BRITISH STANDARD

BS 3900-F11: 1985

[Cathodic disbonding (land-based)]

CONFIRMED
FEBRUARY 1991

Methods of test for paints

Part F11: Determination of resistance to cathodic disbonding of coatings for use on land-based buried structures

It is recommended that this Part be read in conjunction with the general information in the Introduction to BS 3900, issued separately.

Confirmed
October 2008

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Foreword

This Part of BS 3900 is one of a series of standards dealing with the sampling and testing of paints, varnishes and related products. It has been prepared under the direction of the Pigments, Paints and Varnishes Standards Committee.

The method of test described in this Part permits the assessment of the ability of paint and other organic coatings applied to metallic substrates to withstand cathodic disbonding. This method may also afford a basis for the comparison of particular coatings. The conditions of the test are more severe than those likely to be normally encountered and thus coating failure may be accelerated. It is recommended that the test should be carried out for a period of 28 days and hence this method is not suitable as a means of achieving quality control.

In order to carry out the method of test described in this Part it is necessary for certain supplementary information, itemized in clause **3**, to be made available or to be agreed between the parties.

The procedure described in this Part is suitable for coatings to be used for the protection of land-based structures, such as pipelines; it is based on the procedure developed by the British Gas Corporation. The procedure described in Part F10 is based on that developed and evaluated by COIPM (Comité International Permanent pour la Protection des Matériaux en Milieu Marin) and should be used for coatings that are intended for the protection of ships and structures exposed to marine environments.

It has been assumed in the drafting of this British Standard that it will be used and applied by those who are approximately qualified and experienced.

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.

This British Standard, having been prepared under the direction of the Pigments, Paints and Varnishes Standards Committee, was published under the authority of the Board of BSI and comes into effect on 28 February 1985

The Committees responsible for this British Standard are shown in BS 3900: Introduction.

The following BSI references relate to the work on this standard:
Committee reference PVC/10
Draft for comment 82/55585 DC

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 6, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Amendments issued since publication

Amd. No.	Date of issue	Comments

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1 Scope

This Part describes a method of test for determining the resistance to cathodic disbonding of a single coating or multi-coat system of paint, varnish or other organic coating applied to metallic substrates when the surface coating covering the metal substrate may contain or develop discontinuities. It is applicable to coatings that are to be applied to land-based structures, such as buried pipelines.

NOTE 1 For coatings that are to be used in marine environments on ships or partially exposed marine structures, the conditions of the test differ from those for coatings to be used in land-based applications. BS 3900-F10 describes a method suitable for assessing coatings applied to marine structures.

NOTE 2 The test result may be influenced not only by the properties of the coating system under test, but also by the nature and preparation of the substrate, the method of application of the coating system and other factors.

NOTE 3 The titles of the publications referred to in this standard are listed on the inside back page.

2 Definitions

For the purposes of this British Standard, the definitions given in CP 1021 and BS 2015 apply, together with the following

cathodic disbonding
the failure of adhesion between a coating and a metallic surface that is directly attributable to cathodic protection conditions and that is often initiated by a defect in the coating system, such as accidental damage, imperfect application or excessive permeability of the coating

3 Supplementary information

For any particular application, the following supplementary information shall be provided for this method of test.

This information shall be derived, partly or totally, from the product specification, British Standard or other document for the product under test or, where appropriate, should be agreed between the parties.

a) Material, dimensions and surface preparation of the test surface or substrate (see clause **7**).

b) The nature of the coating and the environment for which the coating is intended.

c) Method of application of the test coating to the substrate or test surface and its thickness.

d) Duration and conditions of drying or curing of the coating (or conditions of stoving and ageing, if applicable) before testing.

e) The specific method of measurement of the thickness of the dry coating, in micrometres, in accordance with BS 3900-C5, and whether it is a single coating or a multi-coat system (see **7.5**).

f) Duration of the test and any special conditions for testing (see **8.2**), including the electrolyte used (see clause **5**).

g) Details of the preparation of the artificial holiday (see **7.6**).

4 Sampling

A representative sample of the product to be tested (or of each product in the case of a multi-coat system) shall be taken as described in BS 3900-A1.

Each sample shall be examined and prepared for testing as described in BS 3900-A2.

5 Electrolyte

5.1 *Sodium chloride*, 30 g/L *solution*, prepared by dissolving 30 g of analytical grade sodium chloride (NaCl) in water complying with the requirements of BS 3978 and diluting the solution to 1 L.

6 Apparatus

6.1 *Stabilized d.c. power unit* having either a) a controlled voltage output of between 0 V and 12 V and a current capacity sufficient to supply 20 mA simultaneously to each test specimen in circuit; or b) a cathodic protection circuit, as described in **6.5** of BS 3900-F10:1985.

6.2 *Voltmeter*, with minimum resistance of 10 MΩ and capable of measuring in the range 0 V to 2 V to the nearest 1 mV.

6.3 *Variable resistors*, 0 kΩ to 1 kΩ ± 10 %, 1 W (one required for each test site).

6.4 *Fixed resistor*, 1 Ω ± 1 %, 1 W (one required for each test site).

6.5 *Anodes*, of minimum length 75 mm and of platinum wire of 0.8 mm nominal diameter or of platinized titanium strip, nominally 6 mm wide and 1.5 mm thick. Each test site shall have one anode.

6.6 *Reference electrode, saturated calomel type*, constructed from glass or plastics with a porous plug. The diameter shall be less than 10 mm.

6.7 *Equipment for maintaining the temperature* of the specimens and test sites at 23 ± 2 °C.

6.8 *Rigid plastics tube*, of 50 mm nominal bore (one length of approximately 60 mm for each test site).

6.9 *Elastomeric adhesive*[1)] for sealing the plastics tube (**6.8**) to the surface of the test specimen.

[1)] Suitable materials are two-part polysulphide rubber and silicone rubber. “Silastic” silicone rubber, grade RTV 738 or RTV 732 has been found to be suitable.

7 Preparation

7.1 Test substrates

Test substrates shall be substantially flat and representative of the substrate to which the test coating is to be applied.

If flat samples of the typical substrate are not available, test panels shall be used. The test panels shall be of steel and shall comply with the requirements of BS 3900-A3.

NOTE It may be necessary for the surface finish of the panels to correspond to that of the typical substrate to be used [see clause **3** a)].

7.2 Dimensions

The minimum dimensions of each of the test substrates (**7.1**) shall be 200 mm × 100 mm × 2 mm, unless otherwise specified [see clause **3** a)].

7.3 Preparation and coating of the test substrates

Either prepare and coat each substrate in accordance with the supplementary information given in the appropriate product standard or in the agreement between the parties (see clause **3**) or blast clean each test panel (see note to **7.1**) in accordance with BS 3900-A3 and coat in accordance with the manufacturer's instructions for the product or system under test.

Prepare two test specimens for each product or system under test.

Prepare control specimens, which are not to be connected to the cathodic protection system, in duplicate.

7.4 Drying and conditioning of the specimens

Dry (or stove and age) the coated test and control specimens for the time and under the conditions specified for the product under test (see clause **3**). Unless otherwise specified, condition the specimens at 23 ± 2 °C and at a relative humidity of 50 ± 5 % for a minimum of 16 h, with free circulation of air. Do not expose them to direct sunlight.

Carry out the determination of the coating thickness (see **7.5**), formation of the artificial holiday (see **7.6**) and test sites (see **7.8**) and the test procedure (see clause **8**) as soon as possible after completion of conditioning [see clause **3** d)].

7.5 Thickness of the coating

Determine the thickness, in micrometres, of the dry coating on each test and control specimen in accordance with BS 3900-C5 [see clause **3** e)].

7.6 Artificial holiday

Prepare two artificial holidays each of 6 mm diameter on each test specimen either by drilling a hole through the coating in accordance with the method described in Appendix A or by using the procedure described in **7.7** of BS 3900-F10:1985.

NOTE If preferred, the artificial holiday may be prepared after fixing the plastics tubes to the test specimens (see **7.8**).

7.7 Accidental holidays

Test the coating on each specimen for freedom from accidental holidays as described in Appendix B.

7.8 Test sites

Form a test site around each artificial holiday on each coated test specimen by attaching a 60 mm length of rigid plastics tube (**6.8**) using the elastomeric adhesive (**6.9**). Place the tubes at a minimum distance of 33 mm from the ends of the specimen and from each other, with their centres on the centreline of the specimen width. Place each tube perpendicular to the coated surface and centrally about an artificial holiday.

Leave the test specimens for a minimum of 12 h to allow the adhesive to become fully cured.

8 Procedure

8.1 Determinations

Carry out the procedure on two test specimens for each test coating.

NOTE This will provide four test sites.

8.2 Conditions of the test

8.2.1 Fill each plastics tube to a depth of approximately 50 mm with the electrolyte (**5.1**) and connect the apparatus as shown in Figure 1. Ensure that the temperature of each specimen and test site is at 23 ± 2 °C, and switch on the d.c. power unit (**6.1**).

Connect the voltmeter (**6.2**) as shown in Figure 2 and, with the porous tip of the calomel reference electrode (**6.6**) placed within 10 mm of the holiday in the coating, adjust the electrical input by means of the variable resistor (**6.3**) until the voltmeter indicates – 1 500 ± 5 mV with respect to the calomel electrode. (If conventional potentiostats are used, adjust the potential as described in **8.3** of BS 3900-F10:1985.)

At intervals of 24 h, record the voltmeter reading and adjust the variable resistor to correct any drift from the – 1 500 ± 5 mV setting. Check the potential frequently during the first 8 h and, thereafter, check the potential at least once every 24 h. Also, every 24 h, record (see note) the current flow by measuring the voltage drop across the 1Ω fixed resistor (**6.4**).

NOTE Although there is no requirement to report the current flow, a rapid rise in its magnitude is an early indication of disbonding of the coating.

Check each of the plastics tubes every 24 h for loss by evaporation and, if necessary, add distilled water.

As it is essential that there is no leakage at the seal with the test specimen (see **6.9**), if leakage occurs, discontinue the test.

8.2.2 Unless otherwise specified, continue the test for 7 days, maintaining the temperature at 23 ± 2 °C. After this period assess disbonding at one test site on each specimen by the method described in **8.3**. If the disbonding is less than the limit specified, continue the test using the second test site for a further 21 days. Then assess the disbonding by the method described in **8.3**.

8.3 Inspection and assessment of the coating

Inspect and assess each coating immediately after the test period. Detach the plastics tube from the test site. Using a lint-free paper towel, wipe along the surface of the coating and cathode area to remove moisture.

NOTE As alkalis may be formed beneath the coating during the test, care should be taken when handling the specimen. While rinsing may reduce the alkali concentration beneath a blister, the concentration may still be sufficient to cause skin burns.

Make about 12 radial incisions using a sharp knife[2)] through the coating to the substrate extending outwards from the holiday for a distance of 20 mm. Make these incisions at an angle of approximately 30° from each other.

Insert the knife point into the centre portion of the holiday down to the metal substrate. Using a gentle levering action, peel away slowly a radial section of coating, continuing until firm adhesion is encountered. As loss of adhesion is not always obvious, carefully examine the substrate for signs of residual coating which indicates that disbonding has not occurred.

Repeat with each radial segment.

8.4 Reporting of results

Either a) report the extent of disbonding as the average distance in millimetres between the edge of the holiday area and the positions of firm adhesion; or b) if the coating is strongly adherent to the substrate, take the average distance at which the coating breaks as the extent of disbonding.

9 Test report

The test report shall include the following information:

a) the type and identification of the coating under test;

b) a reference to this British Standard, i.e. BS 3900-F11;

c) the items of supplementary information referred to in clause **3**;

d) the British Standards or other published documents supplying the information referred to in c);

e) the period of the test and interruptions during the test including any required for the intermediate examination of the coating (see **8.2.2**);

f) any deviation, by agreement or otherwise, from the test procedure described (e.g. if the procedure for preparing the artificial holiday (see **7.6**) differs from that specified, and if the electrolyte temperature differs from 23 ± 2 °C [see **8.2.1**)];

g) the results of the test in terms of the extent of the loss of adhesion in millimetres (see **8.4**);

h) the dates of the test.

[2)] A Stanley trimming knife blade, type 1991, has been found to be suitable.

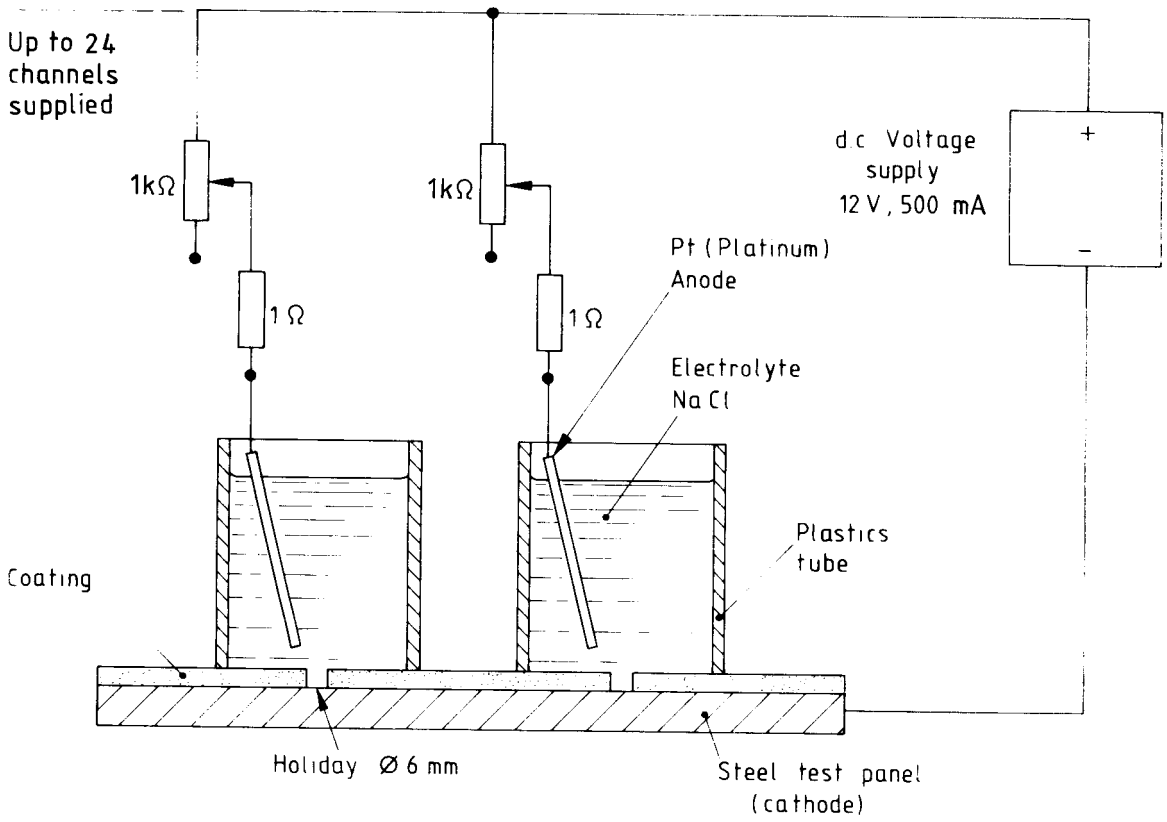

Figure 1 — Stabilized d.c. power unit (see **6.1**)

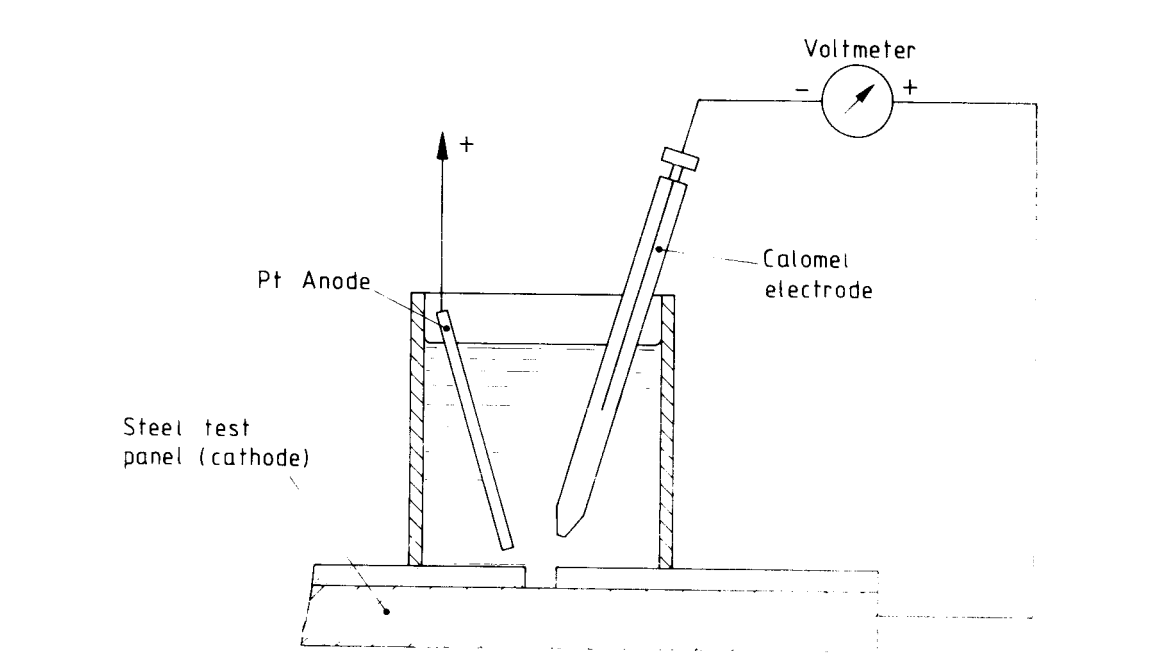

Figure 2 — Arrangement of test cells and the electrical connections (see **8.2**)

Appendix A Method for producing artificial holidays

A.1 Place the coated specimen rigidly in a suitable clamp or vice.

A.2 Drill a hole through the coating to the substrate by use of a 6 mm diameter twist drill with cutting edges at an included angle of 160°.

NOTE The cutting edges of the drill should be periodically sharpened to minimize tearing of the coating, and it is important that the angle be maintained at 160°.

Ensure that the depth of the holiday is minimal but that no coating is visible within the area of the holiday. Avoid excessive penetration into the steel substrate.

A.3 Remove any swarf or detached coating from the specimen.

Appendix B Detection of accidental holidays

NOTE This procedure for detecting accidental holidays in a coating is based on the method described in **J.3.1** of BS 4164:1980.

Examine the test specimen for the presence of accidental holidays by means of a flaw detector, fitted with a soft, metallic bristled, straight brush approximately 75 mm long and 6 mm wide with bristles 6 mm long, adjusted to provide a voltage of 10 kV but so arranged that the maximum short circuit current is not greater than 8 mA. If the flaw detector is not equipped with voltage indication, set it to give a 12 mm spark in air to a steel plate.

Pass the flaw detector over the coated specimen at a distance of approximately 6 mm from the coated steel surface. Ignore any edge effects.

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Publications referred to

BS 2015, *Glossary of paint terms.*

BS 3900, *Methods of test for paints.*

BS 3900-A1, *Sampling.*

BS 3900-A2, *Examination and preparation of samples for testing.*

BS 3900-A3, *Standard panels for paint testing.*

BS 3900-C5, *Determination of film thickness.*

BS 3900-F10, *Determination of resistance to cathodic disbonding of coatings for use in marine environments.*

BS 3978, *Water for laboratory use.*

BS 4164, *Specification for coal-tar-based hot-applied coating materials for protecting iron and steel, including suitable primers where required.*

CP 1021, *Code of practice for cathodic protection.*

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