which may result from swabbing during the commissioning or use of a pipeline is determined by testing the performance of the seal coated surface after five cycles of simulated abrasive pigging.

C.2 Apparatus and materials

C.2.1 *DN 100 cement mortar lined, seal coated pipe*, of standard length, having a spigot at one end.

C.2.2 *Soft bare swab*, bullet shaped, base coated, 125 mm nominal diameter, 28 to 32 kg/m^3 nominal density.

C.2.3 *Silica sand*, mean grading 500 μm, maximum grain size 1 000 μm.

C.2.4 *Polypropylene or nylon rope*, minimum of 10 m in length.

C.2.5 *Test water*, as defined in annex A.

C.2.6 *End cap for pipe*, fitted with a valve.

C.2.7 *pH meter*, having capacity to measure pH 0 to pH 14, with discrimination of a pH of 0.01 or better.

C.3 Procedure

C.3.1 Fit the rope (**C.2.4**) through the swab (**C.2.2**), such that the swab may be pulled through the pipe, tapered nose first.

C.3.2 Incline the pipe (**C.2.1**) relative to the horizontal with the spigot at the lower end as shown in Figure C.1.

C.3.3 At the lower end of the pipe introduce (100 ± 2)g of sand (**C.2.3**) and the swab. Bring the rope through the pipe and out of the higher end.

C.3.4 Fit the lower end of the pipe with an end cap fitted with a valve (**C.2.6**).

C.3.5 Fill the pipe from the spigot end with tap water.

C.3.6 Pull the swab through the pipe by hand, at a rate between 0.25 m/s and 0.5 m/s.

C.3.7 Repeat four times (total of five passages of swab). Fill the pipe with test water (**C.2.5**), leave for a maximum of 2 min, then drain the water through the valve.

C.3.8 Fill the pipe with test water and leave for a minimum of 24 h.

C.3.9 Empty the water from the pipe through the valve.

C.3.10 Rinse the pipe for a minimum of 1 h with tap water.

C.3.11 Empty the water from the pipe through the valve.

C.3.12 Fill the pipe with test water (**C.2.5**) and leave for a maximum of 2 min.

C.3.13 Empty the test water from the pipe through the valve.

C.3.14 Fill the pipe with test water (**C.2.5**) and leave for a minimum of 24 h.

C.3.15 Drain approximately half the contents of the pipe. Measure the pH of the test water using the pH meter (**C.2.7**) in accordance with BS 6068-2.50.

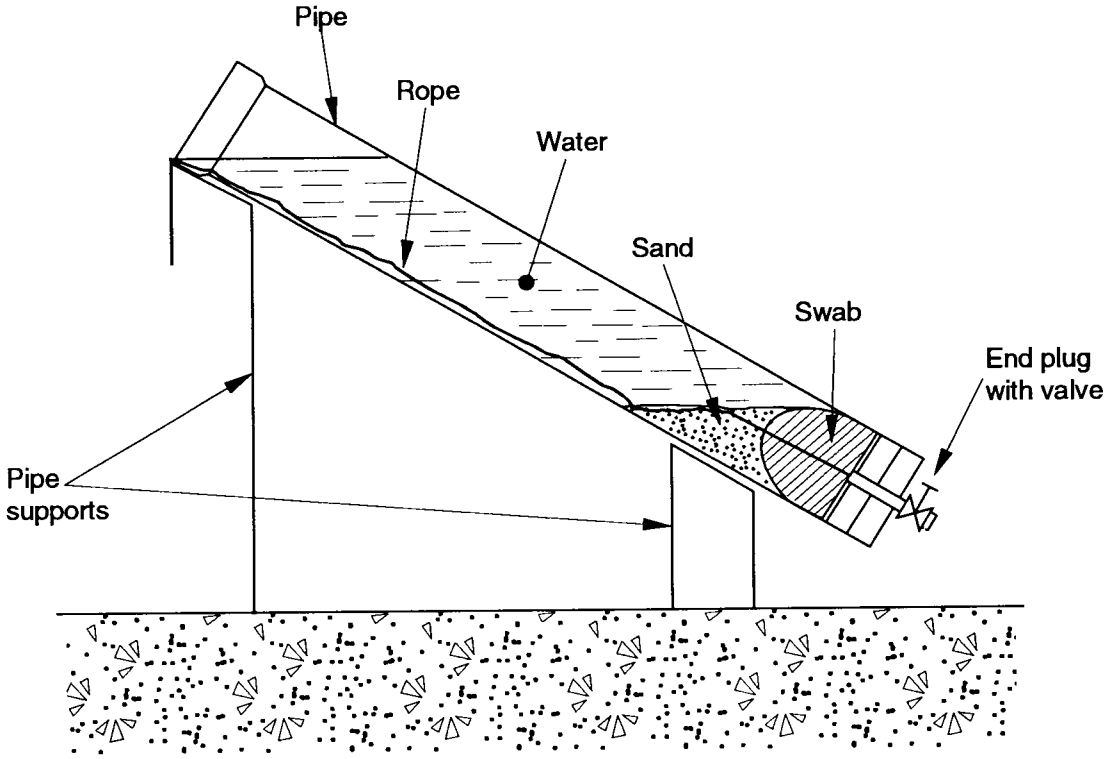

Figure C.1 — Schematic diagram of abrasion test rig

Annex D (normative)
Dry coating thickness measurement using test film

D.1 Principle

The average thickness of dry coating on a test film is determined to within 5 μm either by using a micrometer or by using a weight and area method.

D.2 Apparatus

D.2.1 *Test film*, having a minimum area of 10 000 mm^2.

D.2.2 *Micrometer*, having the capacity to measure to at least 10 mm, with a resolution of 5 μm or less.

D.2.3 *Tape measure*, at least 1 m in length, with a resolution of 1 mm.

D.2.4 *Analytical balance*, having at least 200 g capacity and a resolution of 0.01 g.

D.3 Preparation of test samples

D.3.1 The test shall be carried out using a piece of test film (**D.2.1**) of known thickness and mass/unit area with a minimum area of 10 000 mm^2.

D.3.2 Immediately prior to coating application, attach the piece of test film to the surface of the lining using self-adhesive tape.

NOTE The test film may be attached to the surface by applying tape to two edges of the film.

D.3.3 After the coating application, remove the test film. Allow the coating on the film to dry.

D.3.4 When the coating on the film is dry, determine the dry film thickness using one or both of the methods **D.4** or **D.5**.

D.4 Micrometer measurement method

D.4.1 ***Procedure***

D.4.1.1 Select positions on the test film, where readings are to be taken, that are free from surface irregularities and are not less than 20 mm from the coated test film edge and not less than 20 mm apart.

For large areas of coated test film, select the number and distribution of the test areas to give a representative indication of the coated film thickness.

D.4.1.2 Position the micrometer (**D.2.2**) with the fixed jaw in contact with the underside (uncoated side) of the coated test film immediately opposite the first test area. Gently screw home the movable jaw until a resistance is felt and no further movement of the jaw occurs on turning the ratchet.

Note the reading on the micrometer. Record the reading on a test sheet.

D.4.1.3 Release the micrometer and repeat the whole procedure (**D.4.1.2**) at each of the other test positions.

D.4.2 ***Calculation***

D.4.2.1 Calculate the film thickness at each point by subtracting the mean thickness of the test film from each thickness reading.

NOTE The mean thickness of the test film, if unknown, may be determined in accordance with **D.4.1.2**, using an uncoated test film sample, taking the average of ten or more results thus obtained.

D.4.2.2 Calculate the mean value for the thickness of the coating to the nearest multiple of 5 μm or less (depending upon the accuracy of the micrometer).

D.5 Weight and area method

D.5.1 ***Procedure***

D.5.1.1 Cut away areas of the coated test film which have adhesive tape attached to produce a rectangular sample.

D.5.1.2 Using a tape measure (**D.2.3**), measure the sides of the sample to an accuracy of 1 mm, and then determine the area of the remaining film A in square metres (m^2) to three significant figures.

D.5.1.3 Weigh the coated test film G in grams (g) to three significant figures using the balance (**D.2.4**).

D.5.1.4 Determine the coating thickness T in microns (μm), using the following equation:

$$T = \frac{1}{D} \times \frac{G - W}{A}$$

where

D is the density of the coating dry film in grams per cubic centimetre (g/cm^3); and

W is the mass per unit area of test film in grams per square metre (g/m^2).

Annex E (normative)
Adhesion test

E.1 Principle

The adhesion of a seal coat to a cement mortar substrate is assessed by applying and removing clear pressure sensitive self adhesive tape over an X cut made in the film.

E.2 Apparatus

E.2.1 *Cutting tool*, sharp bladed knife, scalpel, high speed micro abrasive disc or other cutting device.

E.2.2 *Cutting guide*, steel or other hard metal straight edge to ensure straight cuts.

E.2.3 *Soft brush*, for removing debris from the cut area.

E.2.4 *Illumination*, a source of light to assist in determining whether the cuts have been made through the film to the substrate.

E.2.5 *Tape*, 25 mm wide clear or semi-transparent pressure sensitive self-adhesive tape, conforming to BS 3887.

E.3 Procedure

E.3.1 Select an area of seal coated surface and ensure that it is clean and dry.

E.3.2 Using the cutting tool (**E.2.1**) with the straight edge (**E.2.2**) as a guide, in one steady motion, make two cuts in the film, each about 50 mm long, which intersect near their middle with a smaller angle of between 30° and 45°. Remove any cutting debris using a soft brush (**E.2.3**).

E.3.3 Using the source of illumination (**E.2.4**), inspect the incisions to establish that the coating film has been penetrated. If not, repeat **E.3.2**.

E.3.4 Remove a length of self-adhesive tape (**E.2.5**) at least 75 mm long from the roll, and place the centre of the tape at the intersection of the cuts in the same direction as the smaller angles. Smooth the tape into place using finger pressure in the area of the incisions.

E.3.5 Within (60 ± 30)s of application, remove the tape by grasping the free end and pulling it off rapidly (not jerked) perpendicular to the plane of the seal coated lining.

E.3.6 Inspect the area of the tape corresponding to the position of the X cut for removal of seal coat from the substrate, and determine the adhesion in terms of the following scale:

1) no peeling or removal of seal coat;
2) traces of peeling or removal along incisions or at the intersection;
3) jagged removal of seal coat along incisions up to 2 mm either side;
4) jagged removal of seal coat along incisions up to 4 mm either side;
5) removal of most of the area of the X onto the tape;
6) removal beyond the area of the X.

Annex F (normative)
Odour test

F.1 Principle

The capacity of a seal coated, cement lined surface to release odoriferous substances into tap water is assessed by comparing the odour of test water which has been in contact with the seal coat for 24 h with that of a control sample.

F.2 Apparatus and materials

F.2.1 *Cement mortar lined, seal coated pipe*, of standard length, having a spigot at one end.

F.2.2 *Potable tap water*.

F.2.3 *End cap for pipe*, fitted with a valve.

F.2.4 *Screw top glass bottles*, which are clean, airtight, and have at least 500 ml capacity.

F.2.5 *Glass bottles*, which are parallel sided, stoppered, clean and have at least 500 ml capacity.

F.3 Procedure

F.3.1 Hold the pipe (**F.2.1**) with its axis at an angle to the horizontal in an environment representative of that of the production batch, such that the test water is in contact with the seal coated surface. Fit an end cap (**F.2.3**), which permits sampling and draining of the test water, to the lower end of the pipe. Drain the pipe through the end cap.

F.3.2 Fully charge the pipe with tap water (**F.2.2**).

F.3.3 After a minimum of 24 h, collect a test water sample from the pipe in a screw top glass bottle (**F.2.4**), filling the bottle so as to leave only a minimal air gap.

F.3.4 Collect a tap water control sample in a screw top glass bottle (**F.2.4**), filling the bottle so as to leave only a minimal air gap. Store the test water sample and the tap water control sample in the dark at 23 °C to 27 °C until required.

F.3.5 Carry out steps **F.3.6** to **F.3.8** when the test water and tap water control samples have stabilized at 23 °C to 27 °C. The odour test shall be conducted by suitably trained individuals in a controlled environment designated as suitable for such testing which shall provide odour-free, ventilated air and seclusion from distraction and noise.

F.3.6 Remove the screw top from the test water sample bottle and immediately either:

— dispose of approximately one-half of the contents; or

— transfer approximately 200 ml of the test water into the 500 ml stoppered, glass bottle (**F.2.5**).

F.3.7 After refitting the stopper or screw top, shake the bottle containing the test water or control sample vigorously by hand, remove the stopper or screw top, immediately inhaling the vapour which has accumulated in the neck of the bottle.

F.3.8 Repeat steps **F.3.6** and **F.3.7** with the tap water sample, inhaling the vapour as a comparison test.

If no significant difference can be determined between the odour of test water and control samples, then the odour test shall be repeated by another suitably trained individual. Only if neither trained individual can detect a significant difference between the odour of the test water and control samples may the batch be considered to have passed and be released.

F.3.9 If the test water sample fails, drain the test sample completely and repeat the original procedure on the original test sample or a new sample from the same batch. No test sample shall be tested more than twice. The product shall be deemed non-conforming when a total of six consecutive failures have been recorded. (See also **5.5**, Note 2.)

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Bibliography

Standards publications

BS EN ISO 9000, *Quality management and quality assurance standards.*

Other documents

[1] GREAT BRITAIN. Water Supply (Water Quality) Regulations 1989 as amended by the Water Supply (Water Quality) (Amendment) Regulations 1991. London: The Stationery Office.
[2] GREAT BRITAIN. Water Supply (Water Quality) (Scotland) Regulations 1990. London: The Stationery Office.

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