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Amendment No. 1)*

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AUGUST 1987

Specification for

**Bitumen-based  
hot-applied coating  
materials for protecting  
iron and steel,  
including suitable  
primers where required**

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Department of the Environment (PSA) Health and Safety Executive	Timber Research and Development Association
	Trades Union Congress

The organizations marked with an asterisk in the above list, together with the following, were directly represented on the Technical Committee entrusted with the preparation of this British Standard:

British Cast Iron Research Association	Federation of Associations of Specialists and Sub-contractors
British Gas Corporation	Institution of Gas Engineers
British Ironfounders' Association	Road Emulsion Association Ltd.
British Tar Industry Association	The Pipeline Industries Guild
Council of Ironfoundry Associations	Individual manufacturers

This British Standard, having been prepared under the direction of the Elements and Components (of Diverse Materials) for Buildings Standards Committee, was published under the authority of the Executive Board and comes into effect on 31 October 1980

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# Foreword

This revision of BS 4147 has been prepared under the direction of the Elements and Components (of Diverse Materials) for Buildings Standards Committee. BS 4147 was first published in 1967. A revised edition was published in 1973 to take account of metrication.

Since 1967 much has been learned about the specification and testing of bitumen- and coal-tar-based hot-applied coatings, particularly in connection with the extensive installation of steel pipelines for the transmission of oil, water and gas. This standard takes into account these technical advances.

An international standard covering the selection and application of bitumen- and coal-tar-based protections for steel pipes is in course of preparation, the drafting being done by a committee of CEOCOR (Western European Committee on Corrosion and Protection of Pipelines). After many meetings a draft is nearing completion. It is evident that materials and practices vary widely in the countries represented on the committee, and a common standard will have to allow for the well established practices of the various countries. In this British Standard the aim has been to produce a document which is compatible with the current international standard draft, but which also prescribes closer limits for many properties which experience in the UK has shown to be advantageous.

This standard gives guidance on the commonly accepted uses for the different types and grades of coating materials. Performance tests for bend and peel are introduced for type 2 coating materials. The direct impact test is carried out at 0 °C as well as at 25 °C, since steel pipelines coated with these materials are often handled at low ambient temperatures. A surface profile requirement for the steel plates used in performance tests is also introduced.

It should be emphasized that the protective system can be ineffectual if the coating materials are not correctly applied, or they are applied to an unsatisfactory surface. CP 2010-2 and CP 2010-3 gives guidance on application to steel and iron pipelines.

The use of hot-applied bitumen-based coatings in connection with the protection of steel pipes and fittings against corrosion is mentioned particularly in BS 534. Black bitumen coating solutions for cold application are specified in BS 3416. Hot-applied coal-tar based coating materials for protecting iron and steel are specified in BS 4164, a revised version of which is being published simultaneously with this standard.

*Certification.* Attention is drawn to the certification facilities described on the inside back cover of this standard.

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 obligation.**

## Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 10, 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.

## Section 1. General

### 1 Scope

This British Standard specifies requirements for hot-applied bitumen-based materials, unfilled or reinforced with inert powdered fillers or with inert fibrous fillers, which are used to protect iron and steel against corrosion. Requirements for primers are included because the performance of hot-applied coating materials depends on the use of suitable primers.

Different types and grades of material are used for different substrates, conditions of application and service. This standard indicates factors which need to be taken into account in selecting the type and grade for a particular use.

### 2 References

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

### 3 Definitions

For the purposes of this British Standard, the following definitions apply.

#### 3.1

##### **bitumen**

a very viscous liquid or solid, consisting of hydrocarbons and their derivatives, which is soluble in carbon disulphide or trichloroethylene. It is substantially non-volatile and softens gradually when heated. It is black or brown in colour and possesses waterproofing and adhesive properties. It is obtained by refinery processes from petroleum

#### 3.2

##### **hot-applied**

of such a consistency at ambient temperature that heating is required before application

#### 3.3

##### **inert filler**

finely divided mineral powder or inorganic fibre which is not substantially hygroscopic, not electrically conducting and does not react with other ingredients of the coating material or with the environment in which it will be used

#### 3.4

##### **primer**

a material applied as a thin film to metal in order to ensure maximum adhesion of the subsequent protective coating

## 4 Types of bitumen-based coating material

Bitumen-based coating materials shall be classified as follows:

type 1: unfilled coating materials;

type 2: coating materials with inert non-fibrous fillers;

type 3: coating materials with inert fibrous fillers.

NOTE 1 Bitumen-based coating materials are further sub-divided into a number of grades according to the conditions of application and service. Details of these distinctions are specified in section 3.

NOTE 2 Recommendations on the use of coating materials are given in Appendix M.

## 5 Types of primer

Three types of primer are available for use with bitumen-based coating materials.

**Type A. Bitumen-based primers for cold application.** These are available in two grades. Primer of "grade a" is intended for use under the softer coating materials of type 2, "grade a". Primer of "grade b" is intended for use under the harder coating materials.

**Type B. Synthetic primer for cold application.** This is suitable for all grades of coating materials. It is quick drying and application of the subsequent coating is possible within a shorter time.

**Type C. Bitumen primers for hot application.** These are available in three grades. They are usually applied by dipping the product in a bath containing the primer in the molten state.

Primers shall be applied in compliance with the manufacturer's instructions and shall, after application of the coating materials, comply with the appropriate performance requirements given in this standard. If primer and coating materials are obtained from different sources, the two in combination shall be capable of complying with the appropriate performance requirements given in this standard.

## Section 2. Primers

### 6 Type A. Bitumen-based primer for cold application

**6.1 Composition.** Type A primer for cold application shall consist of a homogeneous solution of bitumen in hydrocarbon or other suitable solvent having a consistency suitable for application by spray, brush or other approved method.

The bitumen used as a base for the primer shall have the properties given in Table 1.

**Table 1 — Characteristics of bitumen in type A primer**

Characteristic	Grade a	Grade b	Method of test
Softening point (ring and ball), °C	80 to 100	100 to 120	BS 2000-58
Penetration at 25 °C to 10 <sup>-1</sup> mm	20 to 30	10 to 20	BS 2000-49
Solubility in carbon disulphide or trichloroethylene, min. % by mass	99	99	BS 2000-47

**6.2 Characteristics.** Type A primer shall comply with the requirements given in Table 2 when tested by the methods specified and, when dry, shall provide an effective bond between the metal and the subsequent coating, in accordance with the appropriate performance requirements given in this standard.

When stored in the original sealed containers at atmospheric temperature, the primer shall retain these characteristics for not less than 12 months from the date of dispatch.

**Table 2 — Characteristics of type A primer for cold application**

Characteristic	Limits	Method of test
Flow time (4 mm flow cup at 23 °C), s	50 minimum	BS 3900-A6
Flash points (Abel closed cup), min. °C	23	BS 2000-170

NOTE For type 3 coating material a primer having a viscosity towards the upper end of the range should be used.

## 7 Type B. Synthetic primer for cold application

**7.1 Composition.** Type B primer for cold application shall consist of chlorinated rubber and plasticizer and, when required, colouring matter, together with solvents needed to give a consistency suitable for application by spray, brush or other approved method.

**7.2 Characteristics.** Type B primer shall comply with the requirements given in Table 3 when tested by the methods specified and, when dry, shall provide an effective bond between the metal and the subsequent coating, in accordance with the appropriate performance requirements given in this standard.

**Table 3 — Characteristics of type B primer for cold application**

Characteristic	Limits	Method of test
Flow time (4 mm flow cup at 23 °C), s	35 to 60	BS 3900-A6
Flash points (Abel closed cup), min. °C	23	BS 2000-170
Volatile matter (105 °C to 110 °C), max % loss by mass	75	Appendix A

## 8 Type C. Bitumen primer for hot application

**8.1 Composition.** Type C primer for hot application shall consist of bitumen without fillers.

**8.2 Characteristics.** Type C primer shall comply with the requirements for type 1 coating materials, grade a or grade b, given in Table 4 when tested by the methods specified and, when dry, shall provide an effective bond between the metal and the subsequent coating, in accordance with the appropriate performance requirements given in this standard.

NOTE Alternatively, by agreement between the manufacturer and the purchaser, type C primer complying with the requirements for type 1 coating materials, grade c, given in Table 4, may be used as a primer for hot application.

## Section 3. Coating materials

### 9 Type 1. Unfilled coating materials

**9.1 Composition.** Type 1 coating materials shall consist of bitumen.

**9.2 Characteristics.** Type 1 coating materials shall comply with the requirements for the appropriate grade given in Table 4 when tested by the methods specified.

**Table 4 — Characteristics of type 1 coating materials**

Characteristics	Grade a	Grade b	Grade c	Method of test
Softening point (ring and ball), °C	80 to 100	100 to 120	min. 40	BS 2000-58
Density at 25 °C, max. g/ml	1.06	1.06	1.06	Appendix C
Penetration at 25 °C, 10 <sup>-1</sup> mm	20 to 30	10 to 20	max. 80	Appendix D
Solubility in carbon disulphide or trichloroethylene, min. % by mass	00	00	00	BS 2000-47
Flash point (Cleveland open cup), min. °C	250	250	250	BS 4689

**9.3 Tests.** Type 1, grade a and grade b coating materials detailed in Table 4, in conjunction with an appropriate primer, shall comply also with the requirements given in Table 5 when tested by the methods specified.

**Table 5 — Tests for type 1 coating materials**

Test	Grade a	Grade b	Method of test
Sag, max., mm			
45 °C, 24 h	1.5	—	Appendix E
55 °C, 24 h	—	1.5	Appendix E
Impact			
Disbonded area at 0 °C, max., mm <sup>2</sup>	15 000	15 000	Appendix G

NOTE When materials are to be used in contact with potable water, it is recommended that additional tests be carried out to ensure freedom from contamination.

## 10 Type 2. Coating materials with inert non-fibrous fillers

**10.1 Composition.** Type 2 coating materials shall consist of a uniform mixture of bitumen and inert non-fibrous filler.

The fineness of the inert non-fibrous filler shall be as follows when tested by the method given in clause 6 of BS 1796:1976:

passing 90 µm test sieve complying with the appropriate requirements of BS 410: not less than 93 %;

passing 250 µm test sieve complying with the appropriate requirements of BS 410: not less than 99 %.

**10.2 Characteristics.** Type 2 coating materials shall comply with the requirements for the appropriate grade given in Table 6 when tested by the methods specified.

**Table 6 — Characteristics of type 2 coating materials**

Characteristic	Grade a	Grade b	Grade c	Method of test
Filler content by ignition, % by mass	25 to 35	25 to 35	45 to 55	Appendix B
Density at 25 °C, g/cm <sup>3</sup>	1.2 to 1.4	1.2 to 1.4	1.4 to 1.65	Appendix C
Softening point (ring and ball), °C	100 to 120	115 to 130	120 to 150	BS 2000-58
Penetration at 25 °C, 10 <sup>-1</sup> mm	10 to 20	5 to 17	5 to 15	Appendix D
Flash point (Cleveland open cup), min., °C	250	260	260	BS 4689

**10.3 Tests.** Type 2 coating materials detailed in Table 6, in conjunction with an appropriate primer, shall comply also with the requirements for the appropriate grade given in Table 7 when tested by the methods specified.

**Table 7 — Tests for type 2 coating materials**

Test	Grade a	Grade b	Grade c	Method of test
Sag, max., mm 60 °C, 24 h 75 °C, 24 h	1.5 —	— 1.5	— 1.5	} Appendix E
Bend at 0 °C, min., mm	20	15	10	
Impact Disbonded area, max., mm <sup>2</sup> 0 °C 25 °C	15 000 —	— 6 500	— 6 500	} Appendix G
Peel, initial and delayed, max., mm. 30 °C 40 °C 50 °C 60 °C	3.0 3.0 3.0 3.0	3.0 3.0 3.0 3.0	— 3.0 3.0 3.0	

NOTE 1 When materials are to be used in contact with potable water, it is recommended that additional tests be carried out to ensure freedom from contamination.

NOTE 2 It is recognized that for many of the products covered by this standard a cathodic disbondment test would be of very great value. At present, sufficient data are not available to define such a test but the possibility of including one in the future will be considered.

### 11 Type 3. Coating materials with inert fibrous fillers

**11.1 Composition.** Type 3 coating materials shall consist of a uniform mixture of bitumen and inert fibrous filler.

It may be desirable to add a proportion of inert non-fibrous mineral filler. The fineness of any such filler added shall be as follows when tested by the method given in clause 6 of BS 1796:1976:

passing 90 µm test sieve complying with the appropriate requirements of BS 410: not less than 93 %;

passing 250 µm test sieve complying with the appropriate requirements of BS 410: not less than 99 %.

NOTE For a works-applied bitumen coating, for cast iron pipes only, a coarser grade of inert non-fibrous mineral filler, of which a minimum of 99 % will pass a 355 µm test sieve, may be used.

**11.2 Characteristics.** Type 3 coating materials shall comply with the requirements for the appropriate grade given in Table 8 when tested by the methods specified.

**Table 8 — Characteristics of type 3 coating materials**

Characteristics	Grade a	Grade b	Method of test
Filler content by ignition, % by mass	20 to 40	40 to 60	Appendix B
Density at 25 °C, g/m <sup>3</sup>	1.15 to 1.40	1.40 to 1.65	Appendix C
Penetration at 25 °C, 10 <sup>-1</sup> mm	5 to 20	5 to 20	Appendix D
Flash point (Cleveland open cup), min. °C	250	250	BS 4689

**11.3 Tests.** Type 3 coating materials detailed in Table 8, in conjunction with an appropriate primer, shall comply also with the requirements for the appropriate grade given in Table 9 when tested by the methods specified.

**Table 9 — Tests for type 3 coating materials**

Test	Grade a	Grade b	Method of test
Sag, max., mm 75 °C, 24 h	1.5	1.5	Appendix E
Impact Disbonded area at 25 °C, max., mm <sup>2</sup>	6 500	6 500	Appendix G

NOTE When materials are to be used in contact with potable water, it is recommended that additional tests be carried out to ensure freedom from contamination.

### Section 4. Packaging, marking, sampling

#### 12 Packaging

Unless otherwise ordered by the purchaser, the coating material shall be supplied in one of the following forms:

- a) in paper bags, with easily strippable lining, containing approximately 50 kg;
- b) in steel drums containing not more than 200 litres;
- c) in moulded cakes;
- d) in bulk, in hot liquid form.

Primers shall be packed in steel drums containing not more than 210 litres. The supplier shall provide instructions for storing and handling the material.



### 13 Marking

Containers of bitumen-based hot-applied coating materials shall be legibly and permanently marked with the following:

- a) the number of this British Standard, i.e. BS 4147;<sup>1)</sup>
- b) the type and grade number of the material (e.g. type 2, grade b);
- c) the manufacturer's identity;
- d) the manufacturer's batch number.

### 14 Sampling

When samples of coating material or primer are required for testing, the purchaser and the supplier shall agree on the number of packages to be sampled and the procedure to be adopted. The samples so taken shall be identified by the supplier and one-half retained by the purchaser for the purpose of making such tests as he may require.

In type 2 and type 3 coating materials, the filler will settle during storage. In order to ensure that test samples of these materials are representative, they shall be made up of equal increments taken from the top, middle and bottom of the package.

Sampling of primers shall be carried out in the following manner.

Draw not less than 1 litre either at the filling stage or from one or more previously unopened containers. Fill a suitable clean, dry, airtight container with the sample to leave an ullage of approximately 5 %. Seal and mark each sample container with full details and date of sampling.

### 15 Effect of non-metallic materials on water quality

Non-metallic materials shall comply with the requirements for the testing of non-metallic materials set out in the UK Water Fittings Byelaws Scheme Information and Guidance Note No. 5-01-02, ISSN 0267-0313, obtainable from the Water Research Centre, Water Byelaws Advisory Service, 660 Ajax Avenue, Slough, Berkshire SL1 4BG.

NOTE Pending the determination of suitable means of characterizing the toxicity of leachates from materials in contact with potable water, materials approved by the Department of the Environment Committee on Chemicals and Materials of Construction for use in Public Water Supply and Swimming Pools are considered free from toxic hazard for the purposes of compliance with this clause. A list of approved chemicals and materials is available from the Technical Secretary of that Committee at the Department of the Environment, Water Division, Romney House, 43 Marsham Street, London SW1P 3PY.

<sup>1)</sup> Marking BS 4147 on or in relation to a product is a claim by the manufacturer that the product has been manufactured in accordance with the requirements of the standard. The accuracy of such a claim is therefore solely the manufacturer's responsibility. Enquiries as to the availability of third party certification to support such claims should be addressed to the Director, British Standards Institution, Maylands Avenue, Hemel Hempstead, Herts HP2 4SQ in the case of certification marks administered by BSI or to the appropriate authority for other certification marks.

## Appendix A Determination of volatile matter

**A.1 Procedure.** Weigh to the nearest milligram between 1.0 g and 2.0 g of the primer into a tared flat bottomed circular dish, about 75 mm in diameter. Heat the dish and its contents in an oven at the temperature specified in Table 3 for 3 h. Allow the dish to cool to room temperature in a desiccator and reweigh to the nearest milligram.

**A.2 Calculation.** Calculate the volatile matter,  $V$ , as a percentage by mass of the primer as follows:

$$V = 100 \frac{M_1 - M_2}{M_1}$$

where

$M_1$  is the mass of sample before heating;

$M_2$  is the mass of sample after heating.

## Appendix B Determination of filler content by ignition

**B.1 Procedure.** Carry out the determination in a tared, pre-ignited silica crucible approximately 40 mm in diameter and 30 mm in depth.

Weigh to the nearest milligram between 1 g and 1.5 g of coating material into the crucible. Place the crucible in a cold muffle furnace with good ventilation and raise it to a temperature of 700 °C to 750 °C over a period of about 2 h. Maintain it at that temperature for a period of not less than 2 h. Then remove the crucible from the muffle furnace and allow it to cool in a desiccator. Weigh the crucible and ash to the nearest milligram.

Report the filler content by ignition as a percentage by mass of the original sample of coating material.

**B.2 Calculation.** Calculate the filler content,  $F$ , as a percentage by mass of the coating material as follows:

$$F = 100 \frac{M_2}{M_1}$$

where

$M_1$  is the mass of sample before heating;

$M_2$  is the mass of sample after heating.

## Appendix C Determination of density at 25 °C

### C.1 Apparatus

**C.1.1 Mould.** A polished brass mould as shown in Figure 1, assembled and placed on a polished brass plate.

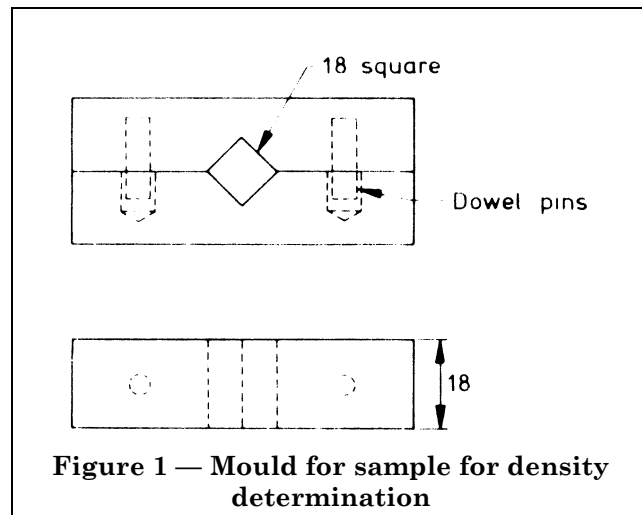


Figure 1 — Mould for sample for density determination

**C.1.2 Melting pot.** Steel pot of approximately 80 mm diameter and 100 mm height. The pot is covered with a loose fitting lid.

**C.2 Procedure.** Heat about 100 g of sample slowly in the melting pot to between 60 °C and 70 °C above the softening point, keeping the lid on when not stirring. Until the sample is completely fluid, stir continually to avoid local overheating and excessive loss of vapour. Thereafter stir occasionally.

Then pour the fluid material carefully into the mould, avoiding the inclusion of air bubbles, until the mould is almost full.

NOTE It is convenient to fill the cylinder for the penetration test and the mould for the density test at the same time.

Allow the material and the mould to cool to ambient temperature and then part the mould.

Suspend the moulded specimen from the hook on a balance using a suitable length of nylon thread, and weigh it to the nearest milligram.

Add a few drops of wetting agent to a small beaker of water at 25 °C. Place the beaker on a bridge across the balance pan. Suspend the moulded specimen from the hook on the balance so that it is fully immersed in the water in the beaker about 25 mm from the bottom of the beaker. Carefully remove all air bubbles adhering to the specimen and to the thread.

Weigh the specimen to the nearest milligram whilst suspended in the water.

**C.3 Calculation.** Calculate the density of the sample as follows:

$$\text{Density at } 25\text{ }^{\circ}\text{C} = \frac{M_a}{M_a - M_w}$$

where

$M_a$  is the mass of sample in air;

$M_w$  is the mass of sample in water at 25 °C.

## Appendix D Determination of penetration

Determine penetration by the method given in BS 2000-49, but do not sieve the sample before pouring it into the penetration tin.

## Appendix E Sag test

**E.1 Preparation of test specimens.** Prepare one test plate, measuring at least 300 mm × 300 mm × 3 mm, by the method given in Appendix J, prime it by the method given in Appendix K and coat it with coating material prepared by the method given in Appendix L. Leave a 15 mm uncoated border around the four edges of the plate and draw three lines parallel with one edge at 75 mm intervals across the surface of the coating material and continued on the uncoated surface of the plate to the edges. Draw the lines in such a way that the prepared surface is not damaged.

**E.2. Procedure.** Store the plate in a vertical position in an oven. Maintain the oven at the temperature and for the period specified for the appropriate grades in Table 5, Table 7 and Table 9. At the end of this period remove the plate and allow it to cool to room temperature. Measure the maximum sag of each line on the plate. In cases of disagreement, the manufacturer and the purchaser shall each repeat the test on two fresh specimens.

**E.3 Recording.** Record the sag of the coating material as the average of the maximum sags of the three lines.

## Appendix F Bend test

**F.1 Preparation of specimens.** Prepare four test plates, measuring 250 mm × 100 mm × 1.5 mm, by the method given in Appendix J, prime them by the method given in Appendix K and coat them with coating material prepared by the method given in Appendix L.

## F.2 Procedure

**F.2.1** Store the plates at 0 °C in a water/ice bath or refrigerator for a minimum of 6 h. Then remove them and test them immediately.

**F.2.2** Test the plates for deflection by supporting them on 3 mm radius knife edges which are spaced on 240 mm centres. Apply the deflecting load centrally across the plate by means of a 12 mm radius mandrel at the rate of 1 mm/s (to produce tension in the coating) until cracking occurs, as indicated by an electrical flaw detector operated continuously as in F.3. Continue the deflection to a maximum distance of 38.0 mm.

Report, in millimetres, the deflection producing the first crack.

## F.3 Evidence of cracking by means of a flaw detector.

Fit a flaw detector with a soft metallic bristled straight brush approximately 75 mm long and 6 mm wide with bristles 6 mm long, and adjust it to provide a voltage of 10 kV 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 approximately 6 mm distance from the coated steel surface. Ignore edge effects and flaws detected prior to refrigeration.

## Appendix G Impact test

### G.1 Preparation of test specimen.

**G.1.1 General.** Prepare a test plate, measuring approximately 300 mm × 300 mm × 12.5 mm, by the method given in Appendix J, prime it by the method given in Appendix K and coat it with coating material prepared by the method given in Appendix L.

**G.1.2 For test at 0 °C.** Allow the plate to reach room temperature and then maintain it at a temperature of 0 ± 1 °C in a refrigerator for 6 h before testing. Remove the plate quickly from the refrigerator, dry it with a lint-free paper towel if necessary and subject it to the impact test.

**G.1.3 For test at 25 °C.** Allow the plate to reach room temperature and then maintain it at a temperature of 25 ± 1 °C in an oven for at least 6 h before testing. Remove the plate quickly from the oven and subject it to the impact test.

## G.2 Procedure

**G.2.1** For test at 0 °C. Support the plate on a flat horizontal surface of a block of wood with the coated face uppermost. Drop a 630 g to 650 g steel ball with a well polished spherical surface from a height 2.45 m above the surface of the plate, so as to strike the coating material at the centre of the plate.

**G.2.2** For test at 25 °C. Proceed as in G.2.1 but drop the steel ball so as to strike the coating material at a point approximately 100 mm along the diagonal from one corner of the plate. Repeat the test in each of the other three quarters.

## G.3 Assessment and recording

Examine the plate for evidence of disbonding (see note 1). Remove all the disbonded coating and measure its area in square millimetres.

Record the area of disbonded coating for impact tests at 0 °C (see note 2) and the average of the four areas of disbonded coating for impact tests at 25 °C.

NOTE 1 Disbonded coating is that which can be easily and readily removed from the plate with little force by the use of a knife blade or similar instrument.

NOTE 2 For tests at 0 °C, if the area disbonded exceeds the maximum given in Table 5 or Table 7, repeat the test as in G.2.1 on two new plates prepared in accordance with G.1.1 and G.1.2. If the disbonded area on each plate is less than the permitted area, the material is deemed to have passed the test.

## Appendix H Peel tests

**H.1 Preparation of test specimens.** Prepare two test plates, measuring approximately 300 mm × 300 mm × 12.5 mm, by the method given in Appendix J, prime them by the method given in Appendix K and coat them with coating material prepared by the method given in Appendix L. After applying the coating material, allow the plates to cool to room temperature.

**H.2 Procedure.** Use one test plate, without further treatment, for the initial peel test. Store the second test plate in a horizontal position, with the coated side up, in an oven at 70 ± 2 °C for 72 h. At the end of this period remove the plate, allow it to cool to room temperature and use it for the delayed peel test.

Carry out the peel test by immersing the plate in a water bath for approximately 30 min at the lowest temperature specified for the particular grade of coating material in Table 7. At the end of this period remove the plate from the bath and immediately test for peel as follows.

Make two parallel cuts through the coating material approximately 20 mm apart and 100 mm long toward the centre of the plate.

Using a stiff scraper with a sharpened square-ended blade of approximately 20 mm width, make a cut through the coating for the full width between the parallel cuts. With a gentle levering action separate an approximately 15 mm long strip of coating from the steel plate. Carefully turn the blade of the scraper, and the separated coating, until they are vertical to the plate. Gripping the coating and blade between finger and thumb, pull upwards until the coating breaks.

Measure the amount of peeling from the point where the separation through leverage and cutting had ceased to the line of breakage of the coating.

Carry out at least two tests at each temperature.

NOTE In case of failures, more tests can be carried out, extending the parallel cuts if necessary and reporting the average results obtained.

Repeat this procedure, making new parallel cuts, separated by at least 15 mm from the cuts for the preceding test, for each of the successive temperatures specified in Table 7.

## Appendix J Preparation of steel surfaces for the tests given in Appendix E to Appendix H

Prepare the steel surfaces used in the tests given in Appendix E, Appendix F, Appendix G and Appendix H as follows.

First free the surface of the steel plate from all oil and grease. Then blast it to a uniform steel grey finish, removing rust, scale and all other foreign matter to the second quality standard of BS 4232, and so that the peak to trough profile is 75 ± 25 µm.

NOTE 1 This quality level is roughly equivalent to the near-white standard of the Steel Structures Painting Council (USA) and the Sa 2 ½ standard of the Swedish standard SIS 05 5900.

NOTE 2 It is important to ensure that blasted steel surfaces are free from traces of previous coating materials and do not subsequently become contaminated with oil or grease.

## Appendix K Priming of steel surfaces for the tests given in Appendix E to Appendix H

**K.1 General.** After preparing the steel surfaces by the method given in Appendix J, prime them using the appropriate primer specified in section 2.

## K.2 Cold-applied primers

**K.2.1 Method.** Apply the primer with a clean flat bristle brush of 25 mm width to the plates lying in a horizontal position. Apply the primer at the rate of coverage specified by the manufacturer in such a manner that the surface is uniformly covered with an even film free from air bubbles. Allow the primer to dry at an air temperature of not less than 15 °C, in a well ventilated atmosphere having a relative humidity not greater than 60 %.

**K.2.2 Type A primer.** When the film is hard dry, apply coating material to the plate by the method given in Appendix L, not less than 16 h nor more than 32 h after application of the primer.

**K.2.3 Type B primer.** When the film is hard dry, apply coating material to the plate by the method given in Appendix L, not less than 1 h after application of the primer.

**K.3 Hot-applied primers.** Hot-applied primers of type C are usually applied by dipping. After priming, apply coating material either to a hot or to a cold plate consistent with the production process under evaluation.

## Appendix L Application of coating material for the tests given in Appendix E to Appendix H

Break 2 kg to 7 kg of the coating material, according to the number of tests required, into pieces not greater than 50 mm size. Melt the pieces in a container of uniform cross section not less than 150 mm nor more than 300 mm in diameter, and fitted with a lid.

Heating may be by any convenient method such as a fluidized or liquid bath, electric hotplate or gas. If gas is used, interpose a steel plate of not less than 6 mm thickness between the container and the gas flame. Heat the container so that the coating material reaches the application temperature recommended by the manufacturer within 2 h.

Stir the material frequently until it reaches the application temperature recommended by the manufacturer, replacing the lid between intervals of stirring. Immediately it has reached the application temperature, pour the coating material over the primed surface of each plate, held in a horizontal position and at a temperature between 15 °C and 30 °C, in such a manner that fresh enamel constantly strikes the specimen surface.

Apply the coating material to a thickness of 1.5 mm to 2.5 mm to each test specimen.

**NOTE** It is convenient to adjust to this thickness immediately after coating by sweeping off the surplus hot enamel with a warmed blade moved along guide rails set for the required thickness.

## Appendix M Recommendations on the use of coating materials

**M.1 Type 1 materials.** Type 1 coating materials are most commonly applied by dipping processes, but may also be applied by flood coating. Grade C is suitable for the coating by hot dipping of articles which have not received a primer coat, but which have been heated before immersion in the dipping bath. Some hardening of this material occurs in the bath and on the coated article. Material of grade C quality is used both for charging and replenishing the bath.

**M.2 Type 2 materials.** Type 2 coating materials are commonly used on steel when heavy duty protection is required. They are applied externally by flood coating or other means and, when lining pipes, by centrifugal action.

**M.3 Type 3 materials.** Type 3 coating materials are also designed to provide heavy duty protection for iron and steel pipes. These materials are applied as mastics.

**M.4 General application.** For the protection of steel pipes, fittings and specials, reference should be made to BS 534. It is important that, when application methods other than dipping are used, the products being protected be first coated with the specified primer.

Agitation of type 2 and type 3 coating materials in the molten state is necessary to prevent settling of the filler.

When the coating materials are applied externally to steel pipes it is usual to incorporate one or more reinforcing layers of inert fabric.

All materials should be applied in compliance with the manufacturers' instructions. Care should be exercised to ensure there is no mixing of material from different sources or of different types unless experience has shown that the final product has satisfactory properties. In particular it should be recognized that the chemical and physical characteristics of coal-tar-based coatings differ from those of bitumen-based coatings and that the two kinds of coating should not be blended in protective coatings. It is also essential to clean out plant thoroughly when the use of bitumen coating materials follows that of coal-tar coating materials or vice versa.

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## Publications referred to

BS 410, *Specification for test sieves.*

BS 534, *Steel pipes, fittings and specials for water and sewage.*

BS 1796, *Method for test sieving.*

BS 2000, *Methods of test for petroleum and its products.*

BS 2000-47, *Solubility of bituminous binders.*

BS 2000-49, *Penetration of bituminous materials.*

BS 2000-58, *Softening point of bitumen (ring and ball).*

BS 2000-170, *Flash point by the Abel apparatus (non-statutory method).*

BS 3416, *Black bitumen coating solutions for cold application<sup>2)</sup>.*

BS 3900, *Methods of test for paints.*

BS 3900-A6, *Determination of flow cups.*

BS 4164, *Coal-tar based hot applied coating materials for protecting iron and steel including suitable primers where required<sup>2)</sup>.*

BS 4232, *Surface finish of blast-cleaned steel for painting.*

BS 4689, *Method for determination of flash and fire points of petroleum products and other liquids by the Cleveland open cup.*

CP 2010, *Pipelines<sup>2)</sup>.*

CP 2010-2, *Design and construction of steel pipelines in land.*

CP 2010-3, *Design and construction of iron pipelines in land.*

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<sup>2)</sup> Referred to in the foreword only

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