BS 6150:2019

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Painting of buildings — Code of practice

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Contents

Summary of pages

This document comprises a front cover, and inside front cover, pages i to iv, pages 1 to 138, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 March 2019. It was prepared by Technical Committee STI/28, *Paint systems for non-metallic substrates.* A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

BS 6150:2019 supersedes BS 6150:2006+A1:2014, which is withdrawn.

Information about this document

This is a full revision of the standard, and it has been restructured and prepared to reflect changes in legislation and coating material technology, and to provide a document that is more accessible and appropriate for the sector.

Attention is drawn to the Construction (Design and Management) Regulations 2015 [1] and the Construction (Design and Management) Regulations (Northern Ireland) 2016 [2] which set out the responsibilities of those involved in construction work, including clients, designers, contractors and workers (available from http://www.legislation.gov.uk/uksi/2015/51/contents/made[1]).

Product references indicated in the text by figures in parentheses, e.g. (B.1/2), refer to the products listed and described in the tables within the annexes.

Hazard warnings

WARNING. This British Standard calls for the use of substances and/or procedures that can 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.

Use of this document

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this British Standard is expected to be able to justify any course of action that deviates from its recommendations.

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Presentational conventions

The provisions in this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is "should".

The word "should" is used to express recommendations of this standard. The word "may" is used in the text to express permissibility, e.g. as an alternative to the primary recommendation of the clause. The word "can" is used to express possibility, e.g. a consequence of an action or an event.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

1 Last accessed 20 March 2019.

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. "organization" rather than "organisation").

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

Introduction

BS 6150, *Painting of buildings – Code of practice*, provides recommendations and guidance concerning paint application on buildings. All parts of a building to which paint and coatings are to be applied need to be designed to avoid, as far as possible, the creation of features or conditions that can cause difficulties in application, impair the performance of coatings, or promote decay or corrosion of structural materials.

Many modern building materials do not require painting. If, however, building materials are chosen which require painting for aesthetic or protective reasons, then design factors need to be considered by the architect at the earliest possible stage. Specifiers need to consider design aspects from the perspective of paint selection, maintenance and expected service life. Opportunities for design change after construction are very limited. For some new build components, e.g. window frames, initial painting is best carried out industrially prior to installation.

Correct selection of paint systems and clear, precise specifying of methods and processes are essential. However, this alone does not ensure that the chosen systems perform satisfactorily, and it is equally important that consideration is given to the factors described in Table 1, including substrate, location and exposure conditions. The influence of design and detailing, proper organization and supervision is of particular importance, and, in some circumstances, an effective inspection procedure. Exposure conditions are the consequence of construction and climatic factors (e.g. see BS EN 927-1:2013, Table 2). The guidance on typical life to maintenance is system specific and applies to mild and moderate exposure conditions. Service life is generally shorter under more severe conditions.

Hazards to health and safety that might be encountered in the painting of buildings and the precautions that need to be taken are described in Annex A. Reference is also made to applicable legislation. These aspects are to be considered in terms of a safe system of work. The health and safety of all persons involved in the building during the painting process, including client, occupier, painter, supervisory and inspection staff, need to be ensured. Annex B gives more information on paints and coatings. Annex C describes the effect of temperature and humidity on paint types and environmental exposure. Annex D gives information on fire. Annex E to Annex I give more information on particular substrates. Annex J provides information on anti-graffiti treatments.

1 Scope

This British Standard gives recommendations for good practice in preparation, initial painting and maintenance painting of buildings (e.g. dwellings, offices, light industrial buildings, schools, hospitals, hotels and public buildings generally) internally and externally, in which decoration is a significant and often the major factor. This British Standard takes into account the need to protect many building materials against weathering or other forms of attack normally encountered. Detailed information is given on wood, metal, masonry and other typical substrates found in buildings.

The paints and coating materials referred to in this British Standard are principally those in common use, with limited reference to specialist coating materials and factory-applied coatings. Some materials have been excluded because of their obsolescence, limited or specialized usage or, in the case of newly developed products, lack of experience of their performance in service.

This British Standard does not cover:

a) the protection of structural steel elements (see BS EN ISO 12944, and BS 5493 for iron structures), including hot spray application;

b) decorative processes and other work usually carried out by specialists, such as asbestos encapsulation, the maintenance of lead surfaces, resin flooring, polymer renders or waterproofing of flat roofs;

c) the particular requirements of listed or historic buildings which are protected by law;

d) limewash and distemper coating materials;

e) preservative treatments for structural timber;

f) reactive coating materials for passive fire protection and systems consisting of these materials (see BS 8202-1, BS EN 16623 and BS 476); and

g) general safety hazards of access for painting (see BS 8210).

The recommendations made in this British Standard are intended to facilitate achievement of standards of finish which, when inspected as described in Clause **10**, will be of a generally acceptable commercial standard for the intended types of buildings, providing that the work of other trades has been completed to a satisfactory standard. Where especially high standards of finish are necessary, more elaborate processes and systems than those described in this British Standard might be necessary.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes provisions of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 476 (all parts), *Fire tests on building materials and structures*

BS 1336, *Specification for knotting*

BS 5493, *Code of practice for protective coating of iron and steel structures against corrosion*

BS 7664, *Specification for undercoat and finishing paints*

BS 7956, *Specification for primers for woodwork*

BS 8221-1, *Code of practice for cleaning and surface repair of buildings — Part 1: Cleaning of natural stones, brick, terracotta and concrete*

BS EN 927 (all parts), *Paints and varnishes — Coating materials and coating systems for exterior wood*

BS EN 1504-10, *Products and systems for the protection and repair of concrete structures — Definitions, requirements, quality control and evaluation of conformity — Part 10: Site application of products and systems and quality control of the works*

BS EN 12811-1, *Temporary works equipment — Scaffolds — Part 1: Performance requirements and general design*

BS EN 13501-1, *Fire classification of construction products and building elements — Part 1: Classification using test data from reaction to fire tests*

BS EN 13914-1, *Design, preparation and application of external rendering and internal plastering — Part 1: External rendering*

BS EN ISO 4618:2014, *Paints and varnishes — Terms and definitions*

BS EN ISO 8501-3, BS 7079-A3, *Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 3: Preparation grades of welds, edges and other areas with surface imperfections*

BS EN ISO 14713 (all parts), *Zinc coatings — Guidelines and recommendations for the protection against corrosion of iron and steel in structures*

BS EN ISO 12944 (all parts), *Paints and varnishes — Corrosion protection of steel structures by protective paint systems*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in BS EN ISO 4618 and the following apply.

3.1 ancillary materials

additional materials other than paint and coating materials used in the painting of buildings

NOTE Ancillary materials include, for example, cleaning agents, sterilizing washes, knotting, stoppers and fillers, mastics and paint removers.

3.2 arris

sharp edge formed by the intersection of two surfaces

NOTE Used particularly in respect of edges in a moulding.

3.3 bring forward

prepare and prime to bring repaired or bare surfaces up to or near the visible appearance of adjacent completed paintwork

3.4 broad wall

large interior wall area, plaster or dry-lined

3.5 checking

form of cracking characterized by fine cracks distributed over the surface of a dry film or coat in a more or less regular pattern

[SOURCE: BS EN ISO 4618:2014, **2.42** – modified, Note 1 to entry removed]

3.6 coating

<noun> layer formed from a single or multiple application of a coating material to a substrate

[SOURCE: BS EN ISO 4618:2014, **2.50.1**]

3.7 coating

<verb> process of applying a coat

NOTE The use of the term "coating" for "coating material" is deprecated.

[SOURCE: BS EN ISO 4618:2014, **2.50.2**]

3.8 cut in

using a brush or small roller to paint areas that are not accessible by other application methods without encroaching onto an adjacent surface

3.9 damp-proof course

barrier through a structure designed to prevent moisture rising by capillary action

3.10 denib

remove fine particles/contaminants that have dried within or on the coating during the drying process by fine abrasion methods in between coats of paint

3.11 drip-moulding

detailing/projection for building components to divert rainwater away from a building

3.12 fat edge

formation of a ridge of accumulated paint often caused by over application

NOTE It can be the result of over application or overlapping areas that have already started to film form, or dry. See 5.7.2.3.

3.13 flashing

<building> strip of an impervious sheet of material which protects a joint, usually from the entry of rainwater

[SOURCE: BS ISO 6707-1:2017, **3.3.5.58**]

3.14 flashing

<paint> non-uniform appearance of a coating applied to walls or other surfaces, where there are noticeable variations in colour or levels of sheen

NOTE This is usually caused by excessive film builds when areas of overlapping occurs in brush or roller application and the wet edge has not been maintained. It may be described as a halo effect. Absorbent surfaces or painting in high humidity/warm conditions can be factors.

3.15 flow

extent to which a paint is able to level out after application

3.16 lay off

lightly apply final brush or roller strokes on any surface in one direction immediately after the paint has been applied to even out the surface

NOTE This helps to eliminate brush or roller marks.

3.17 mock-up

prepared example or required standard of specified works

3.18 patch-painting/patch-priming

part painting/priming particularly bare areas prior to applying mid or undercoats or areas prone to higher levels of wear or contamination

3.19 pattern staining

staining from convection currents carrying dust through poorly insulated areas

NOTE Primarily affects ceilings highlighting joists, seen in the form of stripes.

3.20 roller stipple/orange peel effect

textured appearance created during and after application by roller

NOTE It can also be created by spray application.

3.21 paint

pigmented coating material which, when applied to a substrate, forms an opaque dried film having protective, decorative or specific technical properties

NOTE Commonly used in the general sense, which includes all organic and inorganic coating materials such as enamels, varnish, emulsions, oil-based and water-based paint.

[SOURCE: BS EN ISO 4618:2014, **2.184** – modified, note added]

3.22 snag

areas of completed surfaces not up to the standard expected that need addressing before the project can be signed off

NOTE This term can also be used as a verb to describe the remedial work.

3.23 spray

3.23.1 air-assisted airless spray

modification of airless spray system with the addition of pressurized air at the sides of the spray tip to give greater control and a finer finish

3.23.2 airless spray

spray system that requires no air, using hydraulic pressure to atomize the paint as it is forced through the spray tip

NOTE This usually results in high opacity and film build.

3.23.3 high volume low pressure (HVLP) spray

more conventional spray system using low pot pressure [35 kPa to 70 kPa (5 psi to 10 psi)] combined with a high volume stream of air to atomize and propel the material onto the surface

NOTE Normally used when a fine finish or high transfer efficiency and low wastage and overspray is required.

3.24 mottle

decorative finish with particles of one colour appearing in a uniform background of another colour or shade

[SOURCE: BS EN ISO 19496-1:2017, **3.152**]

3.25 stippled finish

slightly uneven pebbly textured decorative finish due to application or incorporation of aggregates

[SOURCE: BS EN ISO 19496-1:2017, **3.239** – modified]

3.26 tack rag

piece of lint impregnated with a non-drying oil used to remove dust from a surface immediately prior to painting

3.27 thixotropic paint

paint with the property of changing reversibly from a gel or semi-liquid state when undisturbed to a more liquid consistency when brushing, stirring or rolling

3.28 throating

groove in an under-surface that prevents water from running across it

[SOURCE: BS ISO 6707-1:2017, **3.3.5.10** – term changed from 'throat' to 'throating']

3.29 undercoat

relatively highly pigmented matt or mid-sheen materials, applied to primed or previously painted surfaces before the application of finishing coats

3.30 vapour barrier

layer of material intended to restrict the transmission of water vapour

[SOURCE: BS ISO 6707-1:2017, **3.3.2.5**]

3.31 wet edge

undried progressing front of paint application that allows blending in of the next stroke

4 Defining the project

4.1 General

Whether the project relates to painting a new building or maintaining an existing building, the following parameters should be taken into account at the outset to ensure that the most appropriate paint system(s) and application process(es) are selected:

- nature and condition of the substrate;
- location of the surface (inside or outside);
- environmental exposure resistance requirements;
- function of the paint;
- conditions for application;
- paint availability and use;
- sustainability aspects;
- costs and future maintenance; and
- any special constraints.

Table 1 provides further detail on the questions that should be considered with respect to each parameter, what actions should be taken, and the specific subclause for supporting information.

Table 1 — *Parameters to consider at the design stage*

Issue	Question	Comment and action
Substrate	What substrates are involved?	Establish nature of the substrate.
	What is the condition of the substrate(s), especially the nature of previous paint layers, and whether the substrate will be coarse?	Inspect, refer to **5.10**.
	Which characteristics are key?	Confirm and detail, refer to Clause 9 for specific information on different substrate types.
	Are there any specific issues related to substrate preparation that need to be considered?	Establish preparation required, including use of any specialist equipment, and waste control.

Table 1 *(continued)*

Issue	Question	Comment and action
Location	Is the surface internal or external?	Identify location.
	Is the surface easily accessible, or is there a requirement for support equipment, e.g. scaffolding?	Identify any potential issues.
	Are there any other specific issues in the vicinity e.g. related to building layout?	Identify any potential issues.
Exposure conditions	What are the general atmospheric exposure conditions in the vicinity?	Research location, establish any key issues e.g. coastal environment with high salt content.
	What localized or intermittent conditions (e.g. fumes, condensation, heat, vulnerability to abrasion or wear) exist or are to be expected?	Refer to Table 3, Clause 7.
	Are there possible future developments or changes in usage, which might alter the local exposure conditions?	Design for potential changes that could be foreseen.
Function	What are the functional requirements of the paint (e.g. protection, decoration, hygiene or special function)?	Different paints fulfil different functions. Refer to Clause 8.
	Are there any relevant statutory requirements affecting selection?	Refer to relevant legislation (see also Annex A).
Application	What will be the climatic conditions during paint application e.g. cold/damp/humid, or hot/dry?	Paint flow, appearance and drying are susceptible to weather conditions. Refer to Clause 5 and Clause 7.
	What is the preferred method of application?	Refer to Clause 5.
	Is there a potential environmental impact if a certain application method is chosen?	
	Are there any restrictions on methods of application on site?	
	Is specialist equipment required (e.g. spray)?	
	Is application by specialist contractors required?	
Coating materials	Which coating systems are available?	Consult suppliers. Refer to Clause 8.
	Are the coating materials readily available from the usual sources or is special order or manufacture required?	Consult suppliers.
	Are the coating materials suitable for site or factory application?	Consult suppliers.
Sustainability	What are the project's objectives in terms of sustainability? Is the project falling under the remit of one of the 'green construction' schemes?	See 8.1.

Table 1 *(continued)*

Issue	Question	Comment and action
	Is there environmental footprint information available for the candidate paints?	Some environmental footprint information might be of interest, however there is no recognized international method at present to accurately compare the environmental impact of different paints. *NOTE There is a European Product Environment Footprint (PEF) project underway in 2018 to address this issue.*
	Has the durability and lifetime of the finished painted surface been taken into consideration, linking to future maintenance requirements?	More durable paints will require less maintenance and therefore generally have less impact on the environment.
Costs and maintenance	What is the likely first cost of the system, including preparation, materials and application?	Cost analysis of previous work of a similar nature is useful. Consult contractors and suppliers.
	What is the expected life of the system to first maintenance?	Experience of similar systems is useful.
	Does the system provide a satisfactory base for future maintenance, perhaps with different coating materials?	Refer to **8.2**.
Special constraints	Are there constraints relating to the composition of the coating materials in some situations (e.g. in food factories, hospitals)?	Consult client, industry association or supplier.
	Are any constraints imposed by the conditions under which the work has to be carried out (e.g. requiring the use of coating materials which dry very quickly due to access issues)?	Consult client, contractor or supplier. Refer to Clause 7.
	Are there constraints imposed on colour choice due to a high degree of sunlight exposure?	Refer to **9.2.2.3**.

Building materials to which coating materials are to be applied should be chosen for their inherent properties of durability and resistance to decay or corrosion in the exposure conditions in which they are to be used. Over-reliance should not be placed on the ability of coating materials to upgrade the performance of inherently unsuitable materials, especially in circumstances where frequent maintenance is likely to be impracticable or uneconomic.

NOTE Alternative or supplementary treatments, e.g. galvanizing or sprayed metallic coating materials are available, as are ancillary treatments such as wood preservatives, to enhance the protection afforded by coating materials.

Where possible, it is advantageous to undertake initial painting under controlled conditions, e.g. factory conditions. This is often more satisfactory than site application and can offer a wider choice of systems.

4.2 Common elements to painting activity

4.2.1 General

The following elements relating to the actual painting activity are common to both new build and maintenance projects, and should be considered at the initial design stage.

- Health and safety (Annex A)
- Knowledge of paints to be used (Annex B)
- Inspection (Clause **10**)
- Materials, sampling and testing (**5.10**, Clause **8**)
- Workforce and supervision
- Supply and storage of materials
- Scaffolding and equipment
- Order of working

4.2.2 Workforce and supervision

The number of operatives employed should be appropriate to the size of the contract, its planned duration and the nature and availability of the work involved. Preparation is generally more labour intensive than application, and the size and deployment of the workforce should allow for this. Operatives should be skilled and experienced in the types of work involved and with the materials, methods and equipment to be used.

NOTE With novel materials, methods or equipment, special training might be necessary, especially with regard to the safe use of mechanical equipment and employment of personal protective equipment (PPE).

On extensive ceiling and wall areas, there should be a sufficient number of operatives to ensure working wet edges are maintained (see **5.7.2.3**), and working conditions and the characteristics of the coating materials to be applied should be taken into account.

Adequate supervision should be provided, having regard to the nature of the work and the size and deployment of the workforce. Supervisors should be experienced in all aspects of the work for which they are responsible. They should be provided with copies of all working documents (e.g. specifications, painting schedules and product information) necessary for effective supervision and control of the work. They should also be provided with risk assessments and method statements as required and have ready access to test equipment, e.g. moisture meters, film-thickness gauges and flow cups, when the nature of the work requires it.

4.2.3 Supply and storage of materials

NOTE 1 Most conventional decorative materials are available on demand or at short notice from the manufacturer or distributor, but this might not apply to all quantities, colours and container sizes, or to specialist materials. Placing of orders for materials is normally the responsibility of the contractor – the prompt issuing of painting schedules by specifiers reduces the risk of delay in supply that could hold up work.

Consideration should be given at the tender or pre-project stage to the quantities of paint and coating materials needed; having a robust estimating process can eliminate future paint waste (see **5.11**).

On large projects, appropriate facilities should be provided for the storage of materials, having regard to security, avoidance of hazards and protecting the materials from the weather, in accordance with the manufacturers' instructions. In general, to maintain coating materials in good condition and to prevent rusting of containers and deterioration of dry materials, such as powder fillers, materials should be stored in dry conditions, preferably within a temperature range of 5 °C to 30 °C.

Water-borne paints should be protected from frost. Solvent-borne paints are flammable in the liquid state; precautions to prevent accidental ignition should be taken and emergency fire-fighting equipment should be made available. See BS 8000-0 for more information on storage of materials. Attention should be paid to the storage of paints containing volatile solvents, as temperatures exceeding 30 °C can create excessive pressure within containers and increases the risk of auto-ignition and fire.

Containers of highly flammable liquids (flash points below 32 °C), which include certain solvents and specialist paints, usually carry a warning label but, in case of doubt, the manufacturer should be consulted for recommendations regarding safe storage.

NOTE 2 Attention is drawn to statutory requirements regarding the storage of highly flammable liquids (see also Annex A). Further guidance on fire safety is given in the HSE publication HSG168 Fire safety in construction [3].

Extended contracts, when successive batches are delivered at intervals, dates of receipt and batch numbers should be recorded and storage organized so that the materials can be issued in the same order as they were received. Containers should be marked with the date of receipt.

4.2.4 Scaffolding and equipment

The use of scaffolding should be designed to ensure secure and adequate coverage of the building, in quantity and type, to permit safe working and avoid delays. Hazards can be created by the use of unsuitable or defective scaffolding; the guidance given in BS EN 12811-1 should be followed with respect to temporary work equipment.

NOTE Attention is drawn to the Construction (Design and Management) Regulations 2015 [1] and the Construction (Design and Management) Regulations (Northern Ireland) 2016 [2] for information on the condition, erection and use of scaffolding.

Equipment should be suitable for the type of work being undertaken and should be in good condition and working correctly. Mechanical equipment, e.g. for spraying or dust removal (vacuums), should be of a capacity and rating appropriate to the work and should operate efficiently.

Allowance should be made for the provision of temporary heating or drying equipment where necessary. The use of other equipment, including paint test equipment (e.g. to determine whether lead is present) should be considered at the design stage, and the appropriate expertise consulted before purchase, rental or use.

4.2.5 Order of working

Work should be carried out from exterior surfaces to interior, from upper parts to lower.

When buildings are painted internally and externally, the exterior work should be completed first, especially when it is necessary to use rooms and windows to gain access to the exterior surfaces or when painting is carried out from assembled scaffolding.

NOTE Often, the determining factor for the order of working is the weather and/or the time of year.

Work should be carried out from the upper parts of a building or structure downwards. Application of paint following preparation should be carried out in the same order, but circumstances might require an alternative approach. If so, care should be taken to ensure that finished work is not spoiled by dust and debris arising from subsequent preparatory work.

4.3 New build projects

4.3.1 General

The following additional elements to 4.2 should be considered during the design stage of the project and/or the painting of newly constructed buildings:

a) organization of work;

b) components prepared off-site;

c) protection of components;

d) accessibility;

e) moisture control; and

f) profiles.

Future maintenance requirements for a painted surface should be taken into consideration at the design stage of new buildings. The function of a building or the type of occupancy should be established in order to determine the rate of deterioration of coatings, the type of systems used and the frequency of maintenance.

The initial treatment of new substrates should be considered in relation to subsequent maintenance requirements. The aim should be to use systems which provide a sound base for further coats with the minimum of preparation.

NOTE Initial preparatory treatment is especially important as it can affect the performance of coating systems throughout the life of the building. Some effective preparatory treatments, e.g. abrasive blasting of steelwork or preservative treatment of timber, can be difficult or impossible to carry out as maintenance operations.

4.3.2 Organization of work

Where applicable, painting work should be planned in relation to the work of other trades, to ensure that surfaces are in a fit condition to be painted and that completed work is not damaged by subsequent building operations; for example, time should be allowed for plaster and similar surfaces to dry out before they are painted.

In factories and commercial buildings, it might be necessary for work to proceed without interrupting the normal functions of the building; this should be planned carefully to avoid inconvenience to the occupants and minimize loss of productive time by the contractor.

NOTE In such circumstances, it might be necessary to erect temporary partitioning to isolate the areas where painting is in progress.

4.3.3 Building components prepared off-site

Many components, such as primed and finished joinery, blast-cleaned and primed steelwork, pre-treated non-ferrous metal components and primed or sealed building boards, are now factory coated off-site. Where components are supplied partially painted, e.g. primed, the treatment or coating material should have properties appropriate to the exposure conditions or conditions of service. The primer (or other treatment) and coating materials to be applied should be compatible.

Measures should be taken to prevent damage to primed and finished components during transit, as it might not be possible to effect repairs to a standard equal to that of the original. The painting specification for the site work should detail responsibility for repairing any damage. The manufacturer's or supplier's recommendations for repairing damage caused in transit or during installation and for subsequent maintenance treatment should be followed.

4.3.4 Protection of components

Measures should be taken to prevent damage or deterioration of components and factory-applied treatments on site, i.e. during off-loading, handling, storage and erection. If mechanical lifting equipment is used to handle large or heavy components, slings should be well padded at contact points. Wrapping or other means of protection provided by the manufacturer should not be removed before it is essential to do so. Factory-coated articles and components should be stored away from areas subject to pedestrian or vehicle traffic and should be protected against damage and soiling.

Where possible, joinery should not be kept in external storage, especially when it is to be installed in a centrally heated building. Wooden components, whether stored indoors or outdoors, should not be in direct contact with the ground. Metal components (prepared and painted with part or the whole of the coating system before delivery to site) should, size permitting, be stored indoors. If there is a delay between delivery to site and fixing or erecting of joinery, it should be protected against ingress of moisture. Primed joinery, if not fixed or erected immediately, should be properly stored.

If external storage cannot be avoided, the components should be protected against moisture (including rainwater puddles) and other adverse climatic conditions. If stacking is necessary, spacers should be placed between the components to permit air circulation and, in the case of primed surfaces, to prevent sticking. The bottom layer in the stack should be laid on timber packings to raise it above the ground and the rainwater splash zone.

Consideration should be given to applying additional coats, e.g. of primer, when there is a possibility of long delay between initial and final painting after erection.

4.3.5 Accessibility

Spaces between adjacent wood or metal members, e.g. in roof trusses, should be sufficiently wide to allow access for painting. Alternatively, hidden or contact surfaces should receive protective treatment before assembly or erection. Pipes and similar components should be fixed sufficiently clear of walls to allow them to be painted completely.

Access for exterior repainting and maintenance should be considered at the design stage. Where necessary, scaffolding should be provided in accordance with BS EN 12811-1.

NOTE The need for scaffolding for initial or maintenance painting will add considerably to the costs.

4.3.6 Moisture control

NOTE 1 Penetration of moisture is a common cause of the premature failure of coatings; it can also lead to biological decay or corrosion of structural materials.

Attention should be paid to the design and location of damp-proof courses and membranes, vapour barriers, flashings, weatherings, drip-mouldings and throatings. Measures should be taken to prevent the retention of water on horizontal surfaces, e.g. by bevelling or sloping the surfaces or, in the case of structural metalwork, by providing drainage holes. Rainwater run-off or dripping on to coated surfaces should be prevented by appropriate detailing.

NOTE 2 Condensation is likely to occur in most buildings both externally and internally. External condensation (i.e. dew) can, in combination with rainfall, contribute to the overall time of wetness with detrimental effects on durability. Internally persistent condensation can cause failure of coatings both physically and through biological attack, e.g. surface moulds.

Measures to prevent or minimize condensation should be incorporated at the design stage but choice of coating material can also make a contribution (see 7.3).

4.3.7 Profiles

NOTE 1 Coating materials have a tendency to recede from sharp edges during application and this can result in the film having inadequate thickness at these points.

Timber arrises should be slightly rounded, a radius of 1 mm to 2 mm for timber other than sills and thresholds is usually sufficient; sills and thresholds might need a 3 mm rounding.

Sharp edges of metal, e.g. burrs and nibs, should be removed before painting, and steel edges should be rounded to 2 mm in accordance with BS EN ISO 8501-3, BS 7079-A3.

NOTE 2 There is no benefit to rounding steel edges to 3 mm.

4.4 Maintenance projects

4.4.1 General

The following additional elements to 4.2 should be considered during the design stage of the project for maintaining existing buildings:

a) organization of work;

b) timing and frequency;

c) heavy soiling and patch-painting; and

d) structural features.

The general aim of the maintenance of coating systems should be to restore the painted surface to a satisfactory condition, preferably to its original standard, to enable it to continue to meet its function. A planned approach should be adopted in order to achieve this.

The function of a building or the type of occupancy should be established in order to determine the rate of deterioration of coatings, the type of systems used and the frequency of maintenance. Building function and occupancy is likely to change and consideration should be given to the effect on maintenance requirement since the last or initial treatment.

The recommendations given in BS EN ISO 12944 (all parts) and BS 5493 should be followed for the maintenance painting of steel and iron structures respectively, and those in BS EN 1504-10 should be followed for concrete structures. The recommendations given in BS EN 927 (all parts) should be followed for the maintenance painting of wood.

4.4.2 Organization of maintenance work

Reference should be made to 4.3.2 for general guidance on organization of work. The following factors should also be taken into account for maintenance projects:

a) Restricted access, e.g. a requirement that the work be done only at night or weekends. This might impose constraints on the nature or standard of preparatory work or the types of coating materials that can be used. It is also likely to increase costs.

b) It might be necessary to isolate the working area, e.g. by the erection of temporary screens or partitions, to limit interference with the normal functions of the building. Similar precautions might be required to create a satisfactory working environment, e.g. to exclude process fumes or dust from the working area during application of coating materials.

c) In some circumstances, e.g. in food factories, precautions might have to be taken to prevent contamination of products by solvent vapours or other constituents of coating materials. Isolation of the working area, as in b), might be sufficient, but there might also be constraints on the types of coating materials that can be used. Specific requirements should be established and the measures to be taken agreed between the client and contractor.

Specifications should refer to a) to c) and any other special requirements or conditions which might affect the organization of maintenance work.

4.4.3 Timing and frequency

In principle, maintenance should be carried out while the existing coating is in sound condition, when all that is necessary is little more than cleaning down and the application of the minimum number of coats needed to restore the original finish.

Maintenance should be planned and a maintenance schedule should be established for areas with regular treatment at intervals best suited to local conditions and specifications. The maintenance schedule should include provision for regular inspection and recording of the condition of coating systems so that their performance can be monitored and evaluated.

NOTE This allows future maintenance requirements to be assessed and adjustments to be made to the maintenance schedule where necessary.

4.4.4 Heavy soiling and patch-painting

Painted surfaces subjected to heavy soiling and/or pollution from road traffic or other emission sources should be cleaned regularly and might require more frequent painting. The choice of colour for such surfaces should be carefully considered in light of this heavy soiling.

NOTE 1 In practice, the condition after a given period of exposure is unlikely to be uniform over all parts of a building. Typically, some parts will still be in good condition when others require treatment; overall treatment at this stage might well be uneconomic. On the other hand, if deterioration is allowed to proceed too far, it is likely that extensive preparation and possibly complete renewal of the system over large areas will be necessary. The additional cost of the work might then exceed any apparent saving made by delaying maintenance. Hidden costs might also be incurred as a result of deterioration of structural materials, loss of production or revenue decline in amenity value and other factors.

Where there are marked differences in the condition of paintwork on different parts of a building, patch-painting should be considered for areas that are easily accessible.

NOTE 2 Patch-painting, as a form of interim treatment, is generally more applicable to situations where protection is the major factor, e.g. on steel structures, and might not be acceptable where appearance is important. If a significant amount of scaffolding is needed, thereby making the cost of access a high proportion of the overall treatment cost, it might be more economical to repaint the whole structure.

4.4.5 Structural features

Where it is evident that structural or design features have contributed to the deterioration of coatings, they should be modified if practicable and economically justifiable.

NOTE Such modifications may include the following:

a) improving drainage or run-off to avoid retention of water on horizontal surfaces;

b) preventing discharge of steam, water or industrial fumes on to coated surfaces;

c) measures to prevent or reduce condensation on internal surfaces;

d) sealing gaps, e.g. between wood frames and adjacent masonry;

e) providing drip mouldings or canopies over external doors and windows if they are exposed to rainwater run-off;

f) providing guard rails to prevent damage to painted walls in heavy traffic areas, e.g. corridors in factories and hospitals; and

g) enclosing plant and equipment to prevent splashing or spillage.

Where painted surfaces are subject to very heavy wear or other forms of attack, alternative materials should be considered, e.g. ceramic tiles.

4.5 Information exchange and record keeping

4.5.1 General

A painting project can involve several parties, including the client, main contractor and subcontractors, suppliers and inspectors; copies of all relevant documents should be available to all parties, including site personnel responsible for supervision.

Where relevant, there should be an exchange of information at an early stage between the painting contractor or subcontractor and those responsible for the constructional work, including other trades whose work might affect or be affected by painting. This should be in the form of a specification along with other documents, both for new build and for maintenance painting. These documents should be prepared in sufficient detail to provide an adequate basis for the preparation of estimates from contractors for the execution of the work.

Records should be kept of the details, including costs, of all maintenance treatments carried out. Where experience or records are lacking, as they can be with newer buildings, maintenance inspections should be carried out at relatively short intervals in the early stages.

4.5.2 Specification

4.5.2.1 General

The specification should be clear, concise and unambiguous.

NOTE The prime functions of a specification for initial or maintenance painting are:

a) to describe the substrates to be treated and the means by which the required finish is to be achieved, including surface preparation, materials, systems, application methods (where relevant) and the conditions under which the work is to be done;

b) to provide a basis for accurate pricing and tendering;

c) to serve as a comprehensive reference document for all parties; and

d) to act as a reference if disputes arise or arbitration is necessary.

4.5.2.2 Surface preparation

For initial and factory painting, many substrates benefit from specific surface treatments and preparation, which should be discussed with the coating material manufacturer.

The nature and extent of preparatory work should be specified as clearly as possible because of its influence on costs, appearance and subsequent performance. Imprecise terms such as "thoroughly prepare" or "burn off where necessary", without further qualification, should be avoided. In circumstances where it is difficult to describe the standard of preparation to be achieved, for tendering purposes, a sample area should be prepared as an indication of the standard required.

Where a particular method of preparation is specified, it should be appropriate and relevant to the result required. For example, if a requirement to "remove all rust and scale by chipping, scraping and wire-brushing" cannot be achieved, the choice lies between selecting a more effective method or accepting a lower standard of preparation which leads to a shorter life expectancy for the coating system.

4.5.2.3 Coating system materials

All the materials in a coating system should, if possible, be obtained from the same manufacturer. Where differing makes or brands are specified, they should be compatible.

Materials should be used strictly in accordance with the manufacturer's instructions, including guidance on whether thinning is permissible.

For work of modest size or where relatively few finishes or colours are to be used, information identifying different coating systems with particular areas should be incorporated in the specification. Where necessary, the use of special undercoats or additional finishing coats should be covered.

When there is doubt about the extent to which coatings should be removed, the specification should include a contingency allowance for the removal of coatings from a stated percentage of the areas affected and for the subsequent measurement of the area of the coatings actually removed.

4.5.2.4 Application

The specification should clearly state if circumstances require or preclude the use of particular methods of application and should indicate any requirements or constraints in respect of the conditions under which work is to be carried out or, if necessary, suspended, e.g. temperature, humidity, climatic conditions or other factors.

4.5.2.5 Inspection procedure

Where the work is to be subject to inspection, the intended inspection procedure should be described in the specification in accordance with Clause **10**.

4.5.3 Bill of quantities

The bill of quantities should be prepared in accordance with a document such as *NRM2: Detailed measurement for building works* [4]. The relevant edition, or any other method of measurement adopted, should be stated.

4.5.4 Schedules

NOTE For large or more complex projects, the preparation of a painting schedule detailing location, nature of substrate, coating system and (where relevant) colour, is recommended.

A painting schedule should not be regarded as a substitute for the painting specification; site personnel responsible for supervision should have copies of both documents.

4.5.5 Drawings

Drawings should be used for large projects either for tendering purposes or as an aid to the organization and control of work.

4.5.6 Record keeping

NOTE 1 Painting and decorating work is usually carried out at regular intervals as part of an overall maintenance schedule and therefore a planned approach is essential.

Planning is dependent on the availability of information, and therefore, where expenditure on maintenance painting is significant, accurate records should be maintained. The essential information that should be recorded includes dimensions, details of initial and maintenance coating systems (including preparation) and costs.

NOTE 2 Other relevant information might include the conditions (e.g. weather, atmosphere or exposure conditions), methods of application employed, size of labour force and any special difficulties or problems encountered.

When work is subject to independent inspection during application, the inspection reports should be retained as a permanent record. Similarly, where a system of regular inspection of paintwork is in operation, any observations should be recorded.

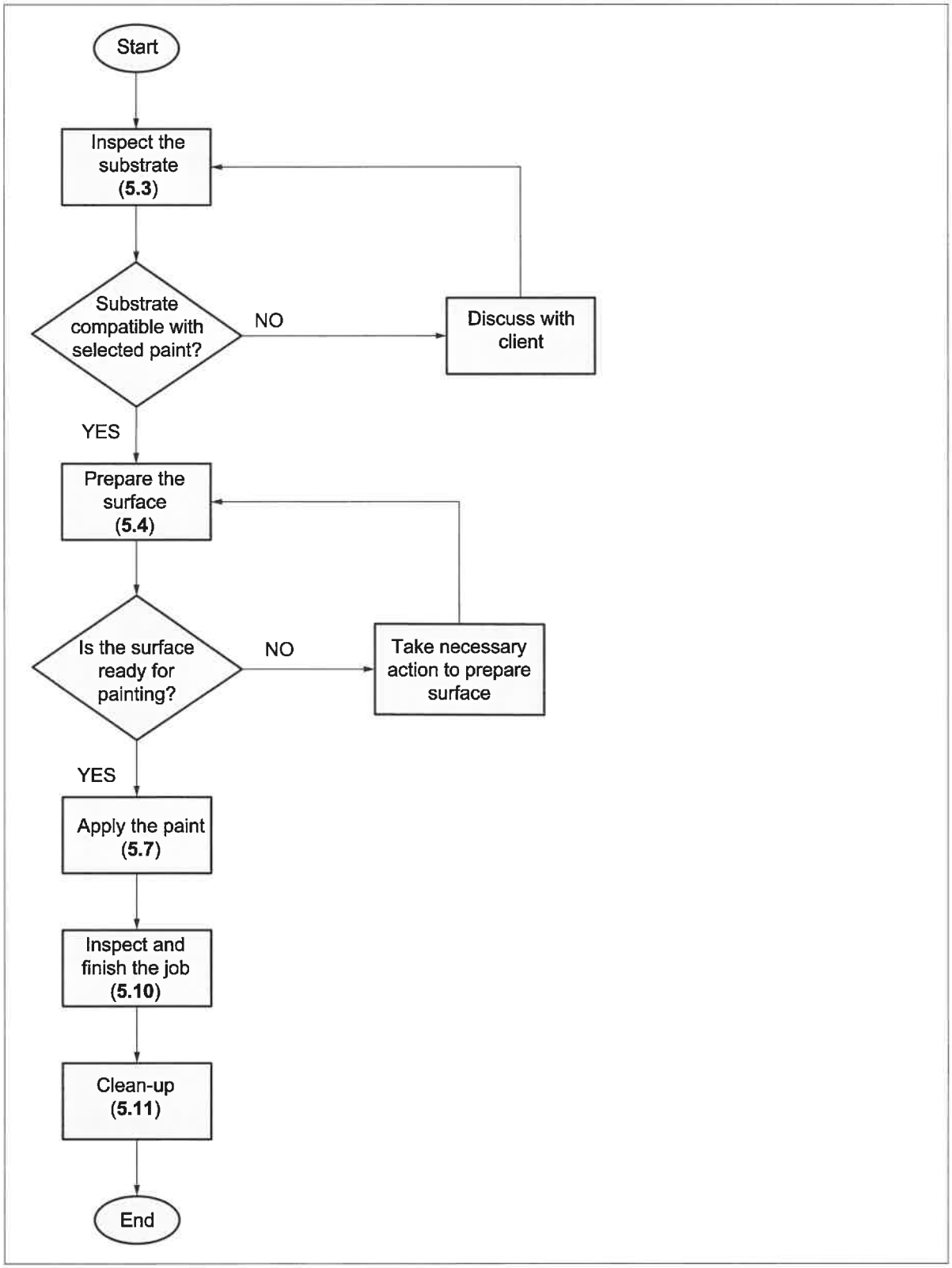
NOTE 3 Apart from its contribution to ease and economy of maintenance, a system of recording can assist in the investigation of failures and the settlement of disputes.

5 Paint application

5.1 General

The procedure in Figure 1 should be followed when painting is to be undertaken.

Figure 1 — *Procedure for painting buildings for new build and maintenance projects*



Material selection should be made with the following in mind:

a) nature of the substrate;

b) condition of the substrate;

c) location of the surface (inside or outside);

d) environmental exposure resistance requirements;

e) function of the paint;

f) conditions for application;

g) sustainability aspects; and

h) future maintenance of the surface.

5.2 Health and safety

Health and safety practices should be in accordance with Annex A.

5.3 Inspecting the surface

The surface should be inspected in accordance with Clause 6.

5.4 Preparing the surface

The surface should be prepared in accordance with 9.1.

5.5 Application conditions

5.5.1 General

NOTE The application and performance of coating materials are affected by the conditions under which they are applied, e.g. temperature, humidity and general exposure conditions.

Paint application should not be started unless conditions are suitable. In particular, seasonal factors should be taken into consideration e.g. rain, overnight frost or condensation.

5.5.2 Lighting

Good lighting is essential to efficient working; where natural daylight is lacking, an adequate level and type of artificial lighting should be provided before work begins and during inspection. The lighting whilst painting should simulate, as far as practicable, the final lighting scheme in intensity and direction of lighting. These lighting conditions should also be used for final inspection (see Clause 10).

NOTE Information concerning suitable illumination for differing purposes is given in the CIBSE Code for Lighting [5].

5.5.3 Temperature and humidity

NOTE 1 Temperature and humidity affect the performance of coating materials.

The manufacturer's recommendations in respect of temperature and humidity should be followed at all times; specifically, paint application should not be started or should stop if the ambient temperature is below that recommended or the relative humidity is above that recommended.

In addition to the ambient temperature, the temperature of the surface to be painted should be taken into account. The temperature of heavy metal sections or plates, as well as plaster, rendering and masonry, for example, can be several degrees lower than the ambient temperature, especially early in the day.

NOTE 2 See Annex C for information on the impact of temperature and humidity on different paint types.

In assessing conditions of application, account should be taken of changes in temperature and relative humidity that are likely to occur within a few hours of application, and especially the effects of overnight frost or high humidity on recently applied coatings.

For some speciality coating materials, such as two-pack epoxy and polyurethane, the manufacturer's recommendations in respect of temperature and its relation to curing time and pot life should be observed.

5.5.4 Surface moisture

NOTE 1 Adhesion, drying and other properties are likely to be adversely affected if paint and coating materials are applied to wet surfaces.

Application should not proceed if, as a result of adverse weather, high humidity or other cause, there is a visible film of moisture on the surface.

When conditions improve, wet surfaces should be dried off, and time should then be allowed for contained or trapped moisture to evaporate; moisture testing might be necessary.

NOTE 2 Condensation is often a problem in unheated buildings during the winter months. In some circumstances, e.g. when painting metal surfaces, it might be necessary to delay application when the temperature of the surface is below the dew point of the air because of the risk of condensation, even though condensation has not yet occurred.

NOTE 3 See Clause 9 on absorbency and moisture for specific substrates.

The choice of paint systems for substrates employing wet materials of construction should be determined by the moisture content at the time of painting. Resistant coating materials should not be applied to surfaces which are not dry.

5.5.5 Air movement and wind

Painting should be avoided under windy conditions unless precautions are taken, because the wind can carry dust and grit onto wet paint and mar its appearance.

Adequate movement of air assists drying and prevents build-up of vapours; painting should therefore generally be done under well-ventilated conditions.

5.6 Preparing the paint

5.6.1 Stirring

Unless the manufacturer's instructions state otherwise, painting materials should be stirred before use and at intervals during use.

NOTE 1 The solid constituents in liquid paints can settle during storage and their re-incorporation is essential to avoid defects such as poor opacity and retarded drying. Manual stirring is the method generally used for small quantities.

A clean broad-faced stirrer, long enough to reach the bottom of the container, should be used, and stirring should continue until no settlement remains.

NOTE 2 Mechanical equipment for stirring or shaking paint is available, and its use is advantageous when large quantities are involved.

There are some speciality coating materials that should not normally be stirred before use. These are indicated on the product label and the technical data sheet. For example, thixotropic coating materials should not normally be stirred before use as stirring or shaking temporarily impairs the thixotropic properties, and two-pack clear coating materials should be stirred slowly to avoid aeration. The manufacturer's instructions in this respect should be followed.

5.6.2 Thinning

NOTE Paints and coating materials for buildings are generally supplied ready to use. Thinning of primers might be necessary to improve penetration or facilitate application, e.g. on surfaces of high or variable porosity. Thinning might also be necessary for spray application of coating materials.

If thinning is necessary, it should be carried out with the types of thinners and in the proportions recommended by the manufacturer.

5.6.3 Two-pack materials

Two-pack materials are supplied as two components, e.g. base and activator, hardener or curing agent; these should be combined before use in a clean suitable container. The base and activator can be held in separate containers or in a dual-pack container; in either case, the components are present in the correct proportions in relation to the total quantity of material supplied. If a smaller quantity than a standard pack size is required, it should be measured to ensure that the correct proportion of each component is used. Care should be taken to ensure both components are thoroughly mixed.

The manufacturer's instructions in relation to induction period (standing time) and pot life (i.e. length of time during which the material is usable) should be observed.

NOTE Some two-pack materials require an induction period after mixing and before they are ready to use. Most have a limited pot life, and this is temperature-dependent.

5.6.4 Intermixing

Batch to batch colour variations might occur and therefore paint from different containers which is to be used on the same wall should be intermixed unless there is confidence that the different containers contain paint from the same ready-mixed batch. If there is doubt over correctly identifying the batch number, the manufacturer should be contacted and batches should be intermixed.

Different brands or types of paints should not be intermixed.

5.7 Application methods

5.7.1 General

The principal methods of applying paint and coating materials to buildings are by brush, roller and spray. The choice of method should be determined by the nature of the work or the type of material to be applied. The manufacturer's recommendations regarding the suitability of paint and coating materials for application by particular methods should be followed.

Whichever method is employed, operatives should be skilled and experienced in the techniques of application, as well as in the care and maintenance of tools and equipment, use of PPE related to the method and, where relevant, in the setting up and adjustment of equipment to obtain optimum results.

5.7.2 Brush application

5.7.2.1 Characteristics

NOTE 1 Most paints and coating materials may be applied by brush. Brushes are particularly suitable for applying paint to small areas or where there is much cutting-in or frequent changes of colour.

A brush should be used to coat internal angles and corners, e.g. between ceilings and walls. Brush application should also generally be used for the application of conventional types of primers to building surfaces, on the principle that the shearing action of brushing forces the paint into intimate contact with the surface, increasing the adhesion properties of the paint, although suitable types of rollers can be equally effective in this respect.

Unless recommended by the manufacturer, multi-colour finishes should not be applied by brush and should be sprayed.

NOTE 2 Brush application to large, unbroken areas is slower than roller or spray application and it is more difficult to obtain a uniform coating, especially with quick-drying paint.

5.7.2.2 Types of brushes

Brushes should be of good quality and robust construction. Synthetic filament brushes are suitable for all paints and varnishes. Bristle-based brushes are available but should not be used for water-borne trim.

NOTE Synthetic filament brushes do not absorb water to the same extent as natural bristle brushes, and therefore deliver a smooth, consistent application, improve the flow and wet-edge time of the coating material and reduce brush marks. Synthetic filament brushes are generally easier to clean.

In selecting appropriate sizes of brushes, the general principle should be to use the largest sizes consistent with application of a uniform coating without undue effort and appropriate to the surface.

5.7.2.3 Basic techniques

In general terms, the basic technique of brush application involves three phases. First, the material should be applied in a reasonably full coat and evenly spread, working most of it out of the brush and recharging as necessary. Then, without reloading the brush, it should be drawn in one direction (crossed) and then at right angles to this in order to distribute the coating evenly and uniformly. Finally, the coating should be laid off, i.e. the brush is drawn lightly in the direction of the greatest length of the work, in order to eliminate brush marks as far as possible.

Many undercoats and most finishes have good flow properties and for final laying off, lighter pressure should be used. Repeated crossing and laying off is not usually practicable with quick-drying paints which should be applied as quickly as possible with the minimum of brushwork; roller or spray application of this type of paint is usually preferred, especially for large areas. When applying matt and mid-sheen paint to ceilings and walls, the material should be applied and laid off using criss-cross strokes (switching) rather than in one direction.

Over-heavy application of paint should be avoided as this can cause runs and sags, particularly with free-flowing materials such as gloss finishes and varnishes. With some types of paint, a surface skin can form which retards thorough drying. The opposite extreme of brushing out too far should also be avoided as this produces excessively thin films with poor appearance or lacking in protective properties.

Heavy accumulations of paint (fat edges) along edges and arrises should be avoided by brushing towards the edge or arris rather than in the reverse direction.

Application, especially to large areas, should be organized so that wet edges are maintained, i.e. each section of the work is joined up to the preceding section before its edge has set, thus preventing unsightly finish. On large areas, the number of painters deployed should be sufficient to permit wet edges to be picked up with minimum delay. Where scaffolding is necessary, its arrangement should facilitate quick transfer from one section of the work to the next.

5.7.3 Roller application

5.7.3.1 Characteristics

NOTE 1 Most paints and coating materials may be applied by roller. This method is quicker than brushing on large, unbroken areas, such as ceilings, walls, flush doors, floors and plate work but is not recommended for small areas or where much cutting-in is required.

Rollers with appropriate sleeves should be used for the application of paint to rough or uneven surfaces, such as rough-cast external walls; for this purpose, they are usually quicker and more effective than brushes.

NOTE 2 A degree of stipple or surface texture is a characteristic of paint applied by roller but, if the appropriate type of sleeve is used, this can hardly be discernible.

Under critical lighting conditions, spray application should be considered in preference to roller application to avoid visible differences arising from variations in roller stipple due to the direction of travel of the roller. This can appear as roller marking however it is a characteristic of this type of application method, in combination with lighting conditions.

5.7.3.2 Types of rollers

Rollers should be of good quality and robust construction. Preferably, they should have interchangeable roller sleeves which can be selected depending on the surface or paint.

NOTE 1 Materials for roller sleeves include various natural and synthetic fabrics and fibres. Sleeves employing synthetic fibres are widely used; they are generally described in relation to the length of the fibres, i.e. as short, medium, or long pile types.

Short and medium pile types should generally be used for application to smooth surfaces when it is necessary to avoid excessive stippling of the coating. Long pile types should be used for application to brickwork, rough-cast and similar surfaces or when it is necessary to impart a texture to the coating. The roller or paint manufacturer's recommendations regarding the most suitable types of roller sleeve should be followed.

NOTE 2 For general use, rollers about 200 mm wide are suitable, but larger and smaller sizes can be obtained. Special rollers are available for paint application to corrugated sheeting, pipes and curved surfaces. Many rollers, including the special types, can be mounted on an extension pole to extend the painter's reach.

Rollers should be charged by dipping the head of the roller into the material and then rolling it over a corrugated or coarse mesh surface to distribute the material evenly around the sleeve. Roller trays and paint roller buckets are available, which are designed for this purpose.

NOTE 3 Rollers are also available in which material is supplied from a separate container under pressure, known as pressure rollers. See the manufacturer's instructions for use.

5.7.3.3 Basic techniques

Although it is generally easier to obtain a film of uniform thickness by roller than by brush, the weight of the paint applied and the nature of the surface should be taken into consideration. In particular, excessive rolling-out with a dry roller should be avoided. As with brush application, work should proceed systematically in sections, and the same attention should be paid to the maintenance of wet edges (see 5.7.2.3) although, in this respect, the greater speed of roller application is an advantage.

Brushes should be used for cutting-in and for internal angles and this should be done just before rolling, with the roller then being promptly taken as close to the angle as possible.

When it is required to eliminate the slight stipple that can be produced with roller application, as might be the case with undercoats for gloss finishes, a brush should be used for laying off immediately after rolling.

5.7.4 Spray application

5.7.4.1 General

WARNING Use of spray equipment creates a fine mist that is hazardous to health. See Annex A for appropriate precautions to be taken.

Because of the very high pressures involved, caution should be exercised in the handling of spray equipment; in particular, the spray gun should never be pointed towards any part of the body while the equipment is in operation. The correct PPE should be used. Due to the hazards involved, spray equipment should be used by trained personnel only.

NOTE 1 There are several types of spray equipment, differing in method of operation and in the paints and coating materials and types of work for which they are suitable. In general, however, it can be assumed that there is spray equipment available for the application of virtually every type of paint likely to be used for buildings and structures.

The spray equipment manufacturer's guidance should be followed with regard to setting up the spray equipment. Many paints require thinning for use with different types of spray equipment and guidance should be sought from the paint manufacturer in relation to this.

NOTE 2 Spraying can be used on large, unbroken areas where the nature of the work permits continuous working for lengthy periods, enabling a speed of application which is faster than brushing or rolling.

Spraying should not be used on small-scale work unless the paint is of a type for which spray application is essential or preferred; brush or roller application can be more economic and have better transfer efficiency.

Spray application should be used for most multi-colour finishes and is preferred for paints and coating materials based on solution binders, especially for application to large areas. Zinc-rich epoxy primers may be applied by spray or brush. The manufacturer's recommendations regarding the preferred method of application should be followed.

The following possible limitations to spray application should be taken into account.

a) Possible hazards to health or safety (see Annex A). Ideally spray equipment should not be used in occupied buildings in circumstances where spray mist would create a nuisance.

b) The need for extensive masking or protection of surfaces that are not to be coated, although this is influenced by the type of equipment used.

c) Spray application on exterior work in windy weather can cause difficulties as spray mist can be carried considerable distances and can cause damage or nuisance. As in relation to b), the type of equipment used is a relevant factor.

d) Generally, conventional primers for masonry and wood building surfaces should not be applied by spray. Exceptions to this include zinc-rich epoxy primers for metal surfaces and some specialist types which might be unsuitable for brush or roller application.

e) Legislation requires volatile organic compound (VOC) levels to be calculated for solvent-borne paints when ready for application [6], and the majority of solvent-borne paints are supplied ready to use. Where solvent-borne paint requires thinning for spray application, the manufacturer should be consulted regarding thinning ratios and the maximum permissible VOC level.

5.7.4.2 Types of spray equipment

NOTE The following types of spray equipment are in general use for the site application of coating materials:

a) airless spray;

b) air-assisted airless spray; and

c) high volume low pressure (HVLP) spray.

Modified forms of spray equipment include hot spray and electrostatic spray equipment, but these are not used to a significant extent for site work.

Thorough cleaning after use is especially important with spraying equipment as residues of previously used materials can affect later applications or impair the efficiency of the equipment.

5.7.4.2.1 Airless spray

NOTE In airless spray equipment, a fluid pump forces the material at very high pressure through a restricted orifice in the spray gun so that on release to the atmosphere the material immediately atomizes. Airless spray equipment is available in a wide range of sizes and capacities.

High rates of application can be achieved with airless spray equipment, and the absence of atomizing air means that there is almost no spray mist and consequently little waste of material or necessity for extensive masking.

Most types of coatings can be applied by airless spray, with the possible exception of those containing coarse aggregates or fibres, e.g. some masonry paints. Airless spray should be used for the application of high-build specialist coating materials as thicker films can be obtained compared with other spray techniques.

With some types of airless spray equipment, a separate source of compressed air is required to operate the fluid pump. When this is supplied by a compressor powered by a petrol or diesel engine, precautions should be taken in respect of exhaust fumes.

Because of the very high pressures involved, caution should be exercised when handling airless spray equipment; in particular, the spray gun should never be pointed towards any part of the body while the equipment is in operation.

5.7.4.2.2 Air-assisted airless spray

Air-assisted airless spray equipment should be used where fine control is required to deliver a superior finish.

NOTE Air-assisted airless spray combines some of the characteristics of high-pressure air and airless spray methods. A pump unit of similar type to that used for airless spray is employed, but it operates at a lower pressure. In addition, the spray gun is supplied with a small volume of air at low pressure. The benefits of air-assisted airless spray over traditional spray techniques include better application control, reduced spray mist and more economical use of the coating material.

5.7.4.2.3 HVLP spray

HVLP spray equipment should be used for detailed and controlled fine finish applications; it produces a fine finish with little material preparation and less thinning, and can dramatically reduce overspray.

NOTE HVLP spray is specially developed for on-site application and is ideal for use with stains, epoxies, lacquers and varnishes. The atomization of paint in the paint gun is managed automatically; the gun chooses the most appropriate air:fluid ratio based on the fan width needed.

5.7.4.3 Basic techniques

All masking and protection of adjacent surfaces should be completed before spraying starts.

NOTE Elaborate masking might be unnecessary when airless spray equipment is used; because of the virtual absence of spray mist or overspray, it is often possible to cut in by using a hand-held shield.

If masking tape is used in spraying, it should be removed as soon as possible after completion of the work. A sharp knife should be used to cut along the edges of the tape to prevent the coating film being pulled away with the tape.

Equipment should be checked to ensure that it is in good condition and working efficiently. The flow rate for the tip should not be greater than the maximum flow for the sprayer. Filters should be checked at regular intervals and if blocked, should be replaced. The spray gun should be compatible with the spray feed equipment being used; serious injury can result from the use of an inferior gun. Spray guns should be set up in relation to the coating material to be applied; reference should be made to the equipment or paint manufacturer's guidance in this respect. All hoses should be checked regularly for damage and replaced where necessary.

Paints and coating materials should be prepared for use as described in 5.6. It should not be assumed that paints for spray application necessarily need to be thinned. Unless the manufacturer's recommendations are to the contrary, or experience suggests otherwise, a trial application of unthinned paint should first be made. If thinning is necessary it should not exceed the manufacturer's recommendations; if excessive amounts of thinner are required to facilitate application, it is likely that the equipment is unsuitable or is not operating correctly.

When spraying, the gun should be held at right angles to the surface, horizontally and vertically. In air spraying, the distance between the front of the gun and the surface should be between 150 mm to 200 mm; in airless spraying, the distance should be between 300 mm to 375 mm. These distances should be maintained as the gun is moved across the surface, i.e. it should not be swung or moved in an arc. Each stroke should be made at a constant rate to maintain a uniform thickness of coating. The trigger of the spray gun should be pressed just before the start of each stroke and released just before it is completed. With air spray guns, the trigger movement should be gentle and progressive, but with airless spray guns it should be firm and abrupt. Each stroke should overlap the previous one to ensure uniform coverage; overlap by 50% is recommended.

5.8 Application of multi-coat systems

5.8.1 Intervals between application of successive coats

NOTE 1 Manufacturer's recommendations can include minimum and maximum intervals for overcoating.

Generally, each coat in the system should be dry throughout its thickness before the next coat is applied.

Except with coating materials formulated for lengthy exposure without further coats, such as some primers for metal and wood, intervals between coats should not normally exceed a few days, otherwise adhesion might be impaired.

NOTE 2 Atmospheric conditions can affect the rate of drying and, in consequence, the interval between coats. Some coating materials might be suitable for wet-on-wet application, i.e. a second coat can follow immediately.

5.8.2 Intercoat preparation

It should be ensured that the surface is clean and dry before application of each coat in the system.

NOTE 1 This is important if there has been a lengthy interval between coats especially in situations where contamination of the surface is likely, e.g. in marine or industrial environments.

In general, light abrasion with fine-grade, preferably part-worn, abrasive paper is sufficient to remove nibs and adherent dust particles but care should be taken not to scratch or tear the coating material.

NOTE 2 Plastic abrasive pads (typically nylon) are also well suited for denibbing.

If abrasion tears the coating or the abrasive paper rapidly clogs, the coating should be left to cure for longer before abrading.

NOTE 3 Vigorous abrasion between coats is rarely necessary to assist intercoat adhesion except when the previous coating has exceeded the time limit stated by the manufacturer.

If extensive flatting of a previous coat is necessary to assist adhesion or provide a smooth level surface, wet abrasion with waterproof abrasive paper and water is usually the most effective method, but the coating should be hard before it is attempted.

5.8.3 Differing colours

The manufacturer's recommendations with respect to the colours of undercoats and first-coat colours should be followed.

5.9 Defects troubleshooting

5.9.1 Defective materials

If, during the course of the work, it appears that the coating material might be defective, no more should be applied until the matter has been investigated by the manufacturer or supplier.

NOTE To continue to apply coating material which might be defective can involve additional costs for which compensation could not justifiably be claimed from the manufacturer or supplier even if the material proves to be defective.

5.9.2 Coating film defects arising during, or shortly after, application

NOTE The more commonly encountered defects, typical causes and considerations in respect of remedial treatment can be found in Table 2 for those arising during or shortly after application. See Table 5 for those arising after a period of exposure.

The information in Table 2 should be used to assign a treatment for paint film defects arising during or shortly after application.

Table 2 — *Coating film defects arising during, or shortly after application*

Defect	Typical causes	Remedial treatment
Bleeding	Solvent or water reactive or extractable stain, timber extractives, nicotine, tar or bitumen	Remove as much contamination as possible, seal with stain block primer, alkali-resisting primer or aluminium wood primer.
Blooming, or milky appearance usually on gloss paint, also slight matting of the gloss	Cold temperatures, high humidity and/or moisture during the drying process of the paint. Usually associated with winter months	Abrade and recoat.
Ropiness (brush marks)	Poor flow of the paint, over brushing, rapid drying, etc.	Abrade and recoat.
Cissing or fish eyes (appearance of voids in paint film whilst wet)	Surface contamination, wax, grease, can also occur when applying incompatible paint over poorly prepared surface, e.g. water-borne paint over oil-based paint	Remove as much contamination as possible, degrease, abrade thoroughly and recoat. Ensure application tool is also free from contamination.
Sleepy gloss (low sheen)	Contamination, e.g. wax or sinkage into substrate due to incorrect or insufficient primer or undercoat	For medium density fibreboard, abrade and then apply a water-borne acrylic primer as described in B.3/2, then recoat. Other surfaces might simply require recoating.
Halo effect (flashing arising where paint has been touched up)	Trying to "touch up" areas, especially sheen paints, but can occur with all paints	Re-paint the whole area or to the nearest visible cut-off point.
Flashing	Losing the wet edge of the paint during application	Re-paint the whole area or to the nearest visible cut-off point, ensuring the wet edge is maintained. For water-borne paints only, reduce ventilation and airflow so that humidity is increased to assist with extending wet edge time.

Table 2 *(continued)*

Defect	Typical causes	Remedial treatment
Roller marking (visible mark between tracks of the roller)	Roller stipple folding over in a different way depending on whether application was an upstroke or a downstroke. Often only visible when viewed under oblique lighting conditions. More noticeable when the wet edge has started to dry	Re-paint the whole area or to the nearest visible cut-off point, ensuring the wet edge is maintained. Lay-off in one direction. Possibly thin water-borne paint so that roller stipple flows out more readily.
Curtains, runs, sagging, floatation of pigment	Over application, i.e. too much paint applied unevenly	Allow excessively thick areas to harden, sometimes scraping off excess thickness will be required. Abrade and recoat.
Cracking/crazing	Usually associated with applying a fairly brittle paint over a highly flexible layer, i.e. matt over silk	Abrade, correctly prime, i.e. alkali-resisting primer, and recoat. Severe instances might require lining paper.
Pickling (looks like wrinkling)	Solvent attack, i.e. applying chlorinated rubber paint over a conventional paint. Solvents act as a stripper	Complete removal of all affected coatings might be required.
Wrinkling, rivelling, shrivelling	Application too thick, usually gloss paints. The paint layer skins over but remains wet underneath. Can also be caused by overcoating before previous layer is dry	Allow affected areas to harden, then abrade with wet and dry abrasive paper to smooth, and recoat.
Rainspotting (also known as pitting)	Rain/water attack during the drying phase	Wet abrade to smooth, and recoat.
Bittiness	Contaminated paint, dusty atmosphere, substrate not clean, application tool not clean	Abrade, recoat, ensure application tools are clean, strain the paint.
Orange peel effect	Application by roller without laying off the paint with a brush (such as applying gloss to doors). Poor atomization when spraying	Wet abrade to smooth, and recoat using correct method and adjustment.

5.10 Inspection, sampling and testing

Finished paintwork should be inspected in accordance with Clause **10**.

In cases of dispute, sampling and testing of materials should be carried out if required for either of the following reasons:

a) to ensure compliance to specification and the use of correct materials; or

b) as a safeguard against over-thinning, adulteration or similar practices during application.

In either case, samples should be taken or set aside for examination by the specifying authority.

For the reason indicated in a), samples should be in the original unopened containers. In respect of b), samples should be taken during application, e.g. from painters' kettles or spray equipment containers. At least two samples should be taken, one for testing and one for the contractor; it might be advisable to take additional samples for submission to the manufacturer if this subsequently proves to be necessary.

NOTE Arranging testing is generally the responsibility of the specifying authority who might contact the manufacturer for assistance.

Samples should be compared against a reference manufacturer's specification and/or wet standard and any discrepancies should be identified and recorded.

5.11 Clean up and waste disposal

NOTE 1 See also Annex A on health and safety.

The Technical Data Sheets and Health and Safety Sheets from paint manufacturers will include recommendations for cleaning and the safe disposal of paint. Recommendations will differ from a decorative paint to more specialist industrial coating materials and therefore if in doubt, further information should be sought from the manufacturer.

When cleaning the tools used, effort should be made to remove as much paint or coating material as possible.

Equipment should be cleaned promptly with warm water or cleaning agents. To avoid emptying waste into a drain, the waste water should be stored in sealable containers and disposed of in accordance with local authority requirements.

NOTE 2 Some local authorities provide paint waste disposal facilities. There are a number of initiatives and outlets that accommodate waste paint for reuse or recycle which aims to reduce the impact of waste through can and container disposal. The BCF PaintCare website, for example, has further information on the reuse of decorative paints, www.paintcare.org.uk[2].

To avoid generation of additional waste, equipment and tools should be stored in a resealable, airtight container if the intention is to use them again the next day.

6 Surface inspection

Surfaces should be in a fit condition to allow work to proceed without detriment to the paint and coating materials to be applied, especially with regard to the moisture content of the surface. Work by other trades that might affect painting should have been completed. If some time has elapsed since preparation of the specification, any change in the nature or condition of the surfaces that might necessitate modification of the specification should be drawn to the attention of the specifier.

Factory-primed components should be inspected to ensure that the condition of the primer is satisfactory; if it is not, remedial action should be taken (see Clause 9).

For maintenance projects, the form and extent of any deterioration that has occurred influences the nature of the preparatory work necessary and, in many instances, the selection of coating types and systems. Its significance should be assessed in relation to the functional requirements.

Causes of deterioration should be investigated, unless they are obvious, so that corrective action can be taken. Where there are differences in deterioration, patch-painting should be considered.

Where unusual or rapid deterioration is apparent, expert investigation and advice should be sought in order to upgrade the specification if necessary.

2 Last accessed 20 March 2019.

7 Environmental conditions

7.1 Exposure conditions

General and local exposure conditions and the conditions of service should be taken into consideration when selecting coating systems as they can have a significant influence on the suitability of materials.

NOTE A broad distinction can be made between external and internal exposure conditions but, in either, there can be considerable variation in the severity of local environmental conditions or micro-climates, even within a single building.

Externally, the main variables are location, proximity to the coast and level and nature of atmospheric pollution but elevation, aspect and the direction of prevailing winds can also have a significant effect. Internally, high humidity and the presence of process chemicals and dust can create severe conditions.

The factors in Table 3 indicating the broad categories of external and internal exposure conditions should be considered. Table 3 is intended to provide general guidance; it is not possible to take into account the many local variables that can influence the nature of the exposure conditions and the selection of coating systems in specific circumstances.

Table 3 — *Exposure condition categories (as defined in BS EN ISO 12944-2:2017)*

Severity of exposure	Corrosivity category	External	Other external factors	Internal	Other internal factors
Mild	C1 (very low)	–	–	Heated buildings with clean atmospheres, e.g. offices, shops, schools, hotels and domestic situations	Light soiling, abrasion or handling of surfaces
	C2 (low)	Inland areas (more than 10 km from the coast), non-industrial with low levels of pollution and average rainfall	–	Unheated buildings where condensation might occur, e.g. depots, sports halls	–
Moderate	C3 (medium)	Urban and industrial atmospheres, moderate sulfur dioxide pollution. Coastal areas with low salinity	–	More frequent moderate condensation, e.g. in kitchens, bathrooms, washrooms etc. Production rooms with high humidity and some air pollution, e.g. food-processing plants, laundry services, breweries, dairies	Moderate soiling, abrasion and handling of surfaces

Table 3 *(continued)*

Severity of exposure	Corrosivity category	External	Other external factors	Internal	Other internal factors
Severe	C4 (high)	Industrial areas and coastal areas with moderate salinity. Coastal ship- and boatyards	Areas with a driving rain index of 7 or more (see BS 8104 for further information)	Exposure conditions subject to frequent high humidity or heavy condensation, especially if pollutants, e.g. sulfur dioxide or ammonia, are present. Chemical plants, swimming pools	Exposure conditions in which heavy soiling or hygiene requirements necessitate frequent cleaning of surfaces. Surfaces subject to heavy abrasion or impact
Very severe	C5 (very high industrial or coastal onshore)	Industrial areas with high humidity and aggressive atmosphere, or coastal with high salinity	–	Buildings or areas with almost permanent condensation and with high pollution and/or high salinity	Surfaces in contact with chemicals, chemical solutions, process liquors and other aggressive agents
	CX (offshore)	Offshore areas with high salinity	Classification used only for offshore areas	–	–

NOTE For wood, the exposure conditions are better classified in accordance with BS EN 927-1, which takes into account the construction and the climate.

7.2 High humidity

Most paints are resistant to the levels of humidity normally encountered internally in the majority of domestic and non-industrial situations. Where conditions of moderate or high humidity prevail intermittently, as in kitchens and bathrooms, only resistant paints and coating materials should be used.

NOTE This will include most solvent-borne paints and some water-borne paints (see Table B.1).

The processes or activities carried out in some buildings can give rise to conditions of constant or frequent high humidity or cause surfaces to be splashed with water. Examples of where such conditions might prevail include kitchens, bathrooms, swimming baths, laundry services and factories engaged in the manufacture of food and drink, paper and synthetic and natural fibres. In these conditions, and especially for the protection of steel, wood and other substrates vulnerable to attack by moisture, specifically moisture-resistant paints and coating materials should be used.

Moisture-resistant protective paints and coating materials should be applied in accordance with the manufacturer's recommendations with regard to thickness, preparation and priming.

7.3 Condensation

Condensation should be prevented or controlled by providing good ventilation to remove moisture-laden air from buildings, preferably from a point near the source of moisture. Adequate levels of heating increases the capacity of the air to hold moisture but should be combined with good ventilation, otherwise the problem is aggravated.

NOTE 1 Thermal insulation also helps to reduce condensation by keeping surfaces warmer and reducing the cost of heating.

NOTE 2 Most condensation in buildings is caused by warm, moist air coming into contact with cooler surfaces. In domestic and non-industrial buildings, condensation is usually light and intermittent although, in some situations, it can be sufficient to cause water runs and drips, disfigure paintwork or promote mould growth. In dwellings, condensation is most likely to occur in kitchens and bathrooms, but water vapour can be carried by air currents through the house from these rooms and condense on cold surfaces in unheated areas. Guidance on designing to avoid condensation in new buildings and remedial measures in existing buildings is given in BS 5250.

Paint treatment alone should not be used as an alternative to heating, ventilation and thermal insulation measures but, where condensation is moderate and occurs only intermittently, anti-condensation paints can be used.

Anti-condensation paints usually contain aggregates with insulating or absorptive properties. Some coating materials have a textured surface that helps to reduce water runs and drips, but these tend to hold dirt and are not easily cleaned. Absorptive types should be used only in situations where it is expected that condensation will be followed by conditions favourable to drying out absorbed moisture.

As in 7.2, where the function of a building gives rise to conditions of constant or frequent high humidity and measures to prevent or reduce condensation are impracticable or not fully effective, priority should be given to the protection of substrates vulnerable to moisture attack by using specifically moisture-resistant protective paints and coating materials, as recommended by their manufacturers.

7.4 Atmospheric pollution

In industrial situations, fumes can retard the drying or cause discoloration of conventional coatings; in severe cases, it might be necessary to use modified or specialist coating materials, and the manufacturer should be consulted.

The adhesion and drying of coating materials is impaired by the deposition of contaminants, including salt in marine situations. Where this occurs, surfaces should be suitably prepared according to the manufacturer's recommendations and cleaned thoroughly before application of each coat. Intervals between coats should be as short as possible (see also **5.8.1**).

NOTE The effects of fumes and the deposition of contaminants are likely to be most severe in foggy weather and in conditions of high humidity.

Painted surfaces subjected to heavy soiling and/or pollution from external sources, such as road traffic, sea salt, local industry, guano, etc., should be cleaned regularly and might require more frequent painting.

7.5 Mould growth

NOTE 1 Typically, mould has a black, sooty appearance and might be mistaken for dirt although some moulds are coloured. It is often possible to distinguish mould from dirt and chemical stains by examination with a magnifying glass (x 10 or higher) when the filaments of most moulds might be seen.

NOTE 2 Moulds germinate and grow when the relative humidity at a surface rises above 80% and where there is a supply of nutrients.

Mould growth should be avoided by:

a) ensuring the relative humidity does not exceed 70%. Because of its dependence upon a supply of moisture, the growth of mould is most effectively inhibited by reducing humidity and preventing condensation by good ventilation, adequate heating and thermal insulation, as indicated in 7.3; or

b) applying a suitable moisture-resistant protective coating material as recommended by the coating material manufacturer and sterilizing the surface by application of a fungicidal wash

at regular intervals. Proprietary washes containing fungicides are available, and some leave an inhibitive residue on the surface; a solution of household bleach also kills mould but does not have any residual inhibitive properties; or

c) applying mould-resistant paints in domestic and non-industrial situations. When mould-resistant paints or washes are to be used where foodstuffs are prepared or stored, it should be ensured that there is no risk of food products being contaminated with toxic substances or their flavours affected. Mould-infected previously decorated internal surfaces should be treated in accordance with **9.1.3** before painting.

NOTE 3 Mould-resistant paints usually contain mould-inhibitive additives. Some more toxic mould-inhibitive additives might not be suitable for use in situations where foodstuffs are processed.

NOTE 4 Further information on mould growth and its treatment is given in BRE Digest 370 [7].

7.6 Chemical attack

NOTE Coating materials are likely to be chemically attacked by high concentrations of acids and alkalis, acidic and alkaline substances, alcohols, oils, fats and greases, solvents and fresh and salt water.

Where there is a need for resistance to heavy fume attack or direct contact with chemicals, chemical-resistant coating materials should be used.

The resistance of any of the coatings described in Table B.1 is dependent on the specific agent and the form and severity of attack. When there appears to be a need for a chemical-resistant coating material, specialist advice should be sought unless there is previous experience of the satisfactory performance of a particular type of coating material in similar circumstances.

7.7 Fire

NOTE For further information on fire, see Annex D.

7.7.1 General

NOTE A conventionally painted surface is considered as a thin film of flammable material in close contact with a substrate. However, a first application of paint would not normally affect the flammability of the unpainted surfaces. The potential for the release of flammable volatiles (and therefore for a fire to spread) is a function of the nature of the substrate, the nature of the paint film itself and the thickness and number of coats.

In addition to conventional decorative paints, flame-retardant and reactive fire coating materials are also available. Flame-retardant coating materials are specially formulated to reduce the spread of flame. Reactive fire coating materials are formulated to swell under high temperature to maintain the structure of the building.

If a specific fire classification is sought, the paint system and application techniques for this should be professionally specified. Manufacturers should be consulted regarding specialist products and application to be used.

7.7.2 Resistance to surface spread of flame

NOTE 1 Attention is drawn to the Building Regulations 2010 [8], the Building (Scotland) Regulations 2004 [9], and the Building Regulations (Northern Ireland) 2012 [10] regarding construction materials conforming to minimum requirements in relation to the spread of flame across surfaces when tested as described in the relevant parts of BS 476. See also Annex D. Surfaces of wood and wood-based construction materials can have an enhanced reaction to fire classification conferred by factory-applied impregnation treatment or by application of flame-retardant paint. Paint is not regarded as a material of construction and is not subject to the Building Regulations. However, flame-retardant paints are regarded as a material of construction and are subject to the Construction Products Regulation [11].

Flame-retardant paints should have a reaction to fire classification in accordance with BS EN 13501-1 (or the relevant parts of BS 476). Flame-retardant paints should be applied so as to achieve the film

thickness or surface loading recommended by the manufacturer. Reference should be made to the manufacturer's details of the ratings of their paints when applied to specified substrates.

NOTE 2 The flame spread rating of paint cannot be expressed in isolation but only in relation to its performance on a specified substrate.

NOTE 3 Attention is also drawn to the ETAG 028 Guideline for European Technical Approval of Fire retardant products [12].

Conventional paints should not be applied over flame-retardant surfaces, unless specifically recommended by the manufacturer of the flame-retardant paint or treatment. In such instances, details of systems applied, including dates of application and types or brands of paints used, should be recorded for future reference.

7.8 Resistance to abrasion

NOTE 1 Paints and coating materials resistant to abrasion might be required for floors, machine surfaces, storage racks and bins, handrails and similar items, especially in factories and commercial buildings. There might also be a need for wall and ceiling finishes to be resistant to frequent vigorous cleaning in such places as dairies, abattoirs and food preparation areas.

Pigmented and clear two-pack epoxy and polyurethane coating materials should be used where resistance to abrasion is a major consideration, but their use might be limited by the nature of the substrate or the conditions of application.

NOTE 2 The modified one-pack types, although lower in abrasion resistance, can also be used, as they are subject to fewer restrictions in use and perform reasonably well in many situations; one-pack epoxy ester types, for example, can be used as floor and deck paints, often with a non-slip additive. Some modified alkyd paints are reasonably resistant to abrasion and can be used for painting machinery and similar applications. Multi-colour finishes (see B.4/9) can be used for walls in many interior hard wear situations.

8 Material selection

8.1 General

Materials used in the painting of buildings can be divided into two main categories:

a) coating materials, e.g. primers, undercoats, paints, varnishes and wood stains; and

b) ancillary materials, e.g. cleaning agents, fillers, stoppers and materials similarly used in the preparation of surfaces or in coating systems.

NOTE 1 Materials can be selected from the tables given in Annex E to Annex G.

Material selection should also take into account the environmental impacts of paints, including the emission of VOCs and waste disposal (see Annex A).

NOTE 2 There are a number of ways to assess the overall environmental impact of a paint covering composition, production and supply to the painter. These include Environmental Product Declarations (EPDs) and the forthcoming European approach termed Product Environmental Footprint (PEF).

NOTE 3 Material selection in the construction industry plays a prominent role in reducing environmental impacts of built assets; sustainability rating schemes such as BREEAM (BRE Environmental Assessment Method) and LEED (Leadership in Energy and Environmental Design) promote and reward sustainability approaches such as the specification and installation of products in a way that minimizes the impact on the health and wellbeing of occupants.

8.2 Selection of coating systems

8.2.1 General

A number of parameters should be considered when selecting coating systems. These are listed in Table 1. Selection should be made by judging the relative importance of the factors in relation to particular circumstances. There is a considerable degree of interaction between factors involved, and they should not be considered in isolation. The selection of coating systems for the target substrate should be determined by consulting the coating material manufacturers and referring to the relevant information in Clause 9.

Care should be taken to ensure that parameters are comparable; lower initial costs might well be more than outweighed by reduced durability (shorter life) and consequent higher maintenance expenditure. In other circumstances, a single factor might exert so strong an influence that selection is limited to a single type of system.

For new build, there are dominant economic and operational factors for the choice of substrates and methods of construction. Specific coating materials might be required for aesthetic and/or protective reasons but should not be expected to upgrade the performance of incorrectly specified building materials.

For maintenance projects, where the coating materials used previously have performed satisfactorily, materials of similar type should be considered as a preference.

Where previous performance has not been satisfactory, the reasons for this failure should be established before material selection.

NOTE Possible reasons for coating materials failing include:

a) application to new wet substrates, e.g. plaster, concrete, brickwork and similar materials;

b) inadequate or incorrect preparation of surfaces;

c) low film thickness in protective coating systems;

d) adverse conditions, e.g. of temperature or humidity during application;

e) poor application;

f) use of poor quality materials;

g) use of unsuitable materials.

The type of coating material used might have proved unsuitable either because the original requirements were not correctly appraised or because of subsequent changes in the exposure conditions, conditions of service or function.

Where the failure is linked to new wet substrate, this does not necessarily imply a need to use a different type of material, provided drying out is complete and the surface is correctly prepared. However, where a permeable type of coating material was used for initial treatment, functional requirements might indicate a change to a material more resistant to washing or wear.

Where faulty performance is attributable to poor workmanship or material quality, corrective action should be taken in respect of procedures or quality of material rather than a change in the type of coating material.

Because of the diversity of conditions, substrates and coating materials, especially in relation to chemical resistance, it is possible to provide only a general indication of the types of paints and coating materials that might be suitable. For detailed recommendations in specific circumstances, specialist advice should be sought.

8.2.2 Volatile organic compounds (VOCs)

Paint VOC content is stated on labelling and manufacturers' data sheets, including maximum permitted level by category. Precautions should be taken when using paints that contain high levels of VOCs (for example, solvent-borne paints, see Annex A for further details), as breathing in these vapours can be harmful, depending on the quantities inhaled.

NOTE 1 VOCs are chemical substances that contain carbon and have a vapour pressure above 0.01 kPa at room temperature (20 °C), and/or can become gases when heated to temperatures up to 250 °C. All liquid paints contain VOCs – solvent-borne paints contain relatively high levels, whereas the current water-borne decorative paints used for painting buildings generally have minimal VOC content.

NOTE 2 Maximum VOC content limit values apply for paints and varnishes according to UK SI 2012-1715 [6].

NOTE 3 The VOC testing standard for decorative paints is BS EN ISO 11890-2, or BS EN ISO 11890-1 for paints with >15% VOC content.

8.2.3 Compatibility of coating materials

The compatibility of the coating materials selected should be confirmed prior to application.

NOTE 1 It is essential that the individual coats in the system are mutually compatible. Compatibility is influenced mainly by the composition and physical properties of each of the coating materials in the system and, to some degree, by their juxtaposition and age. Incompatibility can be a cause of poor adhesion between coats in a system.

Compatibility problems are less likely to arise with systems comprising coating materials of similar composition and properties but, even with these, slight variations in the same types of coating materials from different manufacturers can adversely affect the performance of the system.

All the coating materials in a system should be from the same manufacturer and should be used in accordance with the manufacturer's recommendations regarding the sequence and number of coats.

The manufacturer's advice should be sought if there are doubts as to compatibility of old and new coating materials, and small-scale trials might be appropriate prior to commencing the project.

It can be difficult to identify existing coatings by type, especially in older buildings. Where identification is necessary, either simple site tests, e.g. the reaction of the coating material to solvents of various types, or in other cases, laboratory examination should be undertaken to provide the information.

NOTE 2 The following are typical of circumstances that might require consideration.

a) Application of water-borne coatings over solvent-borne coatings. Adhesion might be poor, especially in conditions of high humidity and when applied to glossy surfaces (this can be improved by abrading the surface).

b) Application of solvent-borne coatings over water-borne coatings. This does not usually present a problem if the existing coating is sound and firmly adhering, but a primer-sealer might be required on highly pigmented or absorbent coatings.

c) Application of specialist coating materials, e.g. two-pack epoxy or polyurethane types, over drying-oil/resin coatings. This might be possible if the existing coating is sound, hard and aged, but there is a risk that softening, cracking or lifting will occur.

d) Application of drying-oil/resin coating materials over metallic zinc-rich primers. It is recommended that advice is sought when drying-oil/resin coating materials are to be used over metallic zinc-rich primers.

e) Application of all types of coating materials over bituminous coatings.

8.2.4 Components of coating systems

8.2.4.1 General

NOTE 1 A coating system comprises at least two coats of either the same material or a sequence of coats of differing type, typically primer, undercoat and a finish (or topcoat).

If the existing coating is generally in sound condition and materials of similar type and colour are to be used for repainting, either one undercoat and one coat of finish, or two coats of finish, as appropriate, usually provides a satisfactory result. Allowance should be made for bringing forward localized areas from which the old paint has been removed.

Additional coats might be required if a pronounced colour change is to be made, especially if the change is from a dark colour to a lighter colour. Additional coats might also be necessary with some bright or strong colours; manufacturer's advice should be sought if in doubt.

NOTE 2 For some types of finish one coat might suffice e.g. on internal work in good condition and where the same or a similar colour is to be used.

Surfaces from which the old coating has been removed completely should receive a full coating system as prescribed by the coating material manufacturer.

8.2.4.2 Primers and sealers

Primers should be used to secure good adhesion to the surface to which a coating system is to be applied, and thus provide a base to which the succeeding coats will adhere.

NOTE 1 Primers may also be used to:

a) prevent undue absorption of binder from the subsequent coats, leaving them underbound or lacking in gloss on absorbent surfaces, such as wood, lightweight blocks, plaster and many building boards;

b) penetrate porous substrates such as wood and masonry to improve adhesion and other performance factors;

c) inhibit metal corrosion, especially iron and steel;

d) reduce the risk of attack on subsequent coats on surfaces of an alkaline nature, such as concrete, cement rendering, asbestos-cement and some types of plaster;

e) protect surfaces in the interval between erection or fixing and application of the complete coating system on new wood, metal and other materials exposed to attack by moisture or other adverse elements.

Examples of primers include:

1) aluminium-pigmented primers that can be used as wood primers and also as sealers for bituminous surfaces other than wood and smoke affected surfaces;

2) primer-sealers for powdery or friable surfaces or for plaster and similar surfaces of high or variable porosity;

3) protective coating materials, usually unpigmented, e.g. clear sealers for metal-sprayed steel and some multi-coloured finishes.

NOTE 2 Sealer is a term often loosely applied to coating materials which might combine some of the functions of primers described in a) to d) with other functions, or which might be used for purposes other than priming.

NOTE 3 Well-thinned first coats of water-borne paint might be needed on plaster of high or variable porosity. These are sometimes referred to as sealing or mist coats.

Care should be taken when paints are intended to be used over metallic zinc-rich primers that are not compatible, e.g. drying-oil/resin coatings and intumescent coatings. Advice should be sought from the manufacturer when such coating materials are intended to be used over metallic zinc-rich primers.

8.2.4.3 Undercoats

Undercoats should be used to provide a uniformly opaque base of a colour appropriate to that of the finish.

NOTE 1 They also contribute to the thickness, filling properties and cohesion of the paint system.

The manufacturer's recommendations regarding the use of undercoats should be observed.

NOTE 2 In some circumstances, undercoats might not be needed, or can be replaced in part by additional coats of finish. Many solvent-borne matt or mid-sheen finishes, for example, can be applied direct without undercoats to primed or previously painted surfaces.

Solvent-borne gloss finishes are usually applied over undercoats, but in three-coat systems on primed or previously painted surfaces, with the manufacturer's approval, a system of one undercoat and two coats of gloss finish should be used in preference to two undercoats and one coat of finish for greater durability externally or in severe internal exposure conditions.

Where necessary, the use of special undercoats should be covered in the painting specification.

8.2.4.4 Finishes and topcoats

The finish (or topcoat) is the final coat in the system and should be selected to provide the final required colour, degree of gloss, texture or other surface attributes, including resistance to weather, chemical attack and mechanical damage. The finish should not be used to compensate for deficiencies in preceding coats in the system, whether these relate to quality, suitability, compatibility or application.

Where necessary, the use of additional finishing coats should be covered in the painting specification.

8.3 Ancillary materials

8.3.1 General

Ancillary materials should be used in order to prepare the surface to an adequate standard for subsequent painting.

NOTE Possible paintwork defects that might be encountered during and after application and the recommended remedial treatment for these can be found in Table 2 and Table 5.

8.3.2 Cleaning agents

NOTE Surface cleanliness is essential to the performance of coating systems. Detergent solutions are usually adequate for normally soiled surfaces.

All residues should be completely removed prior to applying the coating system. For removal of oil or grease, appropriate specialist cleaning solutions should be used.

8.3.3 Sterilizing washes

Surfaces contaminated with mould or algal growths should be treated before coating materials are applied. Household bleach solutions are often effective in killing the growths but, in severe cases, proprietary mould-inhibitive washes should be used to prevent their reappearance. All residues, including chemicals and dead mould/algal spores should be completely removed prior to applying the coating system.

8.3.4 Knotting

Specialist knot sealers should be used to hold back resin, tannin and other stains, which could discolour wood coatings on some wood species (see 9.2).

NOTE The most common problems are associated with knots in the wood. The problem is most acute with white water-borne finishes.

Where knotting is used to retard discoloration of light-coloured opaque finishes, a quick-drying solution in accordance with BS 1336 (e.g. of shellac in industrial methylated spirit) should be applied to knots or resinous areas in wood before priming. Two coats are more effective than one, however knotting is not likely to be completely effective in cases of resin exudation.

8.3.5 Stoppers and fillers

Stoppers and fillers should be used to fill cracks and holes in wood or masonry surfaces. The manufacturer's recommendations should be followed when selecting an appropriate stopper/filler.

NOTE General purpose stoppers/fillers are usually water-mixed and comprise the following.

a) Water-borne fillers. These are usually based on vinyl or acrylic resin dispersions and are supplied in paste form, ready for use.

b) Powder fillers. These are supplied in powder form for mixing with water and are usually based on water-soluble cellulose and gypsum or white Portland cement. Those containing gypsum are suitable for general use as stoppers and fillers in dry interior situations.

Powder fillers are not usually suitable for use for external work, especially on wood, but the manufacturer's recommendations in this respect should be observed. Portland cement (CEM 1) types are suitable for external use on masonry surfaces and should not be used on woodwork.

Where water-borne fillers are used, the manufacturer's recommendations, especially regarding suitability for exterior use, should be observed. It should be noted that some exterior grades contain coarse particles, making the attainment of a fine finish difficult.

Linseed oil putty should not be used as a stopper.

For stopping deep holes in woodwork, proprietary materials based on two-pack polyester or epoxy resins can give good performance but only a grade supplied specifically for use on wood should be used.

Surface fillers formulated specifically for use on timber should be used when a high standard of finish is required, especially with solvent-borne paint systems. They are supplied ready for use as smooth, finely ground, creamy pastes, and should be applied with a wide filling knife or spatula.

8.3.6 Mastics and sealants

Mastics and sealants are mainly used for the repair or replacement of external pointing between window or door frames and adjacent masonry. They do not need to be over-painted, except for one-pack, non-elastic types, which should be over-painted. Silicone mastics and sealants should not be over-painted.

8.3.7 Water repellents

Water repellent solutions, for example, water-borne silane/siloxane water repellents, should be used when rain penetration of walls has caused internal dampness.

NOTE This type of product allows moisture to escape through the wall as vapour, so minimizing internal dampness due to possible condensation.

9 Substrates

NOTE The coatings referred to in this clause are generally those of conventional type and described in the tables in Annex E to Annex G, but Clause 7 describes some functions and situations for which specialist coatings or modified conventional coatings might be necessary.

9.1 Preparation of surfaces

9.1.1 General

Surfaces not intended to be coated, including floors, furniture and factory-finished components and fittings, should be protected against splashing and spilling of painters' materials or other damage. As far as possible, door furniture, light fittings and similar items should be removed.

NOTE 1 Preparation of surfaces (whether new or previously coated) involves one or more of the following activities:

a) removal of coating;

b) treatment of biological growth;

c) treatment of stains and discoloration;

d) rubbing down;

e) stopping and filling;

f) cleaning;

g) priming;

h) bringing forward.

Tools and equipment should be kept clean while in use and, where appropriate, cleaned immediately after use.

Debris and waste material should be disposed of promptly and should not be allowed to accumulate in the working area. Safety precautions should be observed in the disposal and storage of waste materials.

NOTE 2 For recommendations in respect of personal hygiene and cleanliness, see Annex A.

9.1.2 Removal of coatings

9.1.2.1 General

WARNING Lead-based paint surfaces are extremely hazardous. See Annex A for appropriate precautions to be taken.

Lead-based paint surfaces should be treated with care, following specialist recommendations.

For already coated surfaces, whether or not a coating is to be removed depends upon its condition and its compatibility with the coating material to be applied. Where the general condition of a coating is obviously poor, it should be removed.

NOTE 1 If the existing coating is in sound condition and one of similar or compatible type is to be applied, removal is unnecessary. A significant difference in colour between the existing paint and that to be applied does not usually justify its removal.

Complete or partial removal of coatings should be undertaken where there is general poor adhesion, flaking, peeling, blistering, cracking, crazing and severe chalking or powdering of the coating. Rough (e.g. heavily brushmarked) or textured coatings, although generally sound, should be removed for maintenance purposes where their smoothing or levelling would be impracticable or more costly than removal.

Where the coating material to be applied is not compatible with the existing one, e.g. if a specialist coating material containing strong solvents is to be applied over a coating of conventional type, the coating should be removed. General guidance on the compatibility of coatings is given in 8.2.3, and the manufacturer's guidance should be sought.

Every effort should be made to collect the debris from paint removal and dispose of it in accordance with good waste disposal practices.

NOTE 2 The extent to which removal is necessary might not become apparent until work has started; for example, what might have appeared to be isolated flaking might prove to be indicative of poor adhesion overall.

NOTE 3 Removal of coatings can be achieved by any of the following actions:

a) scraping;

b) abrasion;

c) heating and hot air;

d) paint removers;

e) washing off;

f) steam stripping; and

g) abrasive blasting.

9.1.2.2 Scraping

Coatings having poor adhesion, locally or generally, can often be removed by scraping, without recourse to heating or the use of paint remover. When local areas of poorly adhering material are removed in this way, it should be ensured that adhesion of the remaining coating is satisfactory and that the defective coating is removed back to a firm edge.

9.1.2.3 Abrasion

WARNING Dust is hazardous. See Annex A for appropriate precautions to be taken.

Abrasion includes hand or mechanical sanding, abrasive discs and pads and wire brushing and should be used for removing degraded, heavily chalking or poorly adhering coatings.

Precautions should be taken, including the correct use of PPE, to prevent inhalation of dust and to protect eyes (see Annex A). Dust should be carefully removed and contained. PPE should be used when dust is being created. Dry abrasion should not be used for surfaces painted with lead-based paints.

NOTE 1 Mechanical sanders are available which are designed to be attached to portable dust extraction units.

Abrasives should be of types and grades appropriate to their function and the nature and condition of the surface.

NOTE 2 Unduly coarse grades can cause unsightly scoring and scratching which shows through the finish.

Care should be taken not to damage thin metallic coatings, e.g. thin films of aluminium on composite sheets. Care should also be taken to avoid damage to mouldings, arrises and similar features. If abrasion between coats is necessary, it should be done lightly with fine, preferably part-worn, abrasive paper to avoid tearing or cutting through the coating. For hand-sanding of flat surfaces, abrasive papers should be used in conjunction with a rubbing block.

Surfaces should be abraded to remove debris, create a smooth surface, or improve paint adhesion. The types of abrasive materials in general use are as follows.

a) Glasspaper. Different grades should be used to abrade painted surfaces for different degrees of preparation.

b) Waterproof abrasive paper can be used wet or dry and is more effective than glasspaper for abrading painted surfaces. It should be used wet when abrading surfaces painted with lead-based paint.

c) Open-coated abrasive paper has the abrasive coating (typically aluminium oxide or silicon carbide) sparsely distributed on the paper backing to reduce clogging. It should be used in mechanical sanding machines.

d) Steel wire wool has general application for abrading and cleaning for metal surfaces. If used in the preparation of aluminium for painting, only stainless steel wire wool should be used. Care should be taken in the removal of broken strands of wire wool from surfaces before painting or they can cause rust-spotting or discoloration. Protective gloves should be worn when using wire wool.

NOTE 3 Nylon fibre pads can be used instead of wire wool for some purposes (see 9.4.2.4.3).

For surfaces which have been dry-abraded, dusting or vacuum-cleaning should be undertaken; washing might be necessary. Surfaces that have been wet-abraded should be rinsed with clean water and wiped dry. On absorbent surfaces, time should be allowed for drying out before coating materials are applied. Dust and dirt should be removed before painting otherwise the appearance and performance of coatings can be impaired. Where a high standard of finish is required, especially with gloss finishes, a tack rag should be used to finish off the cleaning process.

9.1.2.4 Removal by heating and hot air

WARNING Removal of paint by heating can result in the emission of toxic fumes. See A.2.5 for appropriate precautions to be taken.

Heating should not be used for the removal of paints containing lead pigment.

For other paints, when scraping alone has failed to remove the coating, a hot air gun should be used to soften the paint prior to further scraping and abrasion. The hot air equipment should be handled in accordance with manufacturer's instructions.

9.1.2.5 Paint removers

Paint removers should be used in accordance with the recommended manufacturer's recommendations.

Paint removers should be used to remove coatings when the nature of the substrate or other considerations preclude removal by heating as described in 9.1.2.4 when scraping alone is insufficient.

Paint removers should be applied liberally and left until the coating has softened sufficiently to enable it to be removed easily. Thick films can require several applications. When removal is complete, the surface should be cleaned in accordance with the manufacturer's instructions. Solvent-borne types should only be used in well-ventilated areas (see also Annex A).

NOTE 1 Professional operators need to take into account procedures required under the Control of Substances Hazardous to Health Regulations 2002 (COSHH) [13] and Control of Substances Hazardous to Health Regulations (Northern Ireland) 2003 [14]. See also Annex A.

NOTE 2 Attention is drawn to the REACH Enforcement (Amendment) Regulations 2014 SI 2014-2882 [15] regarding the requirement for all professionals to be formally trained in the use of dichloromethane (DCM)-based paint strippers prior to using such products. These products are not permitted to be used by non-professionals.

9.1.2.6 Washing off

Distempers, once widely used for ceilings, might be encountered in older buildings. They should be removed before repainting by soaking the material with warm, soapy water until they have softened and can be sponged, scrubbed or scraped off.

NOTE This may also be applicable to certain other water-borne paints.

9.1.2.7 Steam stripping

WARNING Lead-based paint surfaces are extremely hazardous. See Annex A for appropriate precautions to be taken.

Lead-based paint surfaces should be treated with care, following specialist recommendations. Steam stripping should not be used on lead-based paint surfaces.

NOTE Steam stripping equipment involves steam being generated and supplied to a perforated pad held against the surface from which a coating is to be removed. The equipment was designed originally for use in the removal of wallpaper but has been found to be of assistance in the removal of textured water-borne paints from interior walls and ceilings.

Steam stripping should be used for large areas, such as walls or ceilings, as it can be more effective than the washing-off method referred to in 9.1.2.6.

9.1.2.8 Abrasive blasting

Abrasive blasting can be used for the removal of heavy accumulations of old coatings from external surfaces, and consideration should be given to its use when warranted by the condition of the coatings and the extent of the areas. To avoid possible damage to the substrate, care should be taken in the selection of abrasives and air or water pressures, and the work should be carried out only by experienced contractors.

NOTE 1 High-pressure water cleaning can also be an effective method of removing old coatings from external walls.

NOTE 2 Abrasive blasting might be the only practicable method of preparing external walls which have an accumulation of coatings of miscellaneous type in poor condition. In such circumstances, complete removal of the residues of old coatings back to a sound surface might be difficult and application of a primer-sealer after thorough preparation might be necessary (see 9.1.8).

9.1.3 Treatment of biological growth

NOTE The information in 9.1.3 is based upon that given in BRE Digest 370 [7] to which reference can be made for a more comprehensive treatment.

9.1.3.1 External surfaces

NOTE 1 Lichens and mosses are often found on roofs and external walls, especially in rural areas. They can also be found on painted and unpainted wood surfaces, including windows and doors. Their appearance is often regarded as pleasing but, if the surfaces are to be painted, the growths have to be removed. Algae occur in most areas when water runs freely over a surface; they cause unsightly green or black stains and have to be removed before painting. Moulds and algal growths resembling dirt deposits can occur outdoors on paints and wood stains; in the early stages they can be washed off, but moulds can penetrate and damage the existing coatings and affect the new one.

Where biological growths are present on surfaces that are to be painted, preparatory treatment (wash) should include the application of a biocidal product.

NOTE 2 Biocidal products are regulated under EU Biocidal Products Regulation (528/2012) (EU BPR) [16].

When using biocidal products, the manufacturer's instructions should be followed regarding the use of PPE (e.g. goggles, gloves, overalls).

NOTE 3 Professional operators will need to take into account procedures required under the Control of Substances Hazardous to Health Regulations 2002 (COSHH) [13] and the Control of Substances Hazardous to Health Regulations (Northern Ireland) 2003 [14]. See also Annex A.

Biocidal products should preferably be applied during a dry spell. To hasten the biocide action, thick surface growths should be partly removed or torn with a stiff but not wire brush before brushing the wash well in.

NOTE 4 The wash, repeated if necessary, kills the growth, but the dead organism can take some time to disappear. Biocidal products take a few days to become effective and, in wet weather, can be washed out before they have had time to act.

The dead matter should be removed by scraping and brushing, and this is often more effective when the growth is dry; however, asbestos-cement should not be scraped or brushed except when wet.

Particular attention should be paid to dust and debris from biocidal wash activity as it is hazardous waste and should be treated in accordance with Annex A. After removal of the dead growth, a further application of biocidal product (with types having a residual effect) can be used to delay re-establishment of the growth.

Heavy growths should preferably be removed from external walls by high-pressure water cleaning when circumstances permit and should subsequently be treated with a biocidal product.

9.1.3.2 Internal surfaces

NOTE Mould (mildew) is the form of biological growth most likely to affect internal surfaces. The conditions and exposure conditions favourable to its development and measures to prevent or control it are described in 7.5. Preparatory treatment of painted or papered surfaces depends upon the type of decoration and the extent to which it is affected. Where infection is slight and the coating is of a type which will withstand the application of a biocidal product, it might be sufficient to clean down without removing the coating and then to apply the biocidal wash, allow to dry and repaint.

Wallcoverings should always be stripped if mould is evident on or beneath them. Paint should be removed if it is severely affected and the growth is deep-seated. In disposing of stripped paper or paint, care should be taken to avoid contaminating unaffected surfaces. After removal of wallcoverings or paints, the surface should be treated with a biocidal product and kept under observation for a minimum of one week. A further wash should be applied if growth is renewed. The surface should be redecorated when growth has ceased and the surface is dry.

9.1.4 Treatment of stains and discoloration

NOTE Staining or discoloration evident in the existing coating might be transmitted to the new one unless preventive measures are taken. Constituents of the existing coating or the substrate might also cause discoloration of the new coating although it might not have been apparent previously. Some types of mould can cause discoloration but the mould itself might not be visible. Diagnosis of the causes of staining or discoloration and recommendations for remedial treatment might require expert investigation. Specialist stain-resistant paints are available.

9.1.4.1 Knot staining

NOTE Discoloration of paint over knots and resinous areas can be indicative of incorrect or inadequate treatment during initial painting and might be transmitted to paints applied during maintenance painting.

If the existing paint is generally in good condition, i.e. it does not need to be removed, further staining should be minimized by applying fresh knotting or specialist knot treatment. See 9.2 for further details.

9.1.4.2 Tobacco tar staining

NOTE Tobacco tar staining is caused by the deposition of the tarry matter in tobacco smoke. It often results in severe yellowing or browning of painted surfaces and can cause staining and retarded drying of subsequent coats.

To remove the deposit, the surface should be cleaned in accordance with 9.1.7. However, to reduce the risk of the new coat being affected, a paint with stain-blocking properties should be applied according to the manufacturer's instructions.

9.1.4.3 Stains from wallpaper

Treatment might be required to prevent staining of water-borne paints applied over some types of wallpaper although, if there is a risk of this occurring, the old wallpaper should be removed (see 9.5 for further details).

9.1.4.4 Pattern staining

NOTE Pattern staining is a thermal effect; differing rates of heat flow through a composite structure cause variations in the amount of dust deposited upon a surface. A typical example is often seen in ceilings where the presence of joists or beams is indicated by lighter or darker areas. Mortar joints in blockwork and fixings in claddings and linings can produce a similar effect.

Paint treatment cannot significantly affect the rate of heat flow and the consequent deposition of dust but, where pattern staining rapidly develops, paints which resist soiling and can withstand frequent washing should be used to limit reoccurrence.

9.1.4.5 Bitumen staining (bleeding)

Where bitumen surfaces need to be overpainted, they should be treated in accordance with 9.7.2.

9.1.5 Rubbing down

NOTE Abrasive materials and methods are described in 9.1.2.3.

To provide adhesion for the new coating, most surfaces to be painted should be rubbed down (denibbed). The extent of this depends on the surface. Shiny or gloss coating materials should be flatted and can require significant abrasion. Other surfaces might require only minor rubbing down. Some surfaces, such as textured paper, might not require rubbing down. Care should be taken not to cut through to the substrate.

9.1.6 Stopping and filling

9.1.6.1 General

NOTE 1 The term stopping or stopping-up relates to nail and screw holes, open joints, cracks and similar local cavities and deep depressions, while filling implies fine surface filling of shallow depressions and rough, open-textured or coarse-grained surfaces.

Stopping and filling should be carried out as early in the preparation process as the type of material used and the nature of the substrate allow.

NOTE 2 Most materials used for stopping and filling are absorbent and, if applied late in the system, e.g. immediately beneath finishing coats, can cause sinkage and variations in gloss, sheen or colour.

It should be noted that, if overall filling of surfaces is required, this should be clearly indicated in the painting specification.

NOTE 3 The materials in general use for stopping and filling are described in 8.3.5.

9.1.6.2 Stopping

The stopper should be pressed firmly into cavities in order to drive out air, which can prevent proper levelling. It should be knifed flush with the surrounding surface and not allowed to spread beyond the cavity.

NOTE 1 The materials used for stopping are usually fairly stiff in consistency and are generally applied with a putty knife or stopping knife.

NOTE 2 Deep cavities might require stopping in two stages, allowing an interval for the first application to harden.

Nail and screw heads should be adequately countersunk for stopping, with heads normally not less than 2 mm below the surface.

When drying-oil/resin stoppers (putties) are used, surfaces should be primed and the primer allowed to dry before stopping.

NOTE 3 This prevents absorption of the binder from the stopper which might cause it to shrink and fall out. Priming is not usually required prior to the use of water-borne and powder fillers.

NOTE 4 Stopping is made easier if other trades have left a gap of 1 mm maximum between the wall and skirtings or facings.

9.1.6.3 Filling

NOTE 1 Depending on their type and consistency, fillers can be applied with a wide, flexible filling knife or spreader or by brush. On broad surfaces, filling knives or spreaders are generally used, brushes are generally used for mouldings.

Drying-oil/resin fillers are usually applied after priming, but some can be suitable for direct application to unprimed surfaces; the manufacturer's recommendations in this respect should be followed.

NOTE 2 Water-borne and powder fillers can be applied to unprimed surfaces but, on absorbent surfaces, priming might be necessary to facilitate uniform spreading.

Skilled application of fillers by knife or spreader should leave a surface which requires little subsequent treatment, but some abrading might be necessary for final levelling.

Water-borne and powder fillers should be abraded dry. After abrading, surfaces should be rinsed or carefully dusted to remove residues of filler. If the surfaces have been wetted, time should be allowed for drying before painting.

WARNING Dust is hazardous. See Annex A for appropriate precautions to be taken.

Dust should be carefully removed and contained. PPE should be used when dust is being created.

NOTE 3 For medium density fibreboard (MDF), a satisfactory finish can only be achieved by screwing and plugging the MDF.

9.1.7 Cleaning

If existing coatings are generally in sound condition and of types not likely to be affected by wetting, superficial dirt should be removed by washing with a solution of sugar soap, household detergent, cleaning powder or mild soap. Strongly alkaline solutions, which can attack the coating or leave undesirable residues, should not be used. Proprietary cleaning materials should be used strictly in accordance with the manufacturer's instructions.

With all types of cleaning solutions, a final rinse should be done with clean water before the solution has dried. After rinsing, surfaces should be dried off and time allowed for absorbed or trapped moisture to dry out before new coating materials are applied.

NOTE 1 Washing might not be advisable for water-borne coating materials, including some water-borne paints, whose adhesion might be impaired by excessive wetting. Most good quality water-borne paints will, however, withstand sponging with a mild cleaning solution and even light scrubbing of soiled areas.

If there is any doubt about the impact of wetting the surface, cleaning should be limited to dry abrasion and dusting off.

NOTE 2 Washing with cleaning solutions might not remove contaminants such as oil, grease, silicones and wax polish, which can impair the adhesion or prevent the drying of coatings. Contamination of this kind is likely to be encountered in industrial buildings, but it can also occur in other situations, especially around opening edges of

doors or on skirtings adjacent to polished floors. Light contamination can be removed by wiping with a clean cloth and proprietary cleaner followed by washing with cleaning solution and rinsing with clean water.

Proprietary emulsion cleaners or degreasing solutions should be used for the removal of silicones or heavy deposits of oil or grease, as necessary.

NOTE 3 High-pressure water cleaning equipment can be used when soiling is heavy and the area to be cleaned is extensive. Equipment is available which delivers hot or cold water or detergent solutions at pressures of 7.0 MPa (1 000 lbf/in²) or higher.

9.1.8 Priming

Surfaces from which coatings have been removed should be primed depending upon the nature of the substrate and the type of coating material to be applied. Reference should be made to the appropriate substrate in Clause 9 for guidance.

NOTE 1 Preparation can leave surfaces of variable porosity which are unsuitable for direct application of finishing paint.

Where it is required to bring the surface up to a consistent standard ready for final painting, a primer-sealer should be used, in accordance with manufacturer's instructions.

NOTE 2 Application of a primer-sealer is supplementary to thorough preparation.

Glazing rebates, exposed by the removal of defective putties, should be primed before re-applying putty.

If discoloration or staining of the existing paint has occurred, a sealer should be applied, as necessary.

9.1.9 Bringing forward

NOTE Bringing forward refers to the repair of localized areas, e.g. where defective paint has been removed and the substrate is exposed to provide a uniform surface before the application of finishes.

Treatment depends upon the nature of the substrate and the existing system but typically should include priming, stopping and filling and the application of further coats to restore the original film thickness.

9.2 Wood

NOTE For further information on wood, see Annex E.

9.2.1 General characteristics

The following issues should be considered when painting wood surfaces:

- extractives;
- moisture content;
- weathering; and
- fungal attack and preservative treatments.

9.2.2 Specific/relevant characteristics

9.2.2.1 Wood extractives

The potential for extractives to cause problems should be considered during the preparation of wood for coating.

NOTE 1 Extractives confer desirable properties such as durability and colour to wood, and are manifested both as resins and in the form of soluble staining chemicals such as tannin which can disrupt or discolour surface coatings.

Knots often contain a disproportionally high percentage of resin and extractives, which can cause localized discoloration and physical disruption of paint. These problems should be alleviated through the application of a knotting solution or use of a purpose-designed stain-blocking primer.

Some woods contain a high resin content and can give rise to exudation problems. High levels of tannins can also cause discoloration. These woods should be washed down with methylated spirits immediately before priming or varnishing.

NOTE 2 However, they can usually be painted satisfactorily if an aluminium primer or stain blocking primer is used.

Some species of hardwood and softwood contain a relatively high level of tannins distributed throughout the wood. When finishing using a water-borne paint, a primer possessing stain-blocking properties should be used.

Wood species containing high levels of tannins react with iron to produce strong blue-black discoloration. Non-ferrous fixings should be used, and steel wool should not be used on high tannin woods.

9.2.2.2 Moisture content

Wood with a low level of moisture movement should be selected as this will improve the coating's durability. An electrical moisture meter with long probes should be used so that readings can be taken at a depth not so readily affected by surface drying.

Wood should be painted or varnished when its moisture content matches that of the substrate when stabilized under normal service/use conditions.

Circumstances in which the interior coating is more moisture permeable than the exterior coating should be avoided, for example, the use of a permeable water-borne paint inside and a solvent-borne alkyd outside.

NOTE 1 This arrangement can result in interstitial condensation within the frame section and severe blistering of the exterior coating during cold weather.

NOTE 2 Excessively dry timber swells as it takes up moisture, imposing stresses on the coating. Wood with a high moisture content shrinks during drying, causing joints to open, creating further points for water to enter. Also, blistering or flaking of the surface coating is likely to occur on wood with a high moisture content.

9.2.2.3 Weathering

Wood should be protected from the elements, and for exterior exposure, the first coat of any coating system should be a penetrating treatment.

Denatured wood should be removed back to a sound wood surface before the application of a coating as weather-degraded wood is a very poor substrate.

NOTE Even when wood is not obviously degraded, the paint holding properties could be severely compromised.

Dark finishes should be avoided as they exacerbate the effects of solar heat which causes a loss of moisture and leads to shrinkage of wood and consequent cracking and opening of joints; it can also increase resin exudation, resulting in discoloration and disruption of coatings.

9.2.2.4 Fungal attack and preservative treatments

Wood for exterior use should be preservative treated off-site to suit the in-use conditions and the desired service life. See Annex E for treatment for components of a building.

Clear preservative primers are available which contain resin in addition to fungicide and serve to stabilize the wood surface and improve the performance of the coating system. They should be applied liberally, particularly over end-grain surfaces.

Where timbers of a lower durability rating are used, or if appreciable quantities of sapwood are present, application of a suitable preservative treatment should be undertaken to prevent fungal attack.

NOTE 1 BS 8417 provides guidance on the appropriate selection of preservative treatment taking into consideration the desired service life, the type of exposure to weather and moisture and the natural durability of the timber.

Brush application should be used for protection of surfaces of treated wood exposed by on-site cutting, drilling, shaping, etc., treatment of component repairs prior to painting, and also in conferring resistance to blue stain disfigurement of paints and stains.

NOTE 2 Application of preservatives by brush is less effective than impregnation, because penetration of the fluid is limited and the protective zone is relatively shallow.

9.2.2.5 Flame-retardant treatments

NOTE Treated materials can be painted with clear, pigmented and opaque products, using conventional methods of application.

Care should be taken when applying a decorative coating to flame-retarded substrates so that the flame-retardant properties are not degraded. Advice on painting over flame-retardant treated materials should be sought from the manufacturer.

Highly flammable coating materials such as nitro-cellulose-based lacquers should not be used as these can contribute to the risk of flame spread.

The flame-retardant treated substrate should receive at least the first coat of the coating system as soon as possible and before installation.

9.2.2.6 Wood-based panels products

NOTE 1 For further information on wood-based panels, see Annex E.

When it is necessary to paint fibre building board and wood chipboard, the manufacturer's recommendations should be followed in respect of board types and design details.

NOTE 2 The outer layers of plywood exposed to weather are prone to develop checking parallel to the grain, even when painted.

9.2.2.7 Penetration of binder

NOTE Deep penetration is not necessary for priming coats to adhere and can be both wasteful of material and detrimental to performance as binder can be preferentially absorbed, leaving the dried film underbound or weakened.

The large pores in hardwoods can be bridged by paint coatings, leaving an air space beneath the film and forming a weak point that can initiate breakdown. To prevent this, pore filling should be undertaken when hardwoods are painted using appropriate low build, low viscosity primer.

9.2.3 Coating systems for interior use

NOTE 1 Both solvent-borne and water-borne paints are used for painting of interior wood. For information on primers for wood, see Table E.1. For information on coating systems for interior wood, see Table E.2 and Table E.3.

Solvent-borne paints have traditionally been used for finishing trim because of durability, working time, flow and possibility of a high gloss finish. However, when selecting solvent-borne paints for interior use, consideration should be given to the VOC content, ventilation requirements and target surface area.

NOTE 2 Attention is drawn to the VOC legislation SI 2012-1715 [6].

Water-borne paints should be applied using synthetic filament rather than natural bristle brushes as the synthetic filament aids the flow of the coating material and reduces brush-marking.

Before the application of paints, bare wood knots should be sealed to reduce the risk of tannin staining. This is a particular concern for water-borne paints.

9.2.4 Coating systems for exterior use

NOTE 1 For information on coating systems for exterior wood, see Table E.4 and Table E.5.

Coating systems for exterior use should provide a flexible weather-resistant coating that maintains its integrity and protective properties in the long term. Both solvent-borne and water-borne technologies are available and can be formulated to give high performance coatings for exterior wood, and these should be applied in accordance with the manufacturer's recommendations to provide appropriate film thickness and ensure long-term durability. Manufacturers should be consulted on which product system to use.

Coating materials should be selected in relation to the expected end-use requirements.

The standards of performance specified in BS EN 927-2, BS 7664 and BS 7956 should be regarded as a minimum requirement for wood coatings.

Clear varnishes perform very poorly on exterior wood in exposed situations and should not be used unless frequent maintenance is acceptable.

NOTE 2 Most exterior stains and varnishes are therefore pigmented and might contain additives for weather protection.

Product selection should be carefully considered taking into account the viscosity and penetration characteristics of the stain to be used.

NOTE 3 Stains are available with different build levels which result in different degrees of penetration and film thickness.

Maintenance of wood stains should be carried out before any loss of film integrity, because any exposure of the wood to weathering can result in discoloration, which no semi-transparent coating can disguise.

The wood coating's efficiency to exclude moisture is an important property that determines the extent of dimensional movement of coated wood in use, as well as influencing the risk of fungal decay. It should therefore be taken into account when selecting or specifying wood coating materials.

Multi-coat, high-build coating systems are reasonably effective barriers to the free movement of liquid moisture and vapour provided the coating is continuous and remains intact. However, all coatings allow some passage of water during wetting and drying, and this leads to consequent movement of the wood. Thus high permeability wood stains are suitable for fencing where free movement is acceptable. A less permeable coating material should be used for window joinery where movement needs to be controlled.

NOTE 4 For cladding, an intermediate level of permeability is acceptable. Guidance on permeability bands for end-use categories is given in BS EN 927-2.

NOTE 5 Coating materials suitable for use on plywood are shown in Table E.5.

NOTE 6 When installed in accordance with the supplier's recommendations, some types of hardboard and mediumboard are suitable for external use.

Factory-applied treatments suitable for exterior exposure are available but, when site painting is necessary, the types of coating systems (except cement paints) described in 9.3.4 as suitable for external surfaces should be used.

NOTE 7 Typical coating systems for externally sited boards are indicated in Table E.6.

On external cladding, vapour-permeable coating materials should be used; textured coating materials are particularly suitable. The selection of systems and their performance in service is, however, influenced by the materials and forms of construction, and reference should be made to the board and paint manufacturer's recommendations in specific circumstances.

9.2.5 Surface preparation

9.2.5.1 General

Preparatory treatment of wood should be undertaken before priming, e.g. cleaning, abrasion and treatment of knots. Thorough surface preparation is especially important on wood that has been exposed to weather without protection. If there is doubt regarding the moisture content of the wood, then this should be measured before painting and should not exceed the manufacturer's instructions for the product being applied (see 9.2.2.2 for moisture content).

If timber has received preservative treatment, time should be allowed for drying out or evaporation of the solvent before priming.

Except with the more open-surface grades of wood chipboard, building boards do not usually need sanding before being painted. If sanding is considered necessary to improve adhesion to glossy-surfaced hardboards, a fine grade of abrasive paper should be used and care should be taken to avoid scoring the surface as this can result in localized swelling along the score marks when paint is applied.

Boards that have received flame-retardant treatment should be primed to prevent efflorescence or discoloration caused by reaction between water-borne coating materials and chemicals used in the treatment.

NOTE Similarly, priming of single-layer wood chipboard might be necessary to prevent absorption of water and consequent swellings of the chips that produce a rough surface.

9.2.5.2 Cleaning

The surface should be cleaned as a clean surface is essential to the satisfactory adhesion and appearance of the paint system. Dirt and surface deposits, exuded resin and soluble salts arising from preservative treatment should be removed. Solvent cleaning should be used if the surface is contaminated with oil or grease.

Wood surfaces should be cleaned with a stiff, but not wire, brush. Loose dust should be removed with a soft fibre brush or vacuum cleaner (the dust can be strongly alkaline).

9.2.5.3 Abrasion

WARNING Dust is hazardous. See Annex A for appropriate precautions to be taken.

Where necessary, abrasion should be used to clean the surface, reduce roughness and improve paint adhesion. Dust should be carefully removed and contained. PPE should be used when dust is being created.

NOTE Wood can be sanded mechanically or manually using traditional sandpaper or one of the more modern abrasive pads with incorporated grits.

An appropriate grade of abrasive paper should be used according to the surface being prepared; excessively coarse grades can damage the wood fibres, impairing the appearance and possibly the performance of the paint system. The surface should be sanded in the direction of, and not across, the grain without using excessive pressure, which can damage the wood fibres. Care should be taken to avoid damaging moulding but arris edges should be rounded off to ensure good paint adhesion.

Steel wool should not be used on wood surfaces as it can leave tiny particles of wire which can rust and spoil the finish.

Wood should be bright and free from denatured fibres before painting. Surface preparation is particularly important for weather-degraded wood; it should ideally be achieved by planing or mechanical sanding.

9.2.5.4 Knot treatment

Knot treatments should be used where required, especially on resinous areas.

NOTE 1 Discoloration of paint, especially noticeable with light colours, can occur over knots and resinous areas especially if the wood has been treated with preservative containing certain organic solvents.

Heavy applications and the use of knotting which has thickened through the evaporation of solvent should be avoided as paint adhesion can be impaired. White and clear knotting should be used when finishing with semi-transparent wood stains.

In severe instances of resin exudation from knots, consideration should be given to removing the knot by drilling, followed by filling of the hole.

NOTE 2 See E.2.8 for further information on knot treatment.

9.2.5.5 Stopping and filling

NOTE 1 Materials used for stopping and filling are described in 8.3.5 and the techniques are described in 9.1.6.

For stopping-up nail and screw holes and repairing minor damage to the surface, either water-mixed or drying-oil/resin stoppers or fillers should be used. Solvent-borne two-pack filler should be used for applications involving MDF.

In the absence of well-prepared (drilled and plugged) board, exposed heads of nails and screws, unless they are rust-resistant, should be touched-in with quick-drying solvent-borne primer to prevent rust-staining.

NOTE 2 Water-mixed stoppers and fillers can be used on either primed or unprimed surfaces. If a water-mixed material is used for stopping-up after priming or on factory-primed or sealed boards, it might be necessary to touch-in the stopping with primer to ensure a surface of uniform absorption.

Drying-oil/resin stoppers and fillers should be used only on primed or sealed surfaces. If a high standard of finish is desired on some types of wood chipboard, water-mixed or drying-oil/resin fillers can be used, but the surface should first be primed.

NOTE 3 Direct application of water-mixed fillers causes swelling of the wood chips; with drying-oil/resin fillers, the binder is absorbed.

If checking has occurred on exterior plywood and it is to be painted, it should be filled after priming.

The natural surface of chipboard varies according to the method of spreading the chips during manufacturing. If the surface has a coarse or open texture, it should be filled before painting to obtain a satisfactory finish.

NOTE 4 Some methods produce a surface of finer texture requiring little or no filling before painting.

9.2.5.6 Priming

NOTE 1 Primers for wood are listed and described in Table E.1, with typical applications indicated in Table E.2 to Table E.5. Information on site priming of certain boards are given in Table E.6. A good primer, applied to dry, sound substrates, is the foundation of a durable paint system.

If site priming is necessary, it should be carried out immediately after delivery of the joinery, provided that its moisture content is at an appropriate level. If not primed or sealed during manufacturing, building boards should be primed before application of the topcoat system.

The full system should be applied as soon as possible afterwards as single coats of primer provide only limited protection against moisture, especially if the wood has not been treated with a water-repellent preservative.

If primed woodwork has been exposed for a lengthy period, the condition of the primer should be checked before continuing application of the paint system. Areas of defective or poorly adhering primer should be removed and the exposed areas re-primed. If the primer adheres firmly but is chalking or powdery, it should be lightly abraded and a further coat applied.

Varnish and wood stains are usually applied direct without primer, but thinning of first coats might be necessary and the manufacturer's recommendations should be followed.

Bitumen-impregnated insulating boards, if they are to be painted with solvent-borne paints, should be primed with an aluminium primer or stain block sealer to prevent discoloration (bleeding).

NOTE 2 Traditional practice, especially with fibre building boards, is to prime or paint unexposed faces of boards (back-prime/back-paint) to prevent absorption of moisture. In most circumstances, and provided that boards of appropriate types are installed in accordance with the manufacturer's recommendations, this is not necessary.

Unless the board manufacturer advises otherwise, wood-based panel products should not be back-primed.

9.3 Interior and exterior masonry and plaster surfaces

NOTE Interior and exterior masonry and plaster surfaces include interior plaster walls, external rendering, concrete, brick and stone. These have a number of characteristics in common and, to avoid repetition, general principles applying to the selection of paint for these substrate systems are considered here. More information on the characteristics of these substrates, both general and specific, is provided in Annex F. For further information on the protection of concrete structures, see BS EN 1504-2 and BS EN 1504-10.

9.3.1 General characteristics

9.3.1.1 General

The following issues should be considered when painting masonry and plaster surfaces:

- moisture content;
- efflorescence;
- calcium carbonate deposits;
- alkalinity; and
- staining.

9.3.1.2 Moisture content

Electrical moisture meters should be used to determine the moisture content of the substrate. They are easy and convenient to use and enable a number of readings to be taken quickly. If a wall is believed to be damp but meter readings at a shallow depth indicate low moisture content, the area should be covered with a sheet of polyethylene and rechecked 24 h later. If there is adjacent woodwork, its moisture content should also be determined, as there is less likelihood of soluble salts being present in wood and readings are therefore more reliable, especially if they are significantly lower for the wood.

NOTE 1 Moisture meters are frequently calibrated for use on timber and are less reliable on masonry. If the timber equivalent moisture content exceeds 16% then the wall can be considered still drying and if the timber equivalent moisture content exceeds 20% then the wall can be considered still damp. This determines the selection of the paint that can be used.

For masonry and plaster surfaces, moisture meters with longer probes should be used as they give more accurate readings.

NOTE 2 Capacitative moisture meters which do not require probes may also be used.

The moisture meter should give a reasonable indication of whether the substrate is sufficiently dry for painting. If in doubt, further study should be undertaken.

The equilibrium humidity of the substrate should be assessed by sealing a hygrometer probe beneath the polyethylene sheet used to cover the area being assessed. The equilibrium relative humidity should then be measured after a minimum period of 24 h and the results assessed as to whether painting should commence.

NOTE 3 Guidance is given in Table F.1 and Table F.2. The first column of these tables refers to four stages of drying of walls, i.e. dry, drying, damp, and wet, and gives corresponding equilibrium humidity percentages.

9.3.1.3 Efflorescence

Efflorescence, usually sodium sulfate, is likely to disrupt relatively impermeable (e.g. solvent-borne and fully bound water-borne) paints but can come through more permeable (e.g. silicate) paints without much disruption although their adhesion might be impaired. Even permeable paints, therefore, should not be applied until efflorescence has ceased. As efflorescence occurs, it should be removed with a dry cloth or brush, and collected in bags. This should be followed by wiping with a damp cloth wrung out frequently in clean water avoiding excessive wetting. This treatment should be repeated at intervals of a few days until efflorescence has ceased and the substrate should be dry before painting.

9.3.1.4 Calcium carbonate deposits

Thin, hard film known as lime bloom cannot be wiped off but can usually be softened and removed with a steam gun and scraper. Lime bloom can be over-painted without much risk of disruption provided the substrate is substantially dry. The glazed surface might impair adhesion and should be lightly abraded to prevent this.

9.3.1.5 Alkalinity

Alkali-resisting primers provide a measure of protection against alkaline attack and should be used beneath solvent-borne systems, typically but not exclusively alkyd-based, applied to substrates in which alkalis might be present. However, the essential function of primers is to diminish the risk of failure on substrates that are substantially dry. Alkali-resisting primers are generally low in moisture vapour permeability and adequate time should be allowed for drying to occur.

Alkali-resisting primers can also protect and improve the performance of water-borne paint on cement-based substrates; if used, they should be applied thinly to avoid producing a glossy surface to which water-borne paint might not adhere satisfactorily.

9.3.1.6 Staining

If it is suspected that staining is likely to occur, a coat of primer should be applied to prevent it and should also be used over stained water-borne paint to prevent staining of succeeding coats.

NOTE A ready-mixed aluminium priming paint for woodwork (see Table E.1) has been found to be effective.

Staining is only likely to be an issue if the material causing the stain can migrate. Tar-like or water soluble stains are likely to be prevented following the above guidance but if in doubt, further advice should be sought.

9.3.2 Specific characteristics

9.3.2.1 Plaster

NOTE For further information on plaster, see Annex F. For further information on plasterboard, see Annex H.

Added lime (or cement in backing coats) in the presence of moisture might cause alkalinity, and therefore for calcium sulfate (gypsum) an alkali-resistant coating material should be used.

Thin-wall plasters normally present no difficulties in painting when used on dry backings but sometimes appear underbound and can be excessively absorbent; in these cases, a water-borne primer-sealer should be used (see Table B.3).

Cement:sand, cement:sand:lime or other lime-based plasters should be used where strong, hard or moisture-resistant surfaces are needed. They should not be painted until they have substantially dried out, as they will remain strongly alkaline under these conditions.

9.3.2.2 External renderings

9.3.2.2.1 Cement renderings

NOTE The renderings in general use are cement-based and might incorporate hydrated lime. They might not require painting when new, although this might eventually be necessary for appearance or if repairs are carried out.

To be suitable for painting, bell casting should be present to ensure the render is not in direct contact with the ground. However, renderings should not be painted until they have substantially dried out.

9.3.2.2.2 Stucco

NOTE Stucco can be made from lime/sand (pre-1790), Roman or Portland cement-based (dating from about 1790) or oil mastic (1790 to 1820).

Where deterioration or removal of the paint coating exposes the original surface, repainting might be undertaken, for which the rendering should be sound and dry.

9.3.2.2.3 Repairs to renderings

If repairs to old renderings are necessary, they should be carried out in accordance with BS EN 13914-1, using cement-based mixes. The repaired portions should then be treated as for new work in respect of painting.

9.3.2.3 Plasterboard

NOTE Plasterboard consists of a core of gypsum plaster with a thick paper liner on each side. For further information on plasterboard, see Annex H.

9.3.2.3.1 Dry lining

NOTE Plasterboard is most widely used in dry-lining systems in which paint or wallcoverings are applied directly to the board surface after fixing, with joints being filled with a mixture of tape and filler which is subsequently sanded to be flush with the board. This leads to differences in texture and porosity between the sanded filler and the surface of the boards. In critical lighting conditions, where light reflected from the surface is viewed at an angle looking along the wall, painting will not mask the difference in texture between the two materials, sometimes leading to highly visible board joints.

Where visible board joints will be considered unacceptable, the wall should be skimmed with plaster over the whole surface.

9.3.2.3.2 Skimmed plasterboard

Where plasterboard has been skimmed with plaster after fixing, the surface should then be considered, treated and painted as for plaster.

9.3.2.4 Brick and stone

NOTE 1 Brick and stone are durable materials, generally of attractive natural appearance and, when new, do not usually require painting. For information on the characteristics of brick and stone, see Annex F.

Where brick and stone are to be painted, it should be confirmed that the bricks used for facing are suitable for painting, such as concrete (calcium silicate) or sand-faced bricks.

NOTE 2 On older buildings, painting might be necessary to improve appearance, hide repairs and alterations or reduce rain penetration.

On large buildings, painting of external masonry essentially for cosmetic reasons should be undertaken only after consideration of the implications in respect of maintenance expenditure.

NOTE 3 Generally, brick (other than concrete bricks) and stone are not, in themselves, alkaline, but the mortars used in construction are usually strongly alkaline and, until dry, are likely to give rise to the difficulties in painting described in 9.3.1.5.

Efflorescence can also occur from the mortar between brickwork and stonework and should be treated in accordance with **9.3.1.3**.

If moisture penetration occurs, paint coatings are likely to be disrupted and can prevent or retard drying out of moisture, thereby increasing the risk of the brick or stone being damaged by frost. In these situations, brickwork and stonework should not be painted.

Some paints such as inorganic silicate-based paints might be suitable since they will not retard the passage of moisture. If a change of colour or decoration of the surface in question is required, advice on suitable paints should be sought (see Table F.2).

The adhesion of conventional paints to the harder, non-porous stone, especially if the surface is smooth or polished, is likely to be poor; if painting is essential, paints of the types recommended for glazed bricks (see **9.7.1**) should be used.

Generally, traditional common bricks, fletton bricks and engineering bricks should not be painted (see Annex F for more detail).

9.3.2.5 Concrete

NOTE 1 Concrete does not usually require painting for protection although this might be necessary to prevent long-term deterioration in aggressive atmospheres. In relation to painting, the general characteristics of concrete are similar to those of external rendering. Because of the greater thicknesses usually involved, it can take concrete much longer to become dry enough to paint without restrictions on the choice of paints.

Protective painting, using chemical-resistant paints, should be undertaken where there is a need to prevent penetration of carbon dioxide, water and salts after repair of deteriorated concrete, or even on new concrete if the thickness and integrity of concrete over reinforcement is insufficient to provide protection. In most circumstances, however, concrete is painted to improve its appearance, especially on large areas.

NOTE 2 Coating materials that carry an anti-carbonation certificate are available.

NOTE 3 The surface finish of concrete can vary widely from smooth and dense (e.g. with precast components) to rough and porous with large voids. Where large voids exist, it might be necessary to use a suitable filler or sealer in order to achieve a uniform coating.

Specialist advice should be sought in cases where it is difficult to achieve a good, uniform coating unless a suitable filler or sealer has been used.

Moisture is the key issue relating to painting of concrete surfaces. Concrete floors should have a damp-proof membrane beneath to prevent transmission of ground moisture which will disrupt

adhesion. Specialist advice should be sought regarding painting if the floor does not have a damp-proof membrane.

NOTE 4 This can be checked by using the test given in ASTM D4263-83.

Residues of release agents present on the surface of cast and shuttered concrete can seriously impair the adhesion of paints and should be removed. Laitance on trowelled and floated surfaces can also impair adhesion and should be removed.

9.3.2.6 Precast concrete blocks

NOTE For further information on concrete blocks, see Annex F.

9.3.2.6.1 Moisture content

To minimize drying shrinkage, blocks should be kept as dry as possible, particularly during site storage. The moisture content of new blockwork is unlikely to cause serious difficulties in painting but time should be allowed for the mortar joints to dry out before painting.

9.3.2.6.2 Alkalinity

New concrete blocks are strongly alkaline and an alkali-resisting system should be used preferably when the blockwork has substantially dried out.

9.3.2.6.3 Porosity

NOTE Concrete blocks vary considerably in porosity and absorption according to their manufacturing process, density and the nature of the aggregate used, but even the densest blocks are usually sufficiently porous to afford satisfactory adhesion for paint. The more open and porous materials, however, need a more protective system in exposed situations.

Primers or first coats should be thinned in accordance with the manufacturer's instructions.

9.3.2.6.4 Texture

NOTE Blockwork is often painted directly to save the cost of rendering or plastering, but normal paint systems do not completely mask the texture of the blocks and attempting to smooth the surface by conventional filling methods is rarely satisfactory.

Roller or spray application of heavy-bodied, thick coating materials can usefully combine both protective and aesthetic functions. For this type of coating material, one of the coating layers should be applied by brush or roller in order to impart the desired texture. When appearance is important, blocks having an acceptable surface texture, e.g. of facing quality, should be used, with paint being used to complement the texture rather than mask it.

9.3.3 Coating systems for interior use

The choice of paint systems for substrates employing wet materials of construction should be determined by the moisture content at the time of painting. Where time is allowed for drying out, the conditions of service and the requirements in respect of appearance, i.e. colour, sheen level and texture, should be taken into account in the choice of paint systems.

Mid-sheen or matt finishes should be used for walls and ceilings as they minimize the effect of surface irregularities and reduce reflection of light sources.

NOTE Their resistance to wear and repeated washing is generally relative to the degree of sheen, and mid-sheen or matt finishes are less suitable than gloss finishes for use in hard-wear conditions. See Table F.1 for guidance on selection of interior finishing coats.

9.3.4 Coating systems for exterior use

NOTE 1 Coating systems for exterior use are principally to enhance appearance by imparting colour and texture or, in some cases, to prevent rain penetration.

A range of specialized coatings can be used to protect the surface of concrete from potentially harmful agents, e.g. carbon dioxide, sulfur dioxide and salts, and the manufacturer's recommendations should be followed. Initial painting and subsequent maintenance can be costly and, in designing new buildings, consideration should always be given to the use of alternative means of achieving the desired objectives, e.g. by using self-coloured renderings or facings which require infrequent maintenance or are resistant to rain penetration.

Painting might be necessary to provide a uniform appearance when repairs or alterations have been carried out. Although external walls are often not painted until many years after erection, they should still be regarded as new; the considerations in respect of moisture content described in 9.3.1.2 should be applied, especially when rain has penetrated or repairs have been carried out. Additionally, mould and other biological growths might be present, and preparatory treatment to deal with these should be carried out as described in 9.1.3.1.

Masonry paint should not be used as a hoped for cure-all coating for rising damp, walls affected by water ingress from failed rainwater gutters and downpipes and failed lead flashing as it will fail very quickly in these circumstances. Preventive maintenance should be carried out first to overcome water ingress into the substrate before the application of coating materials.

Scaffolding should be positioned well off the work face to avoid patterning which is apparent once the scaffold rig is removed.

NOTE 2 See Table F.2 for guidance on selection of exterior finishing coats.

9.3.5 Surface preparation — cleaning

9.3.5.1 General

New surfaces should normally be brushed down with stiff (not wire) brushes to remove loose material. Efflorescence should be treated as described in 9.3.1.3.

Old unpainted surfaces, especially if rough or textured, might require more rigorous treatment, including washing down, to remove accumulated dirt before painting. If washing is necessary, time should be allowed for drying out. Biological growths might be present on old surfaces and should be treated as described in 9.1.3.

9.3.5.2 Plaster

Dirt and loose surface deposits should be removed by dry brushing. Plaster nibs and splashes should be scraped off, care being taken to avoid damaging the surface. Efflorescence, if present, should be treated as described in 9.3.1.3.

Mould growth can occur on plastered surfaces if drying out has been prolonged, especially in conditions of poor ventilation. The affected areas should be treated as described in 9.1.3.2.

9.3.5.3 Plasterboard

Dirt and loose surface deposits, especially dust from sanding of filled joints, should be removed by dry brushing. Filler nibs and splashes should be scraped off, care being taken to avoid damaging the surface.

9.3.5.4 External renderings

NOTE It is important that external renderings are not in direct contact with the ground which allows wicking and penetration of moisture behind the coating.

Where the render extends to the floor, it should be chipped off at the bottom to create a gap of at least 5 cm, ideally refinishing with a bell casting.

Mould and algal growths can occur on rendered surfaces, especially those facing north, or sheltered by trees. The affected areas should be treated as described in 9.1.3.1.

9.3.5.5 Concrete

NOTE On large areas, it might prove more effective to 'abrasive-blast' surfaces (using non-ferrous abrasives) to remove laitance and glaze to expose fine aggregate. On smooth, shuttered surfaces, paint adhesion might be enhanced when roughened by abrasive blasting.

Residues of release agents should be removed with detergents or emulsifying agents rather than with solvents, which can simply spread the contaminant.

For concrete floors, before painting, it should be confirmed that there is an effective damp-proof membrane underneath. If not, specialist advice should be sought.

9.3.5.6 Brick and stone

Heavily soiled and old unpainted surfaces might require more vigorous treatment, including high pressure washing down, to remove accumulated dirt. Cleaning should be carried out in accordance with BS 8221-1.

9.3.5.7 Cement-based sheets, boards and components

WARNING Asbestos is extremely hazardous. Materials containing asbestos are subject to legislation that requires precautions to be taken in handling them to ensure that they do not constitute a health hazard. See A.2.4 for appropriate precautions to be taken.

With any materials containing asbestos, or suspected of containing asbestos, specialist contractors should be consulted and employed. Non-specialist decorators should not handle any materials containing asbestos.

9.3.6 Surface preparation — Stopping and filling

9.3.6.1 General

Minor cracks, holes and surface imperfections should be stopped and filled with appropriate material before application of first or priming coats.

9.3.6.2 Plaster

Cracks, holes and surface imperfections should be stopped and filled with plaster, water-mixed filler or, in cement plasters, with masonry cement, before application of first or priming coats.

9.3.6.3 Plasterboard

Cracks, holes and surface imperfections should be stopped and filled with plaster or water-mixed filler before application of first or priming coats. The correct grade of filler should be selected for the imperfection to be filled. A general purpose filler should be used for filling holes whilst a fine surface filler should be used for smoothing shallow dips.

9.3.6.4 External renderings

Minor cracks, holes and surface defects should be stopped and filled with exterior grade water-mixed cement-based filler or masonry cement before application of first or priming coats.

9.3.6.5 Brick and stone

On old, unpainted surfaces, repairs and re-pointing should be carried out well in advance of painting to facilitate drying out.

Minor surface defects should be stopped and filled with interior or exterior grade water-mixed filler or with masonry cement before application of first or priming coats.

9.3.6.6 Concrete

Large voids and air-holes should be filled with masonry cement or epoxy resin mortars. Minor surface defects should be stopped and filled with interior or exterior grade water-mixed cement-based filler or with masonry cement before application of first or priming coats.

NOTE Application of cement paint or bagging with a cement:sand slurry can reduce surface roughness and fill minor imperfections.

9.3.6.7 Precast concrete blocks

If necessary, cracks, holes and damaged areas should be stopped and filled with cement mortar, masonry cement, or, in dry interior conditions, water-mixed fillers.

NOTE Overall filling of the surface of blockwork by conventional methods is not recommended. On the finer-surfaced blocks, a cement:sand slurry or cement paint scrubbed into the surface reduces texture and fills small holes. Thick textured coatings are also useful in this respect.

9.3.6.8 Cement-based sheets, boards and components

WARNING Asbestos is extremely hazardous. Materials containing asbestos are subject to legislation that requires precautions to be taken in handling them to ensure that they do not constitute a health hazard. See A.2.4 for appropriate precautions to be taken.

With any materials containing asbestos, or suspected of containing asbestos, specialist contractors should be consulted and employed. Non-specialist decorators should not handle any materials containing asbestos.

The necessity for filling does not normally arise with exterior cladding and roofing materials or with interior linings when patent fixing methods are used. When interior linings are fixed by nailing or screwing, a water-mixed filler should be used for stopping. Fixings should be corrosion-resistant otherwise rust staining could occur, both on interior and exterior surfaces.

Where a high standard of finish is required on flat interior surfaces, smooth-surface boards should be specified but, if necessary, water-mixed fillers can be used.

9.3.7 Application issues specific to masonry and plaster

9.3.7.1 Priming

9.3.7.1.1 General

NOTE 1 Guidance for priming is given in Table F.1 and Table F.2.

Priming is generally essential when solvent-borne paint systems are to be applied but is not usually necessary when water-borne paints are to be used, however this should be confirmed with the paint manufacturer.

NOTE 2 See 9.3.1.5 and 9.3.1.6 for general consideration, and 9.3.6 for specific surfaces.

To accommodate variations in surface porosity and facilitate application, primers or first coats should be thinned strictly in accordance with the manufacturer's instructions.

9.3.7.1.2 Plaster

When water-borne paints are applied to plaster of high or variable porosity, differential absorption can cause difficulties in application or variations in colour or sheen, which can persist through several coats. A well-thinned first coat of water-borne paint, sometimes referred to as a sealing or mist coat, often overcomes the problem but is likely to have relatively poor opacity and, if it is required, should be regarded and specified as an additional coat in the system. The manufacturers' recommendations should be followed.

Where this proves inadequate, a coat of alkali-resisting paint or primer-sealer should be applied, but this should be done only if the substrate is substantially dry. The film should be applied thinly to ensure that it does not provide a glossy surface to which water-borne paint might not adhere satisfactorily.

9.3.7.1.3 Plasterboard

When water-borne paints are applied to dry lining, variable porosity and differential absorption between boards and filled joints can cause difficulties in application or variations in colour or sheen, which can persist through several coats. To reduce the problem, a number of manufacturers offer products intended for application as a first coat to dry lining systems. The manufacturers' recommendations should be followed. This should be regarded and specified as an additional coat in the system. In order to provide as even a surface as possible for further decoration, this coat should be applied and cut in with the same care as subsequent coats in the system.

9.3.7.1.4 Brick and stone

Priming is necessary with solvent-borne systems and, because mortar joints are likely to be alkaline, an alkali-resisting paint should be used.

Where bricks contain high levels of ferrous oxide, a stain-blocking primer should be used for sealing.

NOTE Some bricks contain high levels of ferrous oxide which can be present in raw materials in certain geographical locations. This can cause iron staining which will bleed through most water-borne coatings.

9.3.7.1.5 Cement-based sheets, boards and components

WARNING Asbestos is extremely hazardous. Materials containing asbestos are subject to legislation that requires precautions to be taken in handling them to ensure that they do not constitute a health hazard. See **A.2.4** for appropriate precautions to be taken.

With any materials containing asbestos, or suspected of containing asbestos, specialist contractors should be consulted and employed. Non-specialist decorators should not handle any materials containing asbestos.

NOTE Alkali-resisting paints might not be strictly necessary in solvent-borne paint systems for some types of cement-based insulating boards of low alkalinity, but there is no disadvantage to their use.

Unless the board manufacturer's recommendations are that this is not necessary, fibre-cement sheets should be back-painted to prevent differential carbonation and build-up of alkaline materials. For this purpose, impermeable paints of a similar type to those used on the exposed surface should be used.

9.3.7.2 Finishing

The selection of coating systems for concrete should be in accordance with **9.3.3** and **9.3.4**. Details of systems are incorporated in Table F.1 and Table F.2.

Coating materials which are applied to give additional protection to concrete should be of an impervious type (see those described in Table B.1) to prevent ingress of water, corrosive salts and gases. These should be applied only to dry surfaces.

NOTE By protecting the integrity of the concrete cover over mild or high-tensile steel reinforcement, the time to initiation of disruptive corrosion is extended, as well as reducing the rate of further deterioration of repaired existing concrete. Periodic maintenance is needed. Further guidance on the selection of specialist coating materials for the protection of concrete both new and repaired is given in BS EN 1062-1 and BS EN 1504-2.

9.4 Metallic surfaces

NOTE For further information for coating systems on ferrous substrates, see Annex G.

9.4.1 Ferrous metal surfaces

9.4.1.1 General characteristics

NOTE Many important metal components in construction are pre-painted before delivery to site, and might need no painting or only a top coat.

Painting carried out on site should consist of maintenance and repair of parts which have been installed for several years.

9.4.1.2 Coating systems

For a more comprehensive treatment of ferrous metal, especially in situations where the exposure conditions are classified as moderate or severe, painting should be carried out in accordance with BS EN ISO 12944 Parts 1 to 9. The manufacturers' instructions should be followed with regard to product recommendation and use at all times. For the application of zinc-based paints to ferrous substrates, painting should be carried out in accordance with BS EN ISO 14713 (all parts).

NOTE The effectiveness of coating systems in protecting ferrous metal is dependent upon the following factors.

a) The nature and thoroughness of the preparatory method and the type of primer used. Generally, primers for ferrous metals contain corrosion-inhibitive pigments.

b) The extent to which the system is able to exclude air and moisture. This is determined mainly by the total thickness of the paint film, its physical properties and the conditions of exposure. BS EN ISO 12944 (all parts) provides detailed explanation of protective paint systems for a full range of exposure conditions and durability periods.

9.4.1.3 Surface preparation

9.4.1.3.1 Removal of oil, grease and surface deposits

In common with all substrates, an inspection should be carried out and any oil or dirt should be removed before painting or overcoating a ferrous substrate.

Where possible, proprietary degreasing agents should be used to clean surfaces with a succession of clean swabs. Care should be taken to avoid spreading any oil or grease over the surface.

Surfaces which are contaminated following exposure to marine or chemical atmospheres should be washed with clean water, rinsed and allowed to dry before priming. Rust that develops as a result of washing should be removed.

Special attention should be paid to the washing off of salt deposits from surfaces primed with zinc-rich primers as the corrosion products formed by the reaction between the salts and the zinc can affect the performance of subsequent coats.

9.4.1.3.2 Mild steel

WARNING Use of abrasive blasting equipment is hazardous to health.

Abrasive blasting equipment should only be used by trained professionals. Correct PPE should be used. See Annex A for appropriate precautions to be taken. Abrasive media and debris should be properly collected and disposed of.

Mill scale and rust should be removed before the steel is painted; it is essential that this is done if high-durability or specialist paint is to be applied.

The effectiveness with which mill scale and rust are removed depends upon the method employed. Oil, grease and dirt should also be removed. If ferrous metal has been exposed to severe or very severe exposure conditions, e.g. marine and industrial, where residual surface contaminants can stimulate corrosion, care should be taken in cleaning.

Surface preparation should be done by recognized commercial methods, which may include abrasive blasting, acid washing, or manual abrasion techniques.

NOTE 1 Abrasive blasting is the most effective method of preparing steelwork for painting and is strongly recommended when specialist coating materials are to be used, e.g. in severe and moderate exposure conditions.

In respect of cost and effectiveness, blast-cleaning should be carried out under factory conditions although the method is also suitable for the preparation of erected steelwork in some circumstances.

NOTE 2 BS EN ISO 8501-1 and BS EN ISO 8501-2, BS 7079-A2 describe standards for abrasive blasting. Further information on abrasive blasting, including guidance on its specification and quality control, is given in BS EN ISO 12944-4. In addition to its effectiveness in removing rust and mill scale, abrasive blasting provides a roughened surface which improves paint adhesion.

Abrasive blasted surfaces are extremely vulnerable to corrosion (flash rusting) and should be primed as soon as possible and in any case within 4 hours of cleaning.

NOTE 3 As an alternative to abrasive blasting, for site treatment of steelwork, proprietary acid washes and pastes, usually based on phosphoric acid, may be used. Acid washes do not remove heavy rust or tightly adhering scale but can assist manual cleaning. Many types require washing off; if this is not done properly, the performance of the paint can be affected and, if drying is slow, the steel will rust again.

Washing-off water should not be allowed to run over adjacent brickwork or stonework. Where solutions claim washing off is not required, the manufacturer's recommendations should be followed.

Manual preparation is the least effective method of preparation and should not be used for steelwork exposed to severe or moderate conditions unless the size of the areas or other circumstances might preclude the use of more effective methods. Manual preparation might not provide a satisfactory base for specialist coating materials and therefore especially formulated coating materials which are tolerant of manually prepared surfaces should be used. The manufacturer's recommendations should be followed carefully on such occasions.

Power tools usually give the best results, but care should be taken to avoid surface damage such as burning, indentation, burring and scoring as peaks can be produced which protrude through the paint film and become focal points of corrosion. Over-vigorous brushing with hand or power tools should also be avoided as it can produce excessively smooth and polished areas to which paint adhesion is poor.

NOTE 4 Manual preparation, whether with hand or power tools, is laborious and it is difficult to maintain a uniform standard for any length of time. Visual cleanliness for hand/power tool cleaning is defined in BS EN ISO 8501-1 and BS EN ISO 8501-2, BS 7079-A2.

As the achievable standard of cleanliness from manual techniques is variable (depending on the available methods, ease of access and condition of the existing substrate), a trial area should be prepared to demonstrate the best available standard which is agreed between all parties (e.g. client, paint applicator, coating materials manufacturer), and this area represents the standard to be achieved on the job itself.

9.4.1.3.3 Stainless steel

If painting of stainless steel is necessary, surfaces should be abraded and degreased before application of an appropriate pre-treatment primer as recommended by the manufacturer.

9.4.2 Non-ferrous metals and metallic coatings

9.4.2.1 General characteristics

In general, painting of non-ferrous coatings on buildings, e.g. aluminium window frames when a change of colour scheme is required, is done by specialist contractors. Such persons should be consulted if necessary.

NOTE 1 In most conditions, painting is not necessary except for appearance, but might be needed in some exposure conditions, e.g. in acid or severe marine or road salt conditions.

A characteristic of some non-ferrous metal surfaces is that special preparation or pre-treatment, or the use of primers of a specific type, is necessary to ensure satisfactory adhesion of paint. This is particularly so where thermally sprayed coatings are to be exposed externally, in which case a sealer should be applied prior to priming and overcoating with the specified paint system.

NOTE 2 Further details of common non-ferrous substrates are given in Annex G.

9.4.2.2 Special characteristics

9.4.2.2.1 Aluminium and its alloys

Pre-treatment primers should be used for aluminium and its alloys to assist adhesion on smooth surfaces, e.g. sheets, extruded sections and aluminized steel.

NOTE Although aluminium and its alloys vary in corrosion resistance, similar primers are used for all of them.

9.4.2.2.2 Zinc and zinc-coated (galvanized, sheradized and electroplated) steel

Zinc reacts with most drying-oil/resin paints, forming soluble salts (zinc soaps) beneath the paint film which cause it to become brittle and lose adhesion. Zinc should be primed with a non-oil based primer/pre-treatment primers except possibly on galvanized sheet.

9.4.2.2.3 Sprayed metallic coatings

Where sprayed zinc, aluminium and zinc aluminium alloy coatings are to be painted, following their application they should be immediately coated with a pre-treatment primer in order to retard the development of corrosion products which can affect the adhesion or appearance of the paint. This is especially important if they are to be exposed to damp or corrosive atmospheres. If this is not done and corrosion products have developed, they should be removed and the surface allowed to dry before application of the pre-treatment primer. Except in very mild conditions, the pre-treatment primer should be followed by one coat of compatible primer.

9.4.2.2.4 Copper and its alloys, e.g. brass and bronze

NOTE Copper and its alloys are rarely painted except for appearance.

To aid the adhesion of paint, these surfaces should be abraded with fine abrasive paper, wiped with a proprietary degreasing agent, and then a pre-treatment primer should be applied.

9.4.2.2.5 Lead

WARNING Lead dust and fumes are extremely hazardous. See Annex A for appropriate precautions to be taken.

The creation of lead dust and fumes should be avoided. Specialist advice should be obtained. All efforts should be made to avoid the creation of lead dust when preparing lead surfaces for painting. Lead surfaces should not be abraded dry. Pre-treatment primers and conventional metal primers, which do not contain graphite, should be applied to clean, grease-free lead surfaces.

9.4.2.2.6 Chromium, nickel and tin surfaces

NOTE 1 New chromium and nickel surfaces rarely need painting, but it might be necessary if they become corroded.

The surfaces should be lightly abraded to remove corrosion products before application of pre-treatment primer.

NOTE 2 Tin plate presents few difficulties in painting; most paints adhere after degreasing.

9.4.2.3 Coating systems

The paint manufacturer's recommendations on suitable products and specifications for non-ferrous substrates should be followed.

In most situations, alkyd finish systems can be used, except for un-primed galvanized or other metallic zinc surfaces. It should be ensured that the primer and succeeding coats are compatible, otherwise adhesion failure can occur, especially in wet conditions.

Film thickness should be as per the manufacturer's recommendation, although it is not as critical to the protection of non-ferrous metals as it is with iron and steel. In most conditions, one coat of primer in addition to the possible use of a pre-treatment primer provides a satisfactory base for further coatings; in some circumstances, a pre-treatment primer alone might suffice.

Special consideration should be given in certain micro-climates, where soluble salts can collect on surfaces resulting in highly corrosive conditions where corrosion products are not removed by normal rain washing and a passivating film of relatively insoluble oxides and other salts is not formed. Under such conditions, a greater film thickness, similar to that required for the protection of iron and steel should be used.

9.4.2.4 Surface preparation

9.4.2.4.1 General

To prepare new non-ferrous metal surfaces for painting, dirt, grease and corrosion products should be removed to a satisfactory cleanliness level and then, if required, a treatment to improve paint adhesion should be applied, e.g. to galvanized surfaces and to aluminium sheets and extruded sections.

Sprayed metallic coatings and aluminium castings provide satisfactory adhesion for paint, but the surfaces should be clean and free from corrosion products and might require light abrasion.

NOTE Etch priming might be necessary to improve adhesion. See Annex G for further details of surface preparation techniques.

9.4.2.4.2 Degreasing

Non-ferrous metals readily retain grease and lubricants used in extrusion and drawing processes and these should be removed. On site, after cleaning off any contamination with an appropriate cleaning fluid, e.g. a proprietary cleaning agent, surfaces should be washed using a detergent solution, rinsed and allowed to dry. Alternatively, surfaces should be wiped over with a proprietary cleaning agent and clean swabs. The solvent and swabs should be changed frequently to avoid spreading the contaminant over the surface. In difficult cases, more abrasive materials should be used.

NOTE Degreasing of thermally metal sprayed coatings and sheradizing can lead to problems with subsequent paint coatings due to the porous nature of the coating material, allowing absorption of the cleaning fluids which then remain trapped and can lead to premature breakdown of the paint coating.

9.4.2.4.3 Removal of corrosion products

Sprayed metallic coatings should be sealed otherwise corrosion products can develop fairly rapidly, especially in damp or chemically charged atmospheres. Corrosion products can be detrimental to the metallic coating and affect paint adhesion. They should be removed before painting by scrubbing with clean water and stiff bristle or nylon (not wire) brushes, followed by rinsing with clean water.

Removal of the rough layer of corrosion products which can form on aluminium after several years of exposure can be difficult and abrasion might be necessary. This should be carried out with stainless steel wire wool or nylon pads, using water as a lubricant. Mild steel, brass, or copper wire is not suitable, as broken strands can become embedded in the surface and stimulate corrosion.

If non-ferrous metallic coatings on iron and steel are damaged or become eroded on long exposure, rusting of the exposed base metal is likely to occur. Rusted areas should be cleaned to bright metal and roughened by wire brushing or abrasion, care being taken to avoid damage to the adjacent sound zinc or aluminium coating.

9.4.2.4.4 Pre-treatment (wash or etching) primers

NOTE Although included here with other preparatory treatments, pre-treatment primers have some of the properties of a conventional metal primer in addition to their essential function of assisting adhesion of paint systems to non-ferrous metals. The use of two-pack pre-treatment primers which are generally superior to one-pack types is now being replaced by water-borne adhesion primers and mordant solutions as a way of improving the adhesion of subsequent coating systems to zinc surfaces.

Pre-treatment primers should be applied as thin films. The maximum film thickness specified by the manufacturer should not be exceeded. Except in very mild conditions, pre-treatment primers should be followed by a normal primer.

Some pre-treatment primers are sensitive to moisture in the early stages and their suitability for use in conditions where they are likely to be exposed to rain or dew should be checked with the manufacturer.

9.4.2.4.5 Abrasion

WARNING Dust is hazardous. See Annex A for appropriate precautions to be taken.

Adhesion of paint to non-ferrous metals can be assisted by abrading the surface with fine emery cloth, or abrasive paper and a proprietary degreasing agent; this method should be used for small areas prepared on site. Dust should be carefully removed and contained. PPE should be used when dust is being created. Care should be taken not to abrade through thin films of pure aluminium on composite (clad) sheets; the use of steel wool or hard abrasives should be avoided on these surfaces.

Light abrasion of galvanized surfaces by abrasive blasting (sweep blasting) can be effective at promoting the adhesion of subsequent coats of paint. A suitable, soft blast medium should be used, with low blast pressures (<276 MPa) and an optimized and controlled blasting angle and nozzle-to-work piece distance maintained.

The recommendations given in Table 4 should be followed regarding surface preparation for non-ferrous substrates.

Table 4 — *Site pre-treatment and priming of non-ferrous metals (not factory pre-treated)*

Substrate	Surface preparation and pre-treatment/priming
Aluminium, smooth surfaces, e.g. sheets, extrusions and aluminized steel	Degrease; abrade and/or apply treatment primer (G.1/4). Then prime using zinc phosphate (G.1/5)
Aluminium, rough surfaces, e.g. castings and sprayed metallic coatings	Abrade lightly; remove dust and dirt. Sprayed metallic coatings might require washing. With sprayed metallic coatings, pre-treatment primer (G.1/4) should be applied immediately following application of the coating material. Then prime using zinc phosphate (G.1/5)
Zinc sheet, zinc (hot-dip galvanized, sherardized and electroplated) coated steel, zinc aluminium alloy (hot dip) coated steel	Degrease; abrade coated sheet metal components as necessary; apply pre-treatment primer (G.1/4) or treat with mordant solution (G.1/3). With sherardizing or if a suitable primer is used on other coatings, weathering or application of pre-treatment primer is not needed. Some hot dip coatings might need denibbing and careful abrasion to remove surface deposits and sharp points. Denibbing is usually undertaken before delivery to site. If this does not happen, denibbing should take place prior to painting.
Zinc and zinc aluminium alloy, sprayed	Sprayed metallic coatings might require washing. Apply pre-treatment primer (G.1/4) or treat with mordant solution (G.1/3). With sprayed metallic coatings, this immediately follows application of the coating material. If painted at a later time, first remove dust and dirt; wash surface if necessary.
Copper, brass, bronze	Degrease; abrade lightly or apply pre-treatment primer (G.1/4)
Lead	Abrade wet (see Annex A for health and safety guidance). Apply pre-treatment primer (G.1/4)
Tin coatings	Degrease; abrade lightly
Chromium and nickel coatings (if corroded)	Abrade to remove corrosion products. Apply pre-treatment primer (G.1/4)

NOTE 1 For specialist advice on the substrates listed, check with the coating material manufacturer.

NOTE 2 Abrasion of metals might detract from the aesthetic appearance of the overall finish.

NOTE 3 Detailed pre-treatment and priming is outside the scope of this standard. If heavy duty protection is required, this is best obtained from a manufacturer of specialist protective coating materials.

9.4.3 Application issues specific to metallic substrates

The coating material manufacturer's product data sheets should be followed at all times, and if necessary the manufacturer should be contacted if further technical advice is required.

Priming should follow preparation as quickly as possible and certainly on the same day, otherwise further corrosion can develop. The interval between preparation and priming is especially critical with blast-cleaned surfaces, and priming for these surfaces should follow preferably within 1 hour and certainly within 4 hours. If it is likely to be delayed beyond this, a temporary protective or holding primer should be applied.

Primed surfaces should be overcoated as soon as possible. If there is likely to be a delay in applying further coats, the primer should be resistant to weathering and should afford some protection to the surface.

NOTE Most prefabrication primers (see Table G.1) can be left uncoated for several weeks depending upon the conditions of exposure and the effectiveness of the preparatory work. It is critical that the condition of the primed surface is sufficiently good to continue painting.

Primed steelwork, especially if it has been exposed for a lengthy period, should be examined carefully before further coats of paint are applied. If the primer has deteriorated, e.g. is perished, eroded or poorly adhering, or has been damaged, so allowing corrosion to develop, the affected areas should be re-prepared and primed. If there is evidence of widespread corrosion beneath the primer, it should be removed and the surface again prepared and primed.

In general, a single coat of primer is sufficient for most applications. However, a second coat should be applied to vulnerable points (e.g. any remaining sharp edges, external angles, bolts) as the applied coating can shrink back due to surface tension and leave a reduced film thickness which is prone to early breakdown.

9.4.4 Heated surfaces

In addition to providing protection, paint systems applied to flues, chimneys, radiators, heating panels and other heated metallic surfaces should have the appropriate degree of heat-resistance in accordance with BS EN ISO 12944-5 or as follows.

a) Up to about 50 °C. Normal paint systems are usually satisfactory.

b) 50 °C to 90 °C. Application of two coats of alkyd gloss finish or aluminium paint over primer as in a) is usually satisfactory; with coloured finishes, some discoloration of light colours can occur at the upper end of the range.

c) 90 °C to 120 °C. Two-pack paints such as epoxy and polyurethanes may be specified for dry heat resistance up to 120 °C, although care should be taken as some discoloration can occur at higher temperatures.

d) Above 120 °C. Specialist coating materials are likely to be required, and the coating material manufacturer should be consulted.

NOTE Resistance to heat is influenced mainly by the maximum temperature reached in service and the nature of the heating cycle, i.e. whether sustained or intermittent, and whether the surface is exposed to moisture. The behaviour of the coating is also influenced by the extent to which the surface remains dry when cold.

9.5 Paper and wallcoverings

NOTE For more information on the general characteristics of paper wallcoverings and plasterboard, see Annex H. Problems can be experienced in respect of painting existing coloured wallcoverings.

9.5.1 General characteristics

9.5.1.1 Wallpapers

NOTE The metallic inks used in some patterns can react with water-borne paints and cause discoloration.

In the past, wallpapers containing "gold" or red colours in their pattern often gave rise to discoloration. Therefore, a test area should be painted on such wallpapers to see if discoloration occurs; if it does, a solvent-borne primer or knotting should be applied to seal the surface of the paper or the paper should be removed.

Application of paint to wallpaper makes its removal more difficult if this becomes necessary at a later date, especially if solvent-borne paints are used. Wallpaper should therefore be painted only if it is firmly adhering and without blisters, creases or prominent joins.

9.5.1.2 Vinyl wallcoverings

These can be vinyl-faced (e.g. paper-backed) or sheet vinyls. Vinyl wallcoverings can be painted, but migration of plasticizer from the vinyl into the paint coating can cause softening or the development of glossy patches in mid-sheen finishes. It is not possible to assess the likelihood of this by short-term tests and, in cases of doubt, the manufacturer of the wallcovering and/or paint should be consulted.

Vinyl wallcoverings should be removed by lifting a corner and peeling away the vinyl-coated surface layer.

NOTE The remaining sheet can be used as a sub-surface for painting provided the surface adhesion is sound.

9.5.1.3 Non-woven papers or vinyl-coated non-wovens

NOTE Non-woven papers are wallcoverings containing a proportion of synthetic content. Non-woven papers or vinyl-coated non-wovens allow for virtually direct removal in a single dry strippable sheet.

Any issues such as metallic inks or plasticizer migration arising (as described in 9.5.1.2) should be resolved by removing the wallcovering.

9.5.2 Coating systems

9.5.2.1 Priming

Water-borne paints are usually applied direct to paper and other wallcoverings, the exception being that a purpose-designed primer should be used when there is a risk of discoloration on existing coloured wallpapers.

9.5.2.2 Finishing

Paper, vinyl, hessian and woven glass fibre surfaces are usually coated with water-borne paints. For improved wear resistance, acrylic water-borne paint should be used.

9.5.3 Surface preparation

9.5.3.1 General

In order to assess how much time is needed for the removal of the paper, wallcoverings and plasterboard, the following information should be included in the specification:

a) type of paper/wallcovering being removed;

b) whether the paper and wallcoverings have been painted; and

c) the number of layers to be removed.

Newly-hung lining paper and wallcoverings should be allowed to dry out completely before painting. Dry surfaces should be lightly brushed to remove loose material.

With existing wallcoverings, loose material should be refixed with the recommended adhesive; if adhesion is generally poor, painting makes it worse and the wallcovering should be removed.

Wallcoverings affected by mould growths should be removed and the source of the mould investigated. Subsequently, the surface should be treated in accordance with 9.1.3.2.

If water-borne paints are to be used and there is a risk of discoloration, a test area should be coated with the proposed paint and inspected after 24 hours. If discoloration occurs, it should be treated by applying a coat of knotting (see 8.3.4) or solvent-borne primer (see Table B.3) to the whole surface or to the areas affected. Alternatively, the wallcovering should be removed.

9.5.3.2 Joint treatment

Other than in plasterboard dry-lining systems, it is not possible to hide joints satisfactorily with conventional paint systems of normal thickness, and it is usually recommended that they should be featured, e.g. by using bevel-edged boards or cover strips.

NOTE 1 Plasterboard dry-lining systems employ tapered-edge boards, enabling a smooth, seamless surface to be obtained by taping and filling the shallow trough formed by abutting edges. The process can be carried out manually or mechanically. If a standard decorative paint is used directly onto dry lining, it is possible that a textural difference will be seen between the caulked and sanded joints, and the paper plasterboard surface. Slurry coats

and purpose-made primers can be used to assist in disguising the difference in texture, and also aids to even out the porosity of the substrate prior to painting.

NOTE 2 Requirements and recommendations for internal plastering are given in BS 8481, BS EN 13914-2 and PD CEN/TR 15123. Recommendations for dry lining and partitioning using gypsum plasterboard are given in BS 8212.

9.6 Plastics

NOTE See Annex I for further information on plastics.

9.6.1 General characteristics

If the painting of plastic substrates is being considered as a method of restoring defective or deteriorated surfaces, specialist advice should be sought from the manufacturers of the coating materials.

Before commencing, the following should be taken into account.

a) The type of plastic or plastic coating to be painted should be identified, to ensure that the correct coating system (probably with an appropriate primer) is used.

b) Painting new unplasticized polyvinyl chloride (PVC-U) with certain types of paint can reduce the impact resistance.

c) PVC-U should not be painted in a colour significantly darker than its original colour otherwise heat absorption is increased if exposed to direct sunlight.

d) Glass reinforced polyester (GRP) is less sensitive to solar gain than PVC-U, however lighter-coloured finishes should be used in preference to darker colours due to concerns over heat absorption.

e) Special care should be taken when using solvent-borne paints (especially gloss finishes) over expanded polystyrene as this can create a fire hazard.

9.6.2 Coating systems

The manufacturer's recommendations should be followed for specific guidance on paints for any plastic substrates, and for plastic-coated metals, where bare metal surfaces (edges or damaged areas) might be encountered.

On ageing, PVC-U becomes brittle. Abrasion of new PVC-U also reduces its impact resistance and should be avoided. Surfaces, new or weathered, should be prepared for painting by washing with warm detergent solution, rinsing with clean water and drying. Specialist coating materials have been developed and should be used to introduce new colour or rectify discoloration if it occurs.

NOTE Paints of conventional type can perform satisfactorily on PVC-U and on GRP, but might not perform as well as specialist paints, especially in terms of durability and adhesion.

Consideration should be given to the use of outdoor weather-resistant coating materials on large areas such as PVC-U cladding. Coating materials providing more durable protection are usually of specialist type, e.g. two-pack polyurethanes or epoxies, but specialist advice should be sought.

Expanded polystyrene wall and ceiling linings should only be painted with water-borne paints as solvent-borne paints attack expanded polystyrene, and can create a fire hazard.

9.6.3 Surface preparation

Good surface preparation is vital and varies depending on the condition and type of the existing finish:

a) Surfaces deemed to be in good condition should be washed with warm detergent solution and may be powerwashed to improve cleanliness. Grease and oil should be removed with a suitable

cleaner (soap or detergent) and all traces of cleaner removed by rinsing. The final surface should be dry before painting commences.

b) All loose, flaking and delaminating coatings should be removed by either mechanical means, e.g. powerwash or hand preparations, or chemical means, e.g. paint stripper. All traces of chemical treatment should be removed. Disbonding sections of PVC plastisol should be cut back to soundly adhered material.

c) Rusted areas should be prepared by removal of the coating, oxidation products, dirt and debris, and abraded or blasted, e.g. to Sa2 preparation grade (see BS EN ISO 8501-1), and should be primed before re-oxidation occurs.

d) Severely corroded panels should be replaced either wholly or sectionally, small areas can be repaired using a permanent filler.

e) Prior to priming/coating, areas which have been subject to mould growth should be identified and treated with a fungicidal wash. See 9.1.3.

f) GRP surfaces should be prepared by thorough scrubbing with warm detergent solution and a stiff bristle brush or nylon pad (not wire wool, which can cause rust stains) followed by rinsing and drying. For heavy contamination, a proprietary degreasing solution might be needed.

9.7 Miscellaneous surfaces and materials

9.7.1 Glass, ceramic tiles and inorganic glazed surfaces

9.7.1.1 General characteristics

NOTE In addition to glass, materials in this category include glazed bricks, terracotta, faience, ceramic tiles and vitreous enamel. They are painted in some circumstances, e.g. to obscure clear glass or to renovate glazed surfaces or change their colour. A general characteristic of the surfaces relative to painting is that it is difficult to achieve good paint adhesion to them and this cannot usually be improved significantly by abrasion. Reliance is therefore placed on the inherent adhesive properties of the paint, and this can vary according to type and composition and especially if the surfaces are exposed to weather or high humidity or are subject to abrasion.

The manufacturer's recommendations should be followed for specific guidance on paints for glass and ceramic surfaces.

9.7.1.2 Surface preparation

Surfaces should be clean and dry at the time of painting. Surfaces should be washed with detergent solution, followed by rinsing with clean water.

NOTE Where external surfaces are greasy, solvent cleaning might be necessary (see 8.3.2). On vitreous enamel, abrasion with waterproof adhesive paper while the surface is wet can help to improve adhesion.

Painting should follow cleaning as soon as the surfaces are dry.

9.7.1.3 Painting

Finishes are often applied directly to glass and glazed surfaces, however the paint manufacturer's recommendations in this respect should be followed. Some multi-colour finishes (see B.4/9) are applied over a bonding primer. Where damage or deterioration of vitreous enamel has exposed the metal substrate, the exposed metal substrate should be primed.

In the interiors of buildings, glazed bricks and ceramic tiling are the surfaces most likely to need painting. Multi-colour finishes are used fairly widely and should be applied in accordance with the

manufacturer's recommendations. Alkyd gloss and mid-sheen finishes, one-pack polyurethane finishes and acrylated rubber finishes can also be used and should be applied directly to the surface.

NOTE Some water-borne paints can be suitable in dry conditions and are used to provide temporary shading on glass, however specialist coating materials are available for this purpose.

Where durability and resistance to wear are particularly important, consideration should be given to the use of long-life specialist coating materials which also have good adhesion, e.g. some two-pack polyurethane and epoxy types.

The manufacturer should be consulted regarding the choice of materials and systems.

9.7.2 Bituminous surfaces and materials

9.7.2.1 General characteristics

NOTE Surfaces and materials in this category include bituminous paints and coating materials, some preservative treatments and asphalt surfaces.

These surfaces should not be painted with solvent-borne paints as there is a tendency for these surfaces to discolour the paint (bleeding) and sometimes retard their drying. Cracking of applied paints might occur with some bituminous substrates.

9.7.2.2 Bituminous paints and coatings

NOTE Thin, hard coatings, especially when they are aged, can be primed before they are overpainted with solvent-borne paints using, for example, an aluminium primer.

Water-borne paints should be applied directly without a primer or sealer (some water-borne masonry paint systems include a bituminous emulsion basecoat as a waterproofing membrane for porous external walls).

Paints applied over thick bituminous coatings might crack and craze, and the cracks can subsequently extend into the underlying material. If removal of the bituminous coating is impracticable, it should be overcoated with material of similar type, e.g. tar paint or bituminous aluminium paint.

9.7.2.3 Preservative treatments

NOTE The use of creosote is prohibited, except for some industrial applications.

Bituminous preservatives can be used for wood and some types of fibre insulating boards. Existing creosoted wood can generally be painted if it has weathered for a year or more and is then primed with aluminium primer. A primer of this type should also be used on fibre-insulating board impregnated with bituminous preservative if it is to be painted with solvent-borne paint; water-borne paints can usually be applied directly to the board.

9.7.2.4 Asphalt and bitumen

Light-coloured finishes for asphalt and bituminous roofing materials should be used to reduce heat absorption and improve appearance.

Particular care should be taken in the selection of coating materials, as unsuitable types can crack, resulting in serious damage to the roofing material.

Because of the ponding effect that can occur on flat roofs, it is also necessary for applied coatings to have good resistance to moisture to prevent loss of adhesion. New asphalt should be sand-rubbed to avoid the formation of a bitumen-rich surface.

The sand-rubbed surface assists the adhesion of coatings but the surface should be swept to remove excess sand before application. Specialist coating materials are available for use on asphalt

and bituminous roofing materials, and reference should be made to the manufacturer for specific recommendations.

9.7.3 Anti-graffiti treatments

NOTE 1 Paint graffiti on buildings can be a problem and any organization with buildings that are vulnerable to attack are likely to have a policy on removal or protection. For further information on anti-graffiti treatments, see Annex J.

New or undamaged surfaces should be assessed for the likely risk and cost of countermeasures.

NOTE 2 Choices for the prevention include sacrificial, semi-permanent and permanent coatings (see J.3.1).

Where graffiti is already a problem, measures of removal or obliteration should be assessed taking into account any hazards to the public during removal operations.

NOTE 3 Physical and chemical methods are available but the choice of method depends on the nature of the marker and the substrate.

Specialist manufacturers should be consulted and preliminary testing should be carried out on small areas.

10 Inspection

10.1 General

Once the project is finished, the paintwork should be inspected. On major projects, paintwork should be subject to a full inspection, i.e. inspection after each stage in the painting process.

NOTE 1 Sampling and testing of materials might be required if there are concerns regarding adherence to the specification.

NOTE 2 Inspection can take many forms on a project depending on the client, the scale of the project and the budget.

Inspection should be carried out to ensure compliance with the specification. It should not be considered as a substitute for proper supervision of the work by the contractor nor a means of compensating for an inadequate or incorrect specification.

Inspection should also be carried out to ensure that acceptable standards of workmanship and quality of finish are achieved. Because this can be subjective, where possible, reference standards on representative areas should be used to serve as a basis for tendering and inspection, but it is important to ensure that the standards set are realistic in relation to the system specified, the nature of the substrates and the conditions under which the work is done. Mock-ups should be arranged to avoid confusion and misinterpretation.

When work is subject to inspection, the intended procedure should be described in the specification. It should be ensured that resources are available to implement the procedure described, especially when the work is to be subject to inspection and approval at each stage of the painting process. If the inspector is empowered to suspend work (or take comparable action) or take samples, this should also be stated in the specification.

The responsibility for inspection should be independent from that for application.

NOTE 3 On large projects, the employment of a specialist inspection organization might be justified; in other cases, inspection might be carried out by members of the specifying authority's staff or a clerk of works.

Inspectors should have good knowledge of the materials, processes and techniques employed in the painting of buildings and should be suitably experienced and competent in the inspection of painting works. Wherever possible, there should be continuity of inspector, with the same standards applied throughout the project. Inspection should not be carried out by multiple individuals who are not suitably experienced.

10.2 Duties of the inspector

The inspector should assess whether compliance with the specification has been achieved in all respects. The inspector's duties should include the following, as appropriate:

a) ensuring that surfaces are in fit condition for the application of coatings: this might include checking and recording the moisture content of substrates;

b) ensuring that preparatory work is carried out as specified and, where applicable, to agreed standards;

c) ensuring that defects from other trades, e.g. plaster or dry lining defects are identified, rectified and made good at the stage when only the first coat of paint (mist or priming) has been applied, in order to avoid costly re-application of a full paint system if such defects are identified at a later stage of inspection;

NOTE If repair works, e.g. fine surface filling, are attempted at too late a stage in the painting process then it becomes near impossible to mask the repairs through paint application.

d) ensuring that work is carried out under suitable conditions, e.g. weather, temperature, humidity, ventilation and illumination;

e) ensuring that materials are of the types and makes specified, and are properly stored;

f) ensuring that the specified number and sequence of coats are applied, and that application is in accordance with the specification or the manufacturer's recommendations; this might include checking and recording film thickness;

g) if so empowered, suspending work or taking comparable action when there are reasonable grounds for doing so, e.g. if conditions are unfavourable for painting, work should be stopped if it appears that materials might be faulty (see 5.9.1);

h) taking samples for testing if this is a requirement of the specification or is necessary in order to investigate apparent defects;

i) drawing the attention of the client or specifier to any modifications to the specification which might appear necessary in order to achieve a satisfactory result;

j) maintaining work records and preparing progress reports; and

k) where a separate painting schedule is provided, ensuring that all items are finished in the required colours and types of finish.

10.3 Inspection process

Inspection should be carried out in a reasonable manner taking into consideration the site conditions. No other trades should be working in the same area at that point in time.

Work should be inspected without the use of aids, e.g. torches/mirrors, and should be inspected from a distance of 1 m face on to the item using the same lighting conditions under which the project was carried out. Where possible, an inspection should be carried out prior to final lighting being switched on.

NOTE 1 This will highlight any defects which could reasonably have been identified and corrected whilst working under temporary lighting.

The following factors should be taken into account when determining the frequency and degree of inspection:

a) the nature of the work and the functions of the coating system: for example, normal maintenance redecoration work might not require a full inspection, but this might be necessary for work involving the application of specialist coating materials;

b) the cost of inspection in relation to the value of the contract;

c) the resources available for inspection, especially when several locations are involved; and

d) the quality of supervision likely to be exercised by the contractor.

Although better than no inspection, ad hoc inspection of work in progress might be all that circumstances permit but should not be regarded as an effective method of ensuring compliance with the specification.

NOTE 2 In some circumstances, e.g. when work is of short duration, it might not be possible to do more than inspect the work on completion. This might suffice where finished appearance is the main criterion, but it does little to establish that the work specified has actually been carried out and, in particular, that the surfaces have been correctly prepared.

10.4 Final inspection

Whether or not work has been subject to stage inspection, it should be inspected on completion. Inspection should be under the same conditions of adequate lighting that were used when painting was carried out (see 5.5.2). However, completed work should not be viewed or snagged under a greater lux than the final lighting scheme. As with stage inspection, work should be inspected from a distance of 1 m face on to the finished item. In some circumstances, as noted in 10.3, this might be the only inspection carried out.

Final inspection should be made in the presence of the contractor or the contractor's representative. Arrangements should be made to inspect work which will subsequently be inaccessible before removal of scaffolding.

Visual inspection of the finished work should be judged on the following main points, as applicable:

a) satisfactory stopping and filling: if overall filling of surfaces to achieve a high standard of finish is required, this should be clearly specified;

b) uniformity of gloss, sheen and texture;

c) with pigmented finishes, uniformity of colour and satisfactory hiding of the substrate or previous colour;

d) freedom from conspicuous film defects such as runs, sags, wrinkling or fat edges; entrapped dust, dirt or paint skins; bare or starved areas; prominent brushmarks, excessive roller stipple or spray mottle;

e) freedom from tackiness;

f) accuracy of cutting-in; and

g) general cleanliness, with no soiling or disfigurement of adjacent surfaces.

In assessing the general quality of work, the significance of any observed defect should be considered in relation to the functions of the coating system.

NOTE For example, defects that affect appearance might not be important where protection is the sole or essential function.

Allowance should also be made for the influence of conditions or circumstances outside the control of the contractor, such as the condition of the substrate, which might, for example, be highlighted by low angle illumination.

The information in Table 5 should be used to assign a treatment for paint film defects on inspection after a period of exposure.

Table 5 — *Paint film defects arising after a period of exposure*

Defect	Typical causes	Remedial treatment
Adhesion failure	Application to damp, dirty or weather-degraded substrates, substrates contaminated by biological growth or subsequent entry of moisture, e.g. through open joints in woodwork	Flaking, peeling or poorly adhering coating should be removed (see 9.1.2) and any damaged substrate repaired. Biological growths should be removed (see 9.1.3). Where moisture is the cause, ensure that the substrate is dry before repainting. See 9.2.2.2 in relation to sources of moisture in woodwork.
	Failure to prepare or pre-treat non-ferrous metals	Defective material should be removed. See 9.4.2.4 for preparation of non-ferrous metals.
	Omission of primer or use of unsuitable primer	Defective material should be removed. Refer to the appropriate substrate in Clause 9 for information on priming.
	Application to powdery or friable substrates	Defective material should be removed. Application of a penetrating primer or sealer might be necessary (see Table B.3).
	Application to hard, dense substrates, e.g. glass or glazed surfaces	Defective material should be removed. See 9.7 for subsequent preparatory treatment and manufacturer's recommendations.
	Apparent loss of adhesion on iron and steel, might be due to detachment of mill scale	Removal of mill scale, e.g. by blast-cleaning or flame cleaning, might be impracticable as a maintenance operation and is costly, hence the desirability of effective initial preparation. There might be no alternative to manual cleaning to remove mill scale as it loosens, but this might extend over several repaints.
	Coating incompatibility, i.e. applying a conventional solvent-borne alkyd paint directly over a two-pack epoxy	Remove incompatible coating and recoat in a two-pack surface tolerant material.
Blistering	Blistering is usually indicative of liquid or vapour beneath the coating. The presence of water is a frequent cause. On painted woodwork, migration of water vapour from the inside of a building through the wood can cause blistering if the internal and external coatings do not provide the recommended differential permeability system. Resinous knots might also cause localized blistering.	Depending upon the extent and severity of blistering, preparation might be confined to removal of isolated blisters or complete stripping might be necessary. Where moisture is the cause, time should be allowed for drying out. (See also 9.2.2.2 in relation to sources of moisture in woodwork.) Blistering on resinous external woodwork might be influenced by choice of finishing colour.
Chalking, powdering	Slow erosion and chalking on lengthy exposure, especially externally, is a characteristic of many paints and wood finishes. It is not usually regarded as a defect unless it occurs prematurely and profusely, when the causes might be as follows: a) conditions of exposure exceptionally severe; b) earlier coats in system have failed to satisfy porosity of substrate; or c) incorrect or unsuitable formulation.	In the absence of other defects, lightly chalking surfaces might require only washing and light abrasion to provide a satisfactory base for further coats. Heavily chalked or powdery surfaces will require more vigorous cleaning or abrasion combined if necessary with application of a penetrating primer (see Table B.3).

Table 5 *(continued)*

Defect	Typical causes	Remedial treatment
Colour defects, e.g. fading, staining, bleeding, or other forms of discoloration	Some loss of paint colour might occur on lengthy exposure to bright sunlight but is not usually significant. Early loss of colour might be due to use in unsuitable conditions, e.g. external use of a colour intended only for interior use. Chemical attack might cause change or loss of colour.	If necessary, consult the manufacturer regarding selection of colours or types of finish for repainting.
	Solvent-borne finishes tend to yellow in situations where direct daylight is excluded or when exposed to vapours from other building materials typically containing amines. This is more obvious with white and light-coloured finishes.	If freedom from yellowing is important, consult the manufacturer for guidance on the selection of suitable materials.
	Apparent colour change might be due to the masking of colour by surface chalking or efflorescence, especially on external rendering or on external plywood treated with wood stain. It can also be caused by diffusion of water-soluble salts contained in adhesives.	Normal cleaning usually removes surface deposits. Efflorescence and diffusion of salts on plywood might reoccur until source is exhausted.
	Failure of clear finishes on external woodwork might result in the discoloration of exposed wood.	Clear finish should be removed completely. Sanding or scraping might remove discoloration or damaged timber, but application of coloured wood stain might be necessary to achieve uniform appearance.
	Constituents of the substrate or previous coatings can cause discoloration.	See 9.1.4.
Cracking, other than that due to structural movement	Cracking is usually indicative of stresses within the coating film, caused, for example, by applying hard-drying coating materials over soft coating materials. It might also be the initial stage in adhesion failure. Cracks might be confined to the finishing coat or extend through the thickness of the film.	If cracking is slight and confined to the finishing coat, light abrading might provide a satisfactory base for recoating. If cracking is severe or extends through the thickness of the film, complete removal might be necessary or a lining paper can be applied.
Damage to coating	a) Mechanical damage, e.g. by abrasion, impact or vigorous cleaning; or b) Graffiti	Where surfaces are subject to hard wear, specialist coating materials might be required. Consideration should be given to the use of wear-resistant materials, e.g. ceramic tiles or plastics, where practicable. In relation to graffiti, see Annex J.
Loss of gloss	Some loss of gloss is to be expected after lengthy exposure, especially externally, and might be the first stage in chalking. Where it occurs prematurely, possible causes are as described for chalking above.	Loss of gloss in the absence of other defects is not usually significant in relation to maintenance treatment.
Biological growths, i.e. moulds, algae, lichen, moss, blue stain	See 7.5 and 9.1.3.	See 9.1.3. Consider modifications to design or environment which might eliminate or reduce causes of failure.

Table 5 *(continued)*

Defect	Typical causes	Remedial treatment
Rust-spotting or rust-staining on painted iron and steel	This usually indicates that the thickness of the paint system is insufficient to provide protection on peaks and edges. It might result from application of an inadequate system initially or at the last repaint or from erosion of the film during exposure. A further possible cause is failure to use a rust-inhibitive primer.	Depending upon the severity and extent of the defect, treatment might range from manual cleaning and priming of localized areas to overall removal of the coating and treatment as for new iron and steel (see 9.4.1). Consideration should be given to increasing the film thickness of the system or to reducing the intervals between repaints until an adequate thickness has been built up.

Annex A (normative)
Health and safety

NOTE The information on health and safety in Annex A does not purport to be exhaustive.

A.1 General

All potential hazards encountered during the painting of buildings should be considered prior to commencing work. In addition to potential hazards related to the paint itself, there are also potential hazards associated with substrate preparation and equipment use, as well as physical hazards relating to the actions needed to prepare and paint building surfaces. A risk assessment and method statement should be carried out and suitable precautions taken to minimize risk and to ensure safe working practice and use of materials. PPE should only be used where other measures cannot adequately control exposure, and it should fit correctly.

It might be possible to reduce the risk to health either by changing the process or by using a safer substance. Where this is not reasonably practicable, exposure should be controlled by, for example, enclosure, the use of ventilation equipment, general ventilation, safe systems of work and handling procedures.

The materials used for painting buildings are made from a wide range of chemical substances, including resins, pigments, additives and solvents. The hazards associated with paint products are indicated on labelling and in safety data sheets, and these manufacturers' recommendations should be read, understood and followed before commencing work.

NOTE 1 The Control of Substances Hazardous to Health Regulations 2002 (COSHH) [13] and the Control of Substances Hazardous to Health Regulations (Northern Ireland) 2003 [14] require employers to assess the risks which might arise from hazardous substances at work and determine the measures needed to prevent or adequately control exposure to them. For further information see HSE publication HSG 97, A step by step guide to COSHH assessment [17].

Precautions to be taken by those engaged in the painting of buildings should include the following.

a) Bystanders and children should be kept away from working areas by the use of signs and segmentation, e.g. by using tape or fixed barriers.

b) Particular care should be taken when working with solvents or creating dust when in confined spaces or poorly ventilated areas.

c) Clean overalls should be worn while working but should be removed before eating and before leaving work. They should be laundered at frequent intervals.

d) Appropriate gloves, goggles or safety spectacles and suitable respiratory protection should also be worn when a hazard exists. Protection from dust by using dust masks is essential when sanding down surfaces. Close-fitting FFP3 dust masks are recommended.

e) Dust should be kept to a minimum and under control using dust sheets and vacuum cleaners with a suitable filter, e.g. Class M or H medium to high HEPA, to capture and remove dust safely.

f) Adequate ventilation, either mechanical or natural, should be ensured to minimize vapour build-up.

g) Precautions should be taken against exposure to noise levels, as prolonged exposure to a high noise level, e.g. from compressors and mechanical tools, can damage the hearing of operatives and others nearby.

NOTE 2 Information on noise levels and the corresponding maximum exposure times is given in The Control of Noise at Work Regulations 2005 [18] and the Control of Noise at Work Regulations (Northern Ireland) 2006 [19]. Further information can be found in the HSE publication L108, Reducing noise at work [20] [see also BS 5228 (all parts)].

h) Reasonable measures should be taken to prevent painting materials coming into contact with skin, and hands should be washed before eating or drinking. Splashes should be removed using hot, soapy water – solvents or thinners should not be used. In addition, workers should not smoke except within designated smoking areas, and only during their break times.

i) Paints, solvents and other painting materials should not be poured into containers that are not suitable for such use, e.g. those used to hold food or drink.

j) All materials should be stored safely and kept out of reach of children and animals. All containers should remain with lids on and tightly closed when not in use.

k) Paint spillages should be cleaned up as soon as they occur with an inert absorbent material. The use of rags and sawdust should be discouraged. If used, they should be disposed of safely as they are a fire hazard.

l) The area should be well ventilated to remove solvent vapours, and sources of ignition should be eliminated.

m) If paint, solvent or other material is accidentally swallowed, medical attention should be sought immediately.

n) The work area should be thoroughly cleaned using appropriate equipment (e.g. vacuum cleaners with HEPA filters) prior to allowing the resumption of normal activities. The environment should be adequately protected when working outdoors, ensuring that debris from preparation techniques is captured and disposed of, and measures are put in place to prevent overspray (from spray application) from covering grass or soil.

o) Waste materials and residues and contaminated clothing and PPE should be disposed of safely and in accordance with best practice. Leftover paint may be re-used or recycled. Paint or related materials should not be poured down drains or waterways.

NOTE 3 Schemes such as the BCF PaintCare initiative (www.paintcare.org.uk)[3] provide details on how to recycle leftover paint.

NOTE 4 Any waste that comes from a commercial activity is business waste and anyone who produces, keeps or disposes of such waste has a duty of care and is subject to the waste regulations pertaining to that location. There are different regulations in different parts of the UK: the Waste (England and Wales) Regulations 2011 [21], the Waste (Scotland) Regulations 2012 [22] and the Waste Regulations (Northern Ireland) 2011 [23].

A.2 Specific hazards

A.2.1 Inhalation hazards

Dust inhalation should be avoided by applying wet sanding techniques and by the use of close-fitting FFP3 dust masks. Dust hazards are of major concern in all building and decorating activities and should therefore be well controlled.

NOTE 1 Professional decorators are obliged to hold a certificate showing their mask fits correctly. For further information on protection against dust, see HSE Guidance Note EH44, Dust in the workplace: General principles of protection [24].

Inhalation of solvent vapours in high concentrations can affect the respiratory and digestive systems and cause irritation of the eyes, nose and throat. These effects should be prevented by ensuring

3 Last accessed 20 March 2019.

that there is sufficient ventilation of the compartment being painted to minimize solvent vapour concentrations.

If solvents are used for cleaning or paint stripping, only the minimum amount necessary should be employed. Skin contact with the solvent should be avoided by wearing suitable protective gloves and, as with painting, the work area should be well ventilated to prevent the build-up of solvent vapours. Sufficient time should be allowed for solvent vapour to clear before work proceeds.

NOTE 2 Attention is drawn to the UK: REACH Enforcement (Amendment) Regulations SI 2014-2882 [15] regarding personnel training to use DCM-based paint strippers.

There should be sufficient flow of air through compartments being painted in order to adequately control solvent vapour concentrations. Under some circumstances this may be achieved by natural ventilation, i.e. by means of windows or doors that open directly to outside the building. Where natural ventilation on its own is not always sufficient, a mechanical means of ventilation should be considered.

In difficult or unusual circumstances, professional advice on ventilation should be sought.

Special precautions should be taken when spraying paints to ensure that spray droplets and mist, as well as solvent vapours, are not inhaled.

NOTE 3 This usually requires the use of appropriate PPE, especially when two-pack protective coating systems are applied.

Dust that has accumulated on floors, ledges etc. should be removed with an industrial vacuum cleaner rather than by sweeping.

NOTE 4 For further information on respiratory protective devices, see HSE publication HSG53, Respiratory Protective Equipment at Work: A Practical Guide [25].

A.2.2 Contact hazards

Materials such as paint removers, alkaline cleaning solutions and fungicidal washes can cause serious injury if they enter the eyes and can also cause skin irritation. Goggles, gloves and overalls should be used to prevent these materials from coming into contact with the body.

Appropriate PPE, including eye protection, should be used during paint spraying and during surface preparation work such as chipping, scraping and mechanical sanding, as necessary.

NOTE Attention is drawn to the Personal Protective Equipment at Work Regulations 1992 [26], HSE publication L25, Personal Protective Equipment at Work [27] and the Personal Protective equipment at Work Regulations (Northern Ireland) 1993 [28], which cover all equipment designed to be worn or held to protect against a hazard where risk cannot otherwise be adequately controlled. See also the COSHH Regulations 2002 [13], HSE publication INDG136, Working with substances hazardous to health [29], and COSHH Regulations (Northern Ireland) 2003 [14].

Hands and exposed areas of skin may be treated with silicone-free barrier cream before work starts, and should afterwards be cleaned with an approved hand cleaner. Hands should not be cleaned with paint solvents or thinners as this can result in skin irritation or the absorption of materials through the skin.

Impervious industrial gloves should be used if heavy hand contamination is likely.

A.2.3 Fire and explosion

NOTE 1 Some materials used by painters are flammable or support combustion. Flammable liquids are subject to legislation and there are statutory requirements with regard to their labelling, storage and use. Attention is drawn to the Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) SI 2002-2776 [30] and the Dangerous Substances and Explosive Atmospheres Regulations (Northern Ireland) 2003 [31].

Precautions should be taken to ensure that vapours of flammable solvents do not accumulate in a space, or part of a space, which is being painted, as this could create a potentially explosive mixture with air.

It should be remembered, however, that there might be circumstances where breathing zone concentrations are low but where pockets of high vapour concentrations nevertheless build up quickly due to poor air distribution, for example, in pits and similar confined spaces. Therefore, there should be good air distribution throughout the whole space; this might require the provision of additional means of mechanical ventilation or dispersion to deal with such areas in which there would otherwise be little or no air movement.

Sources of ignition such as lighted cigarettes, matches, blow lamps, elements of electric fires, unprotected light bulbs, electric motors which are not flameproof, etc. should be eliminated from any area where a flammable concentration of vapour might be present or arise.

Rags soaked with solvent-borne paint can ignite spontaneously if they are tightly compressed in, for example, bins or in the pockets of overalls. They should be spread out in the open air outside the building to dry off, or damped down with soapy water.

NOTE 2 Attention is drawn to HSE publication L101, Safe work in confined spaces [32] and HSG178, The spraying of flammable liquids [33]. Reference can also be made to the advice given in the HSE publication HSG168, Fire safety in construction work [3].

A.2.4 Asbestos

WARNING Asbestos is extremely hazardous. Materials containing asbestos are subject to legislation that requires precautions to be taken in handling them to ensure that they do not constitute a health hazard.

With any materials containing asbestos, or suspected of containing asbestos, specialist contractors should be consulted and employed. Non-specialist decorators should not handle any materials containing asbestos.

Cement-based materials containing asbestos fibre constitute a serious hazard to health and, if found, should not be disturbed. Unknown cement fibre-based materials should be treated as containing asbestos fibre until properly identified. Specialist advice should be sought on the treatment of all materials containing asbestos and if necessary, specialist contractors should be employed for safe removal, disposal or encapsulation.

Special precautions should be taken in work involving building materials containing asbestos.

NOTE Attention is drawn to the Control of Asbestos Regulations 2012 [34], the Control of Asbestos Regulations (Northern Ireland) 2012 [35], the Control of Asbestos at Work Regulations 2002 [36] and the Control of Asbestos at Work Regulations (Northern Ireland) 2003 [37]. In case of doubt or for detailed guidance, reference can be made to the HSE publications HSG248, Asbestos: The analysts' guide for sampling, analysis and clearance procedures [38] and EH40/2005, Workplace exposure limits [39].

A.2.5 Lead-painted surfaces

Generally, lead pigments have not been used in UK decorative paints since the early 1980s. However, surfaces in older buildings might have been painted with lead paints and therefore, if there are concerns that this is the case, appropriate measures should be taken to minimize exposure.

WARNING Lead is a cumulative toxicant and affects the functioning of the heart, brain, kidneys, blood, digestive and nervous system. Its effect on children and their brain development is well documented and of most concern, as it is very serious and irreversible.

The main hazards to control related to lead are paint chips and flakes, paint dust and paint fumes. These can enter the body through ingestion or inhalation, so the focus should be on preventing these incidents from occurring to both workers and bystanders. Undamaged intact lead-painted surfaces

are not a major hazard, and should not be disturbed or removed unless absolutely necessary. Paints and coating materials may be applied directly on top of such surfaces, thus encapsulating the lead hazard, however the paint manufacturers' instructions should be followed. If surfaces do require preparation and removal, wet abrasion techniques and comprehensive clean-up procedures should be followed. Neither hot-air or steam removal equipment should be used on lead-painted surfaces as lead fumes are extremely hazardous.

Industry guidance on best practice and safe approach to treating and painting surfaces with lead paint is available and should be consulted at the start of the project.

NOTE 1 Examples of such guidance include BCF documents HS 032 [40], HS 034 [41] and HS 039 [42] available from www.coatings.org.uk[4].

NOTE 2 Because of the possible toxic hazard involved, the use of lead paints and the preparation of lead-painted surfaces are subject to legislation Control of Lead at Work Regulations 2002 [43] and Control of Lead at Work Regulations (Northern Ireland) 2003 [44]. For further information on lead and its exposure levels at work, see HSE publications L132, Control of lead at work [45] and EH40/2005, Workplace exposure limits [39].

A.2.6 Fungicidal washes and coatings

NOTE 1 Some coating materials and preparatory washes might contain or be based on materials intended to inhibit moulds or other biological growths.

Fungicidal washes are by their nature toxic to some organisms. The manufacturer's recommendations regarding their application and also their use on surfaces, especially those in contact with foodstuffs, should be strictly observed.

NOTE 2 Supply of these materials is subject to the EU Biocidal Products Regulation (528/2012) (EU BPR) [16].

A.2.7 Two-pack polyurethane coatings

These products should only be used by trained professionals for specialist applications.

NOTE Two-pack polyurethane coating materials might contain isocyanate substances that are known to be hazardous to health, and therefore require special conditions of use.

A.2.8 Chromate primers

These products should only be used by trained professionals for specialist applications.

NOTE Chromates are known to be hazardous to health, and therefore require special conditions of use. All chromate-based systems are now subject to REACH Restriction and Authorisation measures and can only be used under the conditions stipulated by such Authorisations.

Annex B (informative) General introduction to paints and coatings

NOTE For the purposes of this British Standard, paints and similar coating materials are grouped in three categories as follows:

a) conventional coating materials (see **B.3**);

b) specialist coating materials (see **B.4**);

c) factory-applied coatings (see **B.5**).

Metallic coating materials are referred to in Annex G.

4 Last accessed 20 March 2019.

B.1 General properties of coating materials

B.1.1 General

Most of the coating materials used on buildings pass from a wet stage to a dry film. Properties during the wet stage are described by terms such as viscosity, rheology, etc. and have a direct influence on the application properties, flow and the final film thickness of the dry film. Coating materials are therefore selected according to the conditions under which they are to be used.

B.1.2 Viscosity

For most coating materials, viscosity is the resistance offered by the material to shearing forces, e.g. brushing or rolling, and, consequently, directly affects the ease with which the material can be applied. Indirectly, it can influence film thickness because if the viscosity is low the coating can be spread out too far, yielding an excessively thin film. If it is too high, it can be difficult to apply the coating in a film of uniform thickness, especially by brush.

Application properties cannot always be assessed either from the apparent consistency of the material in the container or by stirring or pouring because of the effect of thixotropy and other rheological effects. Coating materials are normally supplied at the correct viscosity for application, and thinning (addition of solvent or water) is not usually required.

B.1.3 Flow

Although good flow is a desirable attribute in a finish, excessive flow can make the material difficult to control in application and cause running and sagging, therefore, it is recommended that flow properties are determined before work commences. Coating materials with good flow tend to recede from external angles and sharp edges, reducing the thickness and protective value of the film at these points. Some products are available which have been formulated to give better coverage through having reduced flow.

The consequences of poor flow after application by brush, roller or spray are respectively brush marks, roller mottle and spray mottle. This results in thinner areas below the average film thickness which offer less protection to the substrate. Poor flow also adversely affects the reflectance properties and, in gloss paint, results in loss of image and reflection.

B.1.4 Film thickness (build)

Film thickness is determined essentially by the proportion of non-volatile solids (e.g. pigment or resin) present in the coating material and its flow characteristics.

The method of application can affect film thickness, and the protective properties of a coating are generally in direct proportion to its film thickness. Filling and levelling are also affected.

Film thickness can be expressed as wet, i.e. the thickness immediately after application, or dry when the volatile constituents have evaporated. Dry film thickness is the significant factor in relation to protection and filling properties.

Most coating materials have a build determined by the application and other characteristics. Paint manufacturers provide further information on expected film thicknesses.

BS EN ISO 2808 describes methods of determining the film thickness of applied coating materials.

B.2 Functions of coatings

B.2.1 Protection by coating systems

The level of protection coating systems can offer depends upon the ability of the coating to prevent moisture, atmospheric pollutants, aggressive chemicals or other destructive elements coming into direct contact with the surface. The effectiveness of the coating depends upon its composition, its thickness, and the severity of attack.

Where possible, particularly in severe conditions, it is recommended that consideration is given to reducing dependence on the protective properties of coatings, e.g. by using less vulnerable building materials, by modifying the design of components or by environmental changes such as improved ventilation.

B.2.2 Decoration

Even if the main emphasis is on protection or some other function, coatings can contribute to the overall appearance and decorative effect of buildings; in many instances, paint is the main decorative medium, providing the desired colours and degree of gloss or texture.

Paint colours and their coordination with those of other elements in the decorative scheme, such as furnishing fabrics, floor coverings, laminated and ceramic goods, is important to the overall design specification.

NOTE Practical considerations relating to paint colours are described in B.7.

B.2.3 Hygiene

Where high standards of hygiene or sterile conditions have to be maintained, the ability of the coating to withstand regular cleaning might be the most important function. The coating material in this case needs to be of a type that resists not only the soiling agent but also the cleaning agent and method used.

In situations favourable to the development of mould or bacterial growths, coating materials with anti-microbial properties can be helpful, although it is often beneficial to supplement these by other measures as described in 7.5.

B.2.4 Special functions

Coating materials need to be selected so that they are appropriate to the conditions of their use, e.g. with resistance to high humidity or direct chemical attack, a reduction of fire hazard including surface spread of flame or inhibition of mould or bacterial growth.

B.3 Conventional coating materials

Conventional coating materials represent the greater proportion of the coating materials in general use in the painting of buildings and are based mainly on drying-oil or water-borne binders. They are listed and described in Table B.1 to Table B.3 (and also Table E.1 to Table E.5 and Table G.1), generally according to their functions within the coating system.

Conventional coating materials based on binders of the types referred to in Table B.1 to Table B.3 can be modified to impart specific properties, e.g. mould resistance or fire protection (see Clause 7). See the relevant subclause in Clause 9 for more information on paints and coating materials for specific substrates.

Table B.1 — *General pigmented finishes*

Ref.	Description	General composition	Characteristics and usage
B.1/1	Solvent-borne gloss or mid-sheen finish Other descriptions include hard-gloss enamel and high-gloss for gloss finishes; and eggshell, satin, and semi-gloss for mid-sheen finishes	Based on drying-oil/alkyd resin binder which might contain small amounts of polyurethane or other resins to increase hardness, flexibility or durability. Pigmented with titanium dioxide and/or lightfast, coloured pigments	These are protective and decorative finishes suitable for interior and exterior use on most building surfaces. They have good durability and wearing properties in most conditions except those of direct chemical attack or very high humidity. It is recommended that advice is sought from the manufacturer regarding the suitability of mid-sheen finishes for exterior use on different substrates.
B.1/2	Water-borne gloss or mid-sheen finish Other descriptions for mid-sheen finishes include eggshell, satin, silk, and semi-gloss Descriptive terms for sheen can be described as for B.1/1	Typically based on acrylic dispersions or alkyd emulsions. Might contain other modifying resins. Pigmented with titanium dioxide and/or lightfast, coloured pigments	For solvent-borne gloss or mid-sheen finish, drying and recoating times are variable according to composition but, usually, overnight drying between coats is required for drying-oil/alkyd resin types. For water-borne gloss or mid-sheen finish under normal conditions, drying and recoating times are considerably shorter than solvent-borne and same day recoating is a possibility (see manufacturer's instructions). Regulations governing VOC emissions from paints effectively preclude the use of solvent-borne finishes for interior walls and ceilings.
B.1/3	Water-borne scrubbable matt finish	Generally as for B.1/2 adjusted to provide a matt finish but often including some form of ambient cross-link mechanism to develop toughness	Essentially, this is a decorative finish for interior use only providing either a hard-wearing cleanable matt finish for walls or a matt finish trim paint. Drying and recoating characteristics are usually similar to those of B.1/2.
B.1/4	Water-borne matt or flat finish Other descriptions include emulsion paint, latex, vinyl or acrylic paint (see B.6.2.3)	Composition of binder typically based on vinyl or acrylic polymers or combinations of these, with titanium dioxide and/or coloured pigments	They are widely used for ceilings and walls, mainly internally although some might be suitable for use on exterior walls. The choice of sheen level depends largely on aesthetic considerations. Only certain water-borne paints are suitable for use in situations where humidity is high for long periods, e.g. in kitchens and bathrooms (see manufacturer's recommendations).
B.1/5	Contract and general purpose paint	Water-borne. Composition, typically, is similar to that of B.1/4 but with higher pigment content and giving a matt finish	Higher pigment gives increased opacity, compared with that of B.1/4, but at the expense of a reduction in washability and resistance to soiling. Paints of this type are frequently used for new interior walls and ceilings where, apart from economy in use, their high permeability allows contained moisture to dry out.

Table B.1 *(continued)*

Ref.	Description	General composition	Characteristics and usage
B.1/6	Masonry paint, water-borne, smooth or fine-textured	Water-borne binder, typically based on acrylic, vinyl and other polymers formulated to have the degree of flexibility required for exterior use and pigmented with titanium dioxide and/or lightfast coloured pigments which are alkali-resistant. Some types are smooth; others contain fibre, sand or another agent to give a fine texture. Most contain an additive to inhibit mould and algal growth	These are essentially decorative coating materials but have the weather-resistance and durability required for exterior walls. Both the smooth and the fine-textured paints can provide protection of concrete, etc. in combination with sealers, if needed, in accordance with manufacturer's recommendations. These types of paint are generally not suitable for application to wood or metal. Formulations containing fibre, sand, etc. usually provide thicker films than the smooth types. For use on interior surfaces, it is recommended that the manufacturer is consulted regarding the use of masonry paints containing additives to inhibit mould and algal growth because of the possible toxic hazard.
B.1/7	Masonry paint, water-borne heavy-textured	Compositions can vary considerably but consist generally of a heavy-bodied water-borne binder, reinforced with coarse extenders and in some cases, fibrous material and aggregates. Pigmentation is similar to that of B.1/8 and mould/algal inhibitors might be incorporated	Coating materials of this type provide thick (1 mm to 2 mm) weather-resistant coatings, and experience indicates that they are capable of durability in excess of 10 years. Their heavy texture is derived partly from their composition and partly from the method of application, typically by means of specially designed rollers. In addition to their use externally, coating materials of this type might be suitable for internal walls where a hard-wearing textured finish is required.
B.1/8	Masonry paint, solvent-borne, smooth or fine-textured	Composition varies considerably. Older types can be based on a drying-oil/resin type binder, others on modified or synthetic rubber film-formers. Pigmentation is generally as for other masonry paints.	The appearance of this type of coating is similar to that of B.1/6, and film thickness is of the same order. Permeability is usually lower, and the coating might therefore provide greater resistance to penetration by water and other agents and scope for protective use, but it is recommended that it is applied to dry substrates. Brush application will generally be slower than with B.1/6 types. It is more tolerant of poor drying conditions than water-borne types.

Table B.1 *(continued)*

Ref.	Description	General composition	Characteristics and usage
B.1/9	Masonry paints, solvent-borne, thick, textured	Composition varies but typically employs a drying-oil resin binder; can be described as polyester (i.e. alkyd). Usually contains coarse extender and/or fibrous material. Pigmentation as for other masonry paints	These provide coatings of substantial thickness (0.6 mm to 1.0 mm), of relatively low permeability, and therefore have good resistance to moisture penetration. Coating materials of this type are usually applied by spray or roller, often by specialist contractors. Material and application costs are likely to be high.
B.1/10	Silicate-based masonry coating materials	Water-borne. Based on water-soluble silicates with possible addition of minor quantities of organic resins	The coating materials are unusual in being based on an inorganic binder. They are suitable for external and internal surfaces. They provide inert non-flammable films which are less affected by fungal and algal growth than organic coating materials and are compatible with all mineral building materials. It is recommended that external surfaces to be painted are free from dirt and all previous paint coatings. Application can be by brush, roller or spray. While drying, the coating can be very susceptible to rain damage. The liquid paints are highly alkaline (caustic) and hence precautions need to be taken during application. Resistance to moisture penetration can be improved by the use of a hydrophobic impregnation treatment (e.g. silane, siloxanes).

Table B.2 — *Undercoats*

Ref.	Description	General composition	Characteristics and usage
B.2/1	Solvent-borne undercoat	Traditionally drying-oil/resin type binder, pigmented with titanium dioxide and/or coloured pigments	This type of undercoat provides a matt or low-sheen surface for subsequent application of solvent-borne finishes, especially gloss finishes. In normal conditions, overnight drying is usually required before application of further coats. Undercoats for external work need to be specifically designed with adequate flexibility for the purpose.
B.2/2	Water-borne undercoat or primer undercoat	Based on acrylic or other polymers pigmented as in B.2/1. Might be identical in composition to B.3/2	These undercoats are quicker drying than those of B.2/1 and in normal conditions permit same-day recoating. General usage as B.2/1. As primers they might be suitable for priming dry plaster, building boards and wood. It is recommended that only types conforming to BS 7956 are used for priming exterior woodwork.

Table B.3 — *Other available miscellaneous primers*

Ref.	Description	General composition	Characteristics and usage
B.3/1	Alkali-resisting primer	Traditionally solvent-borne. Typically, alkali-resistant drying-oil (e.g. tung)/resin type binder, lightly pigmented	Although described as alkali-resisting, primers of this type are intended for use on substantially dry, possibly alkali-containing, surfaces mainly beneath drying-oil resin finishes; they will not necessarily prevent attack by alkalis on subsequent coats if the structure is very damp.
B.3/2	Self-priming undercoat	Water-borne (typically based on an acrylic polymer). Might be identical in composition to B.2/2 or G.1/9	These primers are for use on dry plaster and similar surfaces. They might also be suitable for priming wood and building boards, metals (universal primer) and as undercoats (see B.2/2 or G.1/9).
B.3/3	Primer-sealer Other descriptions include stabilizing primer or solution, penetrating primer or masonry sealer	Traditionally solvent-borne and lightly pigmented, or semi-transparent with a marker pigment to assist even application. Might also be based on fine particle-sized water-borne acrylic	The essential function of a primer-sealer is to bind down powdery or friable residues of previous coatings which cannot be removed completely. It is not recommended to place too much reliance on the ability of this type of material to penetrate unsound coatings of substantial thickness, and as much as possible of the old material ought to be removed. Primer-sealers can also be used to reduce absorption on surfaces of high or uneven porosity. Masonry sealers are usually formulated specifically for use on exterior surfaces and might not be suitable for interior work; with other types, the reverse might apply. It is recommended that reference is made to the manufacturer's recommendations.
B.3/4	Universal primer (see also B.3/2) All-purpose primer	Typically, drying-oil/resin type binder or water-borne acrylic with white or light-coloured pigments, usually including rust-inhibitive types, e.g. zinc phosphate	A universal primer is typically white or light grey and is convenient for small-scale maintenance work involving patch-priming of a variety of substrates, e.g. wood, metal and dry plaster. For new and large-scale work, primers formulated for specific substrates are generally preferred.
B.3/5	Stain-blocking primer	White/off-white or light-coloured, solvent or water-borne. Water-borne can be cationic or conventional. Aluminium primers can be used as stain-blocking primers in certain circumstances (see E.1/5)	A stain-blocking primer is a specially designed binder system with specific additives to prevent the migration of stains from the substrate to the surface of the paint film. The choice of technology depends on the type of stain to be blocked.

B.4 Specialist coating materials

Specialist coating materials have properties, e.g. of chemical resistance, hardness or other characteristics, not possessed by materials of conventional type. They might require special techniques or conditions of application or necessitate high standards of surface preparation

and might not be readily available from normal sources of supply. Often, the complete system is of specialist type and might not be suitable for use over primers or existing coatings of conventional type.

Table B.4 summarizes the characteristics of the principal types of specialist coating material that can give extra resistance and/or durability. Within the generic categories, there can be considerable variation in the formulation and, in consequence, the characteristics of individual materials. These coating materials can themselves be further modified to provide specific properties such as mould resistance or fire protection.

Reference to manufacturer's recommendations is advised when there appears to be a requirement for the use of specialist coating materials. BS EN ISO 12944 (all parts) and BS 5493 give detailed recommendations regarding specialist coating materials for the protection of iron and steel structures.

Table B.4 — *Specialist coating materials*

Ref.	Description	General composition	Characteristics and usage
B.4/1	Two-pack epoxy primers, undercoats and finishes	Epoxy resin binder with amine or amide curing agent. Pigmentation according to end use, e.g. metal primers usually contain corrosion-inhibitive pigments Primers are generally either zinc rich or zinc-phosphate pigmented. Undercoats often contain micaceous iron oxide (MIO) pigments. Both solvent-borne and water-borne epoxy coating materials are available.	Resistant to some acids and weak alkalis, oils, solvents and abrasion and used for protection of surfaces, especially steelwork, in severe conditions where coating materials of conventional type are inadequate. It is advised these are applied only to stable, well-prepared surfaces. Blast-cleaning of steelwork is essential. Might not be suitable for application to gypsum plaster; a cement plaster base is preferable. Application to substrates liable to significant dimensional change (e.g. external woodwork) can result in cracking of the film. Curing is temperature-dependent, and the manufacturer's recommendations in respect of ambient and surface temperatures ought to be observed. High humidity during application and curing can also affect the coatings.
B.4/2	Hydrocarbon epoxy coatings	Binder blended with hydrocarbon resins and mineral extenders	General characteristics as for B.4/1 but lower resistance to solvents. Main use is for protection in conditions of very high humidity or immersion in fresh or seawater.

Table B.4 *(continued)*

Ref.	Description	General composition	Characteristics and usage
B.4/3	Two-pack polyurethane pigmented coatings, principally finishes	Acrylic modified polyester resin binder with polyisocyanate curing agent and white or coloured pigments	General characteristics as for B.4/1, but low temperature curing is usually better and sensitivity to moisture curing is greater than with epoxies. Principal usage is as non-yellowing chemical-resistant finishes over epoxy primers and undercoats. These products contain isocyanates and need to be handled in accordance with relevant HSE requirements. See A.2.7 for further details on safety precautions handling these products.
B.4/4	One-pack moisture-curing polyurethane primers, undercoats and finishes	Polyether isocyanate binder. Pigmentation according to end use	Resistant to some acids and weak alkalis, oils, solvents and abrasion; and used for the protection of steel and concrete surfaces in severe conditions where coating materials of conventional type are inadequate. It is advised that these are only applied to stable, well-prepared surfaces. Blast-cleaning of steelwork is essential. Might not be suitable for application on gypsum plaster; a cement plaster base is preferable. The film might crack if applied to substrates liable to significant dimensional change (e.g. external woodwork). Curing is humidity-dependent and to some extent temperature-dependent. The manufacturer's recommendations in respect of humidity and temperature ought to be followed. Most formulations can tolerate traces of surface moisture.

Table B.4 *(continued)*

Ref.	Description	General composition	Characteristics and usage
B.4/5	Acrylated rubber primers, undercoats and finishes	Acrylated rubber, pigmented according to end use, as for B.4/1. Some types can be modified with drying-oil/alkyd resin. Formulations yielding coatings of substantial thickness are available.	Suitable for use on most substrates and, as one-pack products, are more convenient to use than two-pack epoxy and polyurethane coating materials, although their chemical resistance might be lower. As for solution binders, drying is essentially by evaporation and is less affected by low temperatures than that of drying-oil/resin, epoxy and polyurethane coating materials. Brush or roller application to large areas might be difficult, and spraying is recommended.
B.4/6	Aluminium paint, general purpose	Traditionally, solvent-borne. Typically, drying-oil/alkyd resin binder pigmented with flake aluminium	The laminar nature of the pigment (see B.6.4.6) imparts moisture-resistance to aluminium paints, and their reflective and heat-resistant properties are useful in many situations. They are suitable for use on most building surfaces.
B.4/7	Micaceous iron oxide paint, general purpose	Solvent-borne. Typically, drying-oil or drying-oil/resin type binder pigmented with micaceous iron oxide. Small amounts of other pigments might be incorporated to modify the natural colour (dark grey) of the main pigment.	Because of the laminar nature of the pigment (see B.6.4.6) and the substantial thickness of the film, micaceous iron oxide paints provide good protection. On weathering, the coating develops a metallic sparkle. The dark colour of the pigment restricts the range of colours available, but overcoating with a solvent-borne gloss finish is often possible.

Table B.4 *(continued)*

Ref.	Description	General composition	Characteristics and usage
B.4/8	Cement paint conforming to BS 4764	Based on white Portland cement with titanium dioxide or coloured pigments, and additives to assist application and increase water-repellence. Supplied in powder form and mixed with water immediately before application	These are low-cost coating materials giving a rough finish and used mainly for exterior wall surfaces, although they can be used inside except on gypsum plaster: they are not recommended for application over other types of paint. On lengthy outside exposure, pastel shades tend to lighten and darker colours tend to become patchy. They can be used as a primer on uncoated exterior wall surfaces prior to finishes of those in B.1/7 or B.1/8. Cement paint is supplied in powder form, and has a highly alkaline pH when mixed with water. See Annex A for further details on safety precautions handling these products.
B.4/9	Multi-colour finishes	There are different types of multi-colour finish. In one type, droplets of pigmented resin solution are emulsified in an aqueous medium so that the coating is water-thinnable. The pigmented droplets remain discrete in the dry film, providing the multi-colour effect. In another type, a pigmented emulsion-type basecoat is followed, when dry, by spray-applied spatter coats of similar material. Alternatively, multi-colour patterns can be produced. Finally, an emulsion-type clear glaze-coat can be applied. In a third type, a pigmented emulsion-type basecoat is followed, when dry, by a clear emulsion glaze with suspended multi-coloured flakes of solid material.	These are quick-drying, hard-wearing finishes for interior wall surfaces, often used in circulating areas, cloakrooms and similar hard-wear locations. Application is usually by spray, but materials of the third type might be suitable for brush or roller application.

Table B.4 *(continued)*

Ref.	Description	General composition	Characteristics and usage
B.4/10	Plastic texture paints	Typically, based on gypsum and supplied as dry powder for mixing with water before use, but ready-for-use water-borne dispersion types are available. These might be referred to as synthetic resin plaster and do not necessarily contain gypsum. The term plastic indicates that the material can be worked after application to provide relief texture effects.	This is essentially a decorative coating material for interior use only. It can be used as a substitute for plaster skimming on plasterboard ceilings or to disguise rough or cracked walls and ceilings. Texture is achieved either directly by spraying or by brush or trowel application and subsequent combing, stippling or other treatment. Some types are self-coloured and require no further treatment; others might require over-painting, e.g. with a water-borne paint.

Table B.5 — *Bituminous and tar-based coatings*

Ref.	Description	General composition	Characteristics and usage
B.5/1	Black paint (tar-based) conforming to BS 1070, types A and B	Water gas-tar solutions	Moisture-resistant protective coatings for general use on metal and other surfaces where decorative appearance is unimportant. Suitable for cold application, e.g. by brush. Type A is required to dry in 8 h and type B in 4 h.
B.5/2	Bitumen-based coatings conforming to BS 6949, types 1 and 2	Bitumen solutions, type 2 with fillers	Generally as for B.5/1. Type 1 without fillers, type 2 with fillers, permitting greater film thickness per coat. Not suitable for use in contact with drinking water (see B.5/3 for suitable types).
B.5/3	Bitumen-based coatings conforming to BS 3416, types 1 and 2	Bitumen solutions, type 2 with fillers	Generally as for B.5/2, but suitable for use in contact with drinking water. Needs to be certified under the Water Regulations Advisory Scheme[A)] in order to comply with EEC Directive 80/778/EEC (as amended) [46].
B.5/4	Bituminous emulsion	Water-borne bitumen emulsion	Black, water-thinnable moisture-resistant coating. Typical use is as a waterproof membrane on exterior walls before application of water-borne masonry paints.

A) The Water Regulations Advisory Scheme is managed for the UK water industry by WRc-NSF Ltd.

B.5 Factory-applied coatings

These range from stoving or air-drying liquid paints, or stoving powder paints, applied to wood and metal components, to coil coating materials mechanically applied to coiled flat sheet for subsequent forming and fabrication.

Coating materials of types unsuitable for site application might be employed; correctly chosen and applied, they can be tougher, harder and more durable than most site-applied coatings. Most of these

coatings can be overpainted for aesthetic or maintenance purposes according to the manufacturer's instructions.

For light gauge steel, (less than 3 mm thickness), BS EN ISO 12944 (all parts) gives guidance in choice of coating materials. BS 5493 also gives guidance for cast and wrought iron, although there have been improvements in and additions to the types described. Liquid organic coating materials for aluminium extrusions (e.g. windows) are defined in BS 4842, and the expected performance of a variety of coating materials on metal and other claddings can be found in BS 5427. Most aluminium is coated with powder coating; see BS EN 12206-1. No such guidance is available for complete factory-applied systems on timber, but they can give better durability than the conventional site-applied coatings at not greater cost.

Components for interior use are sometimes coated by processes suitable for the dry conditions of a completed building, but inadequate for exposure to weather or condensation during erection. To avoid premature failure, a higher grade coating might have to be specified. Likewise, the life indicated for various categories could be extended by additional coats or increased thickness.

B.6 Constituents of coating materials

B.6.1 General

Conventional coating materials consist of binder, solvent or thinner and, in paints and stains, pigment. The binder is the non-volatile film-forming constituent of the coating material. The solvent or thinner imparts the required degree of flow to the binder during application; the combination of binder and solvent forms the vehicle or medium of the coating material.

Pigment provides colour and opacity and might have other functions in some types of coating materials. Other constituents might be present to ensure the stability of the coating or to prevent deterioration in storage or to confer specific characteristic performance attributes, e.g. UV resistance.

B.6.2 Binders

B.6.2.1 General

The nature and proportion of binder present in a coating material largely determines its characteristics, e.g. method of drying, compatibility with other coatings, application properties, degree of gloss, durability and resistance to attack. A characteristic of many binders is that they are dispersions or solutions of synthetic or natural resins or polymers.

Individual resins and other film-forming materials differ widely in properties and provide the basis for a great variety of coatings. The types of binder in general use are described in B.6.2.2 to B.6.2.7.

B.6.2.2 Solvent-borne binders

Many vegetable oils, notably linseed, soya and tung oils, dry slowly to form tough elastic films when exposed to air. A few primers and finishes employ binders of this type but more commonly, drying oils are chemically combined with resins to produce an oil-modified polyester, usually referred to simply as alkyds. These alkyds can be further modified by the inclusion of other resins, e.g. polyurethane, polyamide or silicone, to impart specific properties such as hardness, gloss retention, thixotropy or flexibility. Alkyds are used to produce clear coatings (varnishes) or, when pigmented, paints.

Coating materials based on drying-oil type binders harden by reacting with oxygen in the air and are characterized by being relatively slow in drying and hardening compared to water-borne dispersions. The actual rate depends upon their composition and the conditions of application, but typically they are dry to touch in 4 h to 8 h and recoatable overnight. Initial drying and hardening is slower or can cease altogether in cold or damp conditions or in atmospheres where the movement of air is

restricted. Drying and hardening can also be retarded by the presence of grease or dirt on the surface to which the coating is applied, and by some extractives in wood.

Drying-oil and alkyd-type coating materials are traditionally organic solvent-thinned, usually with white spirit, although the manufacturer's recommendations in this respect need to be observed.

However, it is also possible to solubilize or emulsify alkyds in water, thus moving them into the category of water-borne binders.

B.6.2.3 Water-borne binders

The term water-borne binders covers a variety of polymer types carried in water as solutions, emulsions or dispersions. By far the most common are polymeric dispersions (e.g. vinyl, acrylic, styrene-acrylic) made by a process called emulsion polymerization. These types of binder, and the paints derived from them, are often described as emulsion-binders and emulsion paints. Strictly speaking this term is incorrect, as the term emulsion is technically used to describe one liquid dispersed in another, such as the alkyd emulsions described in B.6.2.2. Water-borne dispersions are also sometimes described as latexes, by analogy with natural rubber latex.

Water-borne dispersions dry and harden by evaporation of the water followed by coalescence of the particles. To aid the latter stage, many dispersions contain additional water-miscible solvents known as coalescing agents. In favourable circumstances, they are dry to touch or even recoatable in 1 h to 2 h, and full washability is attained within a day or so of application. Damp atmospheres retard evaporation and cause delay in drying while very low temperatures can prevent coalescence and produce an unsatisfactory film.

Water-borne acrylic and vinyl dispersions were originally used mainly as coatings for walls and ceilings, but as a result of substantial technical development, they can compete with solvent-borne alkyds in most sectors with the added advantage of low odour and VOC content. In addition, water, rather than expensive thinners, can be used for thinning and for cleaning tools and equipment after use. However, there are numerous detailed differences in areas such as flow, grain-raising and poor penetration of wood, and initial gloss.

It is partly for this reason that there has been a growth in the use of water-borne alkyd emulsions, which combine some alkyd properties with the advantages of water. They still dry by auto-oxidation and will yellow and become more brittle on ageing than acrylics. As a consequence of this, alkyd emulsions are sometimes blended with water-borne acrylic dispersions to produce hybrid binders of intermediate properties. Such hybrids are used in some wood coating materials.

B.6.2.4 Chemically curing binders

Coating materials employing chemically curing binders are supplied as two-pack materials, one container holding the base and the other the appropriate quantity of curing agent, hardener or activator. The two components are combined shortly before use to induce a chemical reaction, which converts the applied film from a liquid to a solid state.

Typical examples utilize epoxy or polyurethane resins and are available as clear or pigmented materials. These are resistant to chemical attack and abrasion but require high standards of surface preparation. Curing of the film is temperature-dependent and is slowed or can be inhibited completely at low temperatures. These factors tend to limit the use of these types of coating materials on building surfaces.

Epoxy and polyurethane resins can be combined with other resins, notably alkyds, to produce one-pack materials, but these are not chemically curing and do not have the degree of chemical or abrasion resistance of the two-pack types.

Two-pack chemically curing binders are usually carried in solvent but there are some water-borne alternatives available.

B.6.2.5 Lacquers

In lacquers, film-forming material is in solution (solution-binder), and conversion to the dry film is accomplished by evaporation of the solvent alone. Examples include solutions of shellac (knotting), vinyl-type resins and nitrocellulose.

The properties of lacquers vary considerably, however, a general characteristic is that they tend to remain more or less soluble in the original solvent, which can create difficulties in applying several coats of the same material, especially by brush. Another characteristic is their rapid drying, which, again, can make them difficult or impossible to apply by brush to large areas.

B.6.2.6 Inorganic (cement and silicate) binders

White Portland cement forms the binding agent in cement paints for use on concrete, brickwork and similar surfaces. This type of coating is usually supplied in powder form and mixed with water immediately before use.

In continental Europe, silicate-based masonry coatings based on water-soluble silicate (e.g. potassium silicate) have been used for a considerable time. The coatings form inert, non-flammable films of considerable durability. The liquid paint is highly alkaline, hence pigmentation is normally by stable metal oxides resulting in a high order of colour stability.

Some specialist coatings for the protection of iron and steel (see BS EN ISO 12944 and BS 5493) are based on silicates.

B.6.2.7 Bituminous binders

Bitumens and tars in solution or as emulsions are used in low-cost coating materials, mainly for waterproofing.

Coating materials based on bituminous materials are usually black although, with some types, a limited range of dark colours is available. They can also bleed into and discolour other types of coating materials applied over them.

B.6.3 Solvents and thinners

B.6.3.1 General

Solvent imparts the appropriate degree of flow, i.e. viscosity, to a paint to facilitate application. During the drying process, solvent evaporates and so determines the initial speed of drying. Solvent vapours in the atmosphere can give rise to toxicity or flammability hazards (see Annex A).

Coating materials are generally supplied ready for use, although further additions of the recommended thinner by the user might be permissible, for example, to assist the penetration of priming coats on absorbent surfaces or for application by spray.

Over-thinning can seriously impair the opacity and other properties of coating materials, but the painting specification need not preclude thinning; as indicated above, thinning might be necessary in some circumstances.

B.6.3.2 Hydrocarbon solvents

Hydrocarbon solvents are generally of the white spirit type, although aromatic hydrocarbons such as xylene or naphtha might be encountered. Low aromatic content solvents such as de-aromatized white spirit are generally used for paints for buildings. As well as having low odour, these solvents are considered to be less harmful than traditional aromatic solvents.

B.6.3.3 Oxygenated solvents

Oxygenated solvents are derived from organic chemicals and small quantities might be included for specific purposes, for example, to help film formation in some water-borne paints. They are a major constituent of cellulose-based paints and knotting solutions (see 8.3.4), and are also used in two-pack epoxy and polyurethane paints.

B.6.3.4 Water

Water-borne paints and bituminous emulsions are thinned using water. However, many water-borne paints contain some oxygenated solvent to give good low temperature film formation.

B.6.4 Pigments

B.6.4.1 General

The major function of the pigment is to provide colour and opacity. Additionally, and according to the nature of the pigments used, they can increase the thickness of the dry film, reinforce it physically, absorb or reflect harmful ultraviolet radiation, inhibit corrosion on metal surfaces or otherwise contribute to the durability or stability of the coating.

A wide variety of pigments, differing in origin, colour and properties, are available. The principal categories are described in B.6.4.2 to B.6.4.6.

B.6.4.2 White pigments

Because of the preponderant use of white and light-coloured finishes, white pigments are of considerable importance in paint manufacturing. Titanium dioxide is the most widely used white pigment; it is non-toxic, has colour and opacity and is resistant to discoloration.

B.6.4.3 Tinting pigments

Tinting pigments comprise pigments that are used primarily for their colour when used alone or as tinters in combination with white, although some can have other properties. The main pigments in this category are natural or synthetic metal oxides, organic pigment dyestuffs and carbon black.

Coloured pigments vary considerably in properties and, in particular, in opacity. Some pigments are relatively low in opacity and, with strongly coloured coatings based on pigments of this type, additional coats might be required (see B.7).

B.6.4.4 Extenders

Extenders are inert materials, usually of mineral origin. Although generally classed as pigments, they might contribute little to the opacity of coatings but perform other useful functions such as reinforcing the mechanical strength of the dry film, assisting application and improving intercoat adhesion.

B.6.4.5 Corrosion-inhibitive pigments

Corrosion-inhibitive pigments inhibit or retard the corrosion of ferrous and non-ferrous metals and are used in primers for these surfaces. They include metallic zinc and zinc phosphate.

The properties of an inhibitive pigment can be influenced by the nature of the medium in which it is used. Metallic zinc is generally used in conjunction with oil-free binders of the solution or chemically curing types, e.g. those based on chlorinated rubber or epoxy resin.

B.6.4.6 Laminar pigments

Laminar pigments resemble small flakes with a flat or plate-like structure, and, within the paint film, the individual flakes lie parallel to the surface and overlap, forming a moisture barrier and improving

tensile strength. Widely used pigments of this type include micaceous iron oxide (MIO), aluminium and graphite. The two latter pigments, in addition to their general use in protective coating materials, are also used in heat-resisting paints.

B.7 Paint colours

The available pigments make a very wide range of colours possible although, in practice, the number of standard paint colours produced is restricted by economic considerations and, in some cases, by technical limitations. Paint manufacturers issue colour cards and fans displaying available colours and combinations in which their products are available. Some colours might be unsuitable for exterior use, and the manufacturer's recommendations on this aspect need to be followed.

BS 4800 gives a range of colours for building paints, derived from BS 5252, which establishes a framework within which a number of colours (237) have been selected as the source for all building colour standards and the means of co-ordinating them. Most paint manufacturers supply the full range of BS 4800 colours although not necessarily in all types of paints or from stock.

A useful function of paint is as a means of identifying the nature of piped services and the location of safety appliances by colour codes. BS 1710 and BS ISO 3864-4 give details of this application.

House colours are used by many large organizations to give corporate identity to buildings, equipment, vehicles, etc.

Texture influences the appearance of colours, and only to an approximate degree can a gloss colour be matched with that of a textured fabric. For accurate matching of colour, the specimen and sample ought to be of the same finish and texture. Larger specimens than those normally given in colour cards need to be used for matching.

Manufacturers might issue swatch books suitable for this purpose, and separate large cards of BS 4800 colours are available from the British Standards Institution.

Other colour palettes are in use in the UK painting sector, for example, the RAL colour scheme.

Colours alter in drying, therefore comparisons of colour in paint cannot be made until the sample and colour match are both dry. The sample and the colour match made to it needs to be viewed in several forms of light, natural and artificial, since many pairs of colours which match in one illuminant appear to be quite different in colour in another. This effect is known as metamerism and usually derives from the choice of different pigment combinations used to prepare the comparison standard and the colour match.

It is important when purchasing paint that, wherever possible, different containers hold paint from the same ready-mixed batch. Slight variations in colour can occur between different batches of paint, which will be noticeable if the products are used at the same time in the same area. See **5.6.4** for recommendations on intermixing.

Coloured pigments vary considerably in opacity and, with many strong colours, special basecoats or additional finishing coats might be needed in order to achieve a satisfactory appearance.

Annex C (informative)
The effect of temperature and humidity on paint types

The initial stage in the drying of most coatings is dependent, in varying degree, on the evaporation of solvent or thinner. Evaporation is slower in conditions of low temperature or high humidity, with a corresponding effect on the drying rate. In very hot conditions, the rate of evaporation can be so rapid as to cause difficulty in maintaining a wet edge (see 5.7).

The paint manufacturer's product data sheets give detailed information on recommended limits of temperature and humidity during application and drying of the paint system.

Solvent-borne coating materials, especially gloss finishes, tend to become thicker and more difficult to apply at low temperatures, and this can result in the application of excessively thick films which harden through slowly or develop surface defects such as sagging or rivelling (wrinkling). High temperatures cause solvent-borne coating materials to become thinner, and this can result in the application of excessively thin films.

The drying of water-borne coating materials depends almost entirely on evaporation of the water content and in highly humid conditions can be very slow, causing the coating to run or sag. With water-borne paints, formation of a homogeneous film, after evaporation of the water, depends upon coalescence of the polymer particles. This can be inhibited at low temperatures, resulting in permanent impairment of film properties, notably washability and film strength.

With two-pack epoxy, polyurethane and similar types of coating materials, there is a secondary curing stage in which the full properties of the material, e.g. chemical resistance, are developed and this stage is temperature-dependent. There might be a lower temperature limit below which application is not recommended. The pot life of two-pack coating materials, i.e. the period during which they are usable, is also temperature-dependent, becoming shorter as temperature increases.

Seasonal variations in temperature, humidity and general weather conditions can impose constraints on the application of coating materials, especially on external work. It is generally accepted that the optimum period for external painting in the UK is from mid-April to mid-September. However, the climate is sufficiently variable, geographically and from year to year, for there to be frequent exceptions.

Conditions are not always favourable during the period indicated, while there are other occasions during the remainder of the year when external painting could proceed without difficulty or detriment to the properties of the coating materials. Confining external painting strictly to the period traditionally regarded as most suitable can often be unduly restrictive.

Annex D (informative)
Fire

D.1 General

Three requirements needed for any fire to occur are:

a) a fuel;

b) an oxidizer (normally oxygen in the air); and

c) an ignition source.

A complex interaction of many factors affects whether a fire occurs and what its characteristics are. Typically, for a solid fuel, an ignition source provides sufficient thermal energy to break chemical bonds in the fuel, resulting in the production of a range of volatile chemical species that forms a gas or vapour around the solid. A proportion of these gases or vapours are flammable, i.e. when combined with an oxidizer in the right ratio, can burn.

Fire types have been broadly classified as smouldering or flaming but although smouldering fires clearly occur at a much slower rate than flaming, the general principles still apply.

D.2 Fire behaviour of coating and substrate

The interaction of a coating film and substrate in determining fire behaviour is a function of both the flammability properties of the paint and the flammability properties and thermal conductivity of the substrate. For a given flammable paint system, substrates with a relatively high thermal conductivity (e.g. metals) tend to conduct heat away from the paint film and can result in more difficult ignition and slower fire development. Substrates with a relatively low thermal conductivity (e.g. timber) might allow easier ignition and faster fire development. Flammability of the substrate, thermal mass and combustible volatiles are key aspects as well.

A further distinction between fires involving paint films and fires involving bulk fuels is the relative importance of heat release and surface spread of flame. Both these parameters are important measurements in tests for fire safety. Generally, the surface spread of flame is more important for paint films as the mass of paint film present is relatively small and would produce a relatively low heat release.

D.3 Fire testing and classification of construction products with coating films

Attention is drawn to The *Building Regulations 2010: Approved Document B – Fire safety [47], Building Standards Technical Handbook 2017, Section 2* [48] (Scotland) and *Building Regulations (Northern Ireland) 2012 Guidance, Technical Booklet E – Fire safety* [49] which give guidance on the fire safety requirements for wall and ceiling surfaces in terms of class ratings. To conform to these requirements, products or systems have to be tested against either British Standard (BS) or European (EN) fire test procedures. For both types of procedure, fire tests are carried out on the substrate and paint film as a composite system.

Historically, for painted surfaces, the main testing requirements for regulatory control have been centred on BS 476-7 (surface spread of flame) and BS 476-6 (fire propagation). With the advent of the Construction Products Regulation [11], a new range of European harmonized tests has been developed, together with a classification system. These European tests, which include BS EN 13823, the single burning item test for measurement of heat release rate and surface spread of flame, can be used as an alternative to the existing British Standard tests. The main distinction between the two testing regimes is that unlike the UK BS 476 tests, the European tests require products to be tested in their end use configuration. For example, for internal lining materials, parameters such as substrate type, air gaps between substrate and backing, joint details, horizontal or vertical orientation need to be considered alongside the testing and classification result. Furthermore, the production of burning droplets and smoke can form part of the final classification for a product.

In addition, reactive fire coatings, also known as intumescent coatings, are commonly used to protect building structures in accordance with BS EN 16623 and BS EN 13381-8.

With paint films there is an added complication in that decoration of surfaces with paint is likely to be a fairly frequent occurrence in buildings, whereas the testing and classification of the product might have only been performed on a single layer or limited layers of paint. This is addressed by the use of the so-called "blue board" substrate, which has been developed to replicate the worst-case scenario in terms of a flammable multi-layer painted surface. This proprietary flammable "blue board" comprises 10 different coats of paint, applied to a plasterboard substrate.

Another route to formal acceptance within Europe, which is particularly relevant to paint films, is the European Technical Assessment (ETA) scheme. This allows the CE marking of products where a harmonized standard cannot be established (e.g. because the products are innovative or too complex) but also for those products which might deviate from a harmonized European standard.

Annex E (informative) Wood

E.1 Design considerations

Timbers can be broadly divided into softwoods and hardwoods, and a range of species from both classes is used in construction. Softwood timbers, derived from coniferous trees and which include species such as pine, spruce and fir, account for the greater volume of timber used. They are relatively soft, and easy to work and finish, though some species can present specific coating problems. Hardwood timbers derived from broad-leaved, deciduous trees are used in the UK selectively in smaller volume. They are in general heavy, hard and close-grained, and include many of the highly figured and highly coloured timbers valued for internal work. Many tropical hardwoods and some temperate species such as oak and chestnut also possess advantages in terms of dimensional stability, moisture impermeability and decay resistance. The structure and properties of wood can have an important influence on the specification of the coating system, and on its subsequent performance in service.

Coating of wood might be required for purposes of decoration and protection. The decorative effect often derives from the colour and sheen of a paint coating, but wood is also one of the few substrates for which there is a demand for transparent coatings that present and enhance the visual appeal of the substrate. Protective purposes include the following.

a) *Sealing.* Untreated wood surfaces absorb liquids, are subject to soiling and chemical staining, and are unhygienic and difficult to clean.

b) *Mechanical damage.* Resistance to scratching and abrasion is an important requirement for flooring and some other internal applications.

c) *Stabilization.* Surface coatings have a major effect on the rate of exchange of water vapour between wood and the surrounding atmosphere, and hence can be an effective means of controlling the swelling and shrinking of the wood.

d) *Weather protection.* Wood surfaces exposed to the weather without surface protection are subject to discoloration, defibration and greying.

e) *Preservation and protection.* Surface coatings cannot generally be classed as wood preservatives as they are not toxic to wood-destroying organisms and do not penetrate sufficiently deeply. Moreover in some circumstances paint can trap water in the wood and increase risk of decay. Nevertheless an intact paint film on all surfaces prevents the wood becoming wet enough to

support fungal growth, and prevents the surface being colonized by moulds and other fungal spores. In this restricted sense, paint contributes to the preservation of the wood surface.

f) *Flame retardance.* Coating materials can be applied to wood and wood-based panel products to raise the resistance to spread of flame.

E.2 Characteristics

E.2.1 Structure

The properties encountered with wood are directly related to the origins of the raw material, namely the structure and functions of a tree. Wood is a cellular material in which most of the cells are aligned vertically in the tree, giving wood its characteristic grain. Other cells lie in horizontal bands (rays) running outwards in the tree.

Moisture uptake in wood arises from the natural liquid pathways found in the growing tree and occurs in softwoods and hardwoods.

E.2.2 Heartwood and sapwood

The trunk of a young tree consists entirely of sapwood, which not only provides mechanical support but also sap conduction processes essential to the life of the tree. As the tree ages, a core of heartwood develops which plays no part in fluid conduction and which gradually becomes impregnated with a wide range of resins, gums, tannins and other chemicals. Heartwood is often distinguished from sapwood by its deeper reddish-brown colour, and in most wood species possesses greater resistance to water uptake and a degree of natural decay resistance. In general, the sapwood of timber is moisture permeable and susceptible to fungal decay, and its effective protection poses a greater challenge when used in applications where it is at risk of wetting.

E.2.3 Moisture content

Green timber contains both free water in the cell cavities and water absorbed by the cell walls. If the moisture content is reduced to about 25% to 30% of the oven-dry mass this removes free water from the cell cavities, but the fibres remain saturated and the wood is fully swollen. Timber shrinks progressively as more moisture is removed.

Shrinkage is greatest across the grain and is reversible; changes in moisture content through exposure to rain or fluctuations in relative humidity cause alternate swelling and shrinkage.

Moisture content can be measured with sufficient accuracy for painting purposes with an electrical moisture meter of the conductive type. Electrical moisture meters can give a falsely high reading if soluble salts are present, e.g. from preservative treatment with disodium octaborate.

E.2.4 Permeability and penetration of liquids

The permeable nature of wood affects not only moisture movement but also the ease of impregnation by preservatives and the behaviour of paint.

In general, penetration is deeper and more rapid through end grain than through lateral surfaces, and is also deeper and more rapid through sapwood than through heartwood. There are also differences in permeability between early and late growth areas causing differential swelling which imposes stresses on surface coatings.

E.2.5 Extractives

Extractives are present as minor non-structural constituents of the cell cavities and cell walls, and differ greatly in quantity and type in different wood species. In most species, the extractive content

averages less than a mass fraction of 5%, but in some tropical hardwoods, and in the knots of many softwoods, it can amount to a mass fraction of 30% or more. The chemical nature of the extractives in both hardwoods and softwoods is very variable.

One of the most commonly encountered extractive problems is associated with knots in resin-rich softwoods such as Scots pine (European redwood) and British Columbian pine (Douglas fir). These resins basically consist of a blend of resin acids or rosin in turpentine, together with small amounts of tannins, which are water-soluble and possess the property of darkening on exposure to light. The resin blend gives rise to two kinds of problems. In hot summer weather the resins are mobilized and exude to the wood-paint interface where they cause blistering of the paint. This problem is most severe when dark coloured paint has been used, and can also be aggravated by retained solvent from preservative treatment. The tannin extractives can additionally migrate into the paint to produce a brown discoloration in the area of paint over the knot, which is particularly noticeable on white and pastel shades, and especially on water-borne coatings. For such timbers coated with wood stains, the resin can penetrate through the film without disrupting it or causing blisters.

E.2.6 External influences — Moisture

As a result of increased attention to heat conservation, internal condensation has assumed considerable importance as a source of moisture. The absence of flues, blocking of unused flues and airbricks, draught-proofing and similar measures have greatly reduced internal ventilation rates, especially in domestic buildings. In consequence, the water vapour produced by normal domestic activities is unable to escape readily and can migrate to colder rooms and condense on single-glazed windows, eventually penetrating open joints, defective putties and other discontinuities in the paint film. This is a frequent cause of timber decay and paint failure on wooden window frames and sills. Wet rot in timber cladding or failure of the external paint can also be caused by condensation within the wall cavity.

Coating permeability has important implications on timber windows. These are usually subject to a higher temperature and relative humidity on the inside compared with the outside, and a consequent vapour pressure differential favouring the transport of warm moist air outwards through the timber frame sections. One of the functions of the interior paint is to provide a vapour barrier, and it is essential therefore that it possesses a relatively low permeability. Circumstances in which the inside coating is more moisture-permeable than that outside, as for example through the use of a permeable water-borne paint inside and a solvent-borne alkyd outside, need to be avoided. This arrangement can result in interstitial condensation within the frame section and severe blistering of the exterior coating during cold weather.

On external exposure to sun and rain, unprotected wood loses its original colour and the surface degrades until it consists of a thin layer of loosely matted fibres, usually dirt-stained and darkened by fungal blue stain and iron staining. After periodic wetting and drying, the growth rings can become prominent and splitting and distortion can occur.

Wood, which is not naturally resistant, is susceptible to fungal attack if its moisture content exceeds a mass fraction of about 22% for lengthy periods. In painted woodwork, the principal agents of decay are wet-rot fungi. Surface moulds and blue-stain fungi have little effect on the durability of timber although they are unsightly and can disfigure paintwork. Exterior timbers not in contact with the ground are unlikely to rot if they are of moderate durability, but this classification applies only to the heartwood; all sapwood is vulnerable to decay.

Moisture could gain entry into the wood through open joints, or where putties and sealants are defective. The paint film might then hold the water in. In jointed components the principal route for moisture entry is through end grain concealed within the joints. To reduce the take up of moisture in

this area and to improve the coating it is recommended that performance components have their end grains sealed during manufacturing.

The extent of movement can vary between timber species and modified timbers can provide substrates that are particularly stable.

E.2.7 Preservative treatments

Preservation of wood components such as exterior softwood joinery and cladding is desirable and is normally carried out in the factory. The main types of preservative used are organic solvent solutions of fungicides or water-borne micro-emulsions applied by double-vacuum treatment or immersion. For cladding and outdoor applications, vacuum-pressure treatment with water-borne salts or fungicides is also employed.

Preservatives are also useful in prior-to-painting repairs on external timber components. After remedy of defective timber using resin or traditional methods of timber inserts, wood which is sound but deemed to be vulnerable to decay might be protected by the insertion of preservative plugs.

E.2.8 Knot treatment

Knotting is rarely effective in preventing physical disruption of paint films by heavy exudation of resin. This is more likely to occur externally over knots in surfaces exposed to strong sunlight, which liquefies the resin and makes it more active. The use of light-coloured paints reduces solar heat gain and can therefore reduce resin exudation although it is unlikely to prevent it completely; also, the resin is more obvious on a light-coloured surface. An alternative is the use of an exterior wood stain (see 9.2.4).

The widespread adoption of water-borne paints has given rise to significant problems of staining over knots due to the extraction of light-sensitive tannins contained in the knots into the coating. Conventional knotting is relatively ineffective in preventing tannin staining; more successful results have been achieved through the use of stain-blocking primers containing reactive pigments.

E.2.9 Resinous and oily materials

Some hardwoods (e.g. gurjun, keruing and agba) and occasionally resinous pines contain a high content of resin distributed through the wood, which can give rise to severe exudation problems. Kiln drying reduces the activity of resin in potentially troublesome timber but when resin content is very high, exudation can continue for long periods, especially on external woodwork exposed to UV exposure. In such situations, dark-coloured paints ought to be avoided.

Other woods, such as teak and some cedars, contain oil, which can impair the drying, hardening or adhesion of coating materials.

E.3 Coating systems

E.3.1 General

For specific information on the testing, evaluation and classification of wood coatings, refer to the BS EN 927 series. Table E.1 gives examples of primers for wood.

Table E.1 — *Primers for wood*

Ref.	Description	General composition	Characteristics and usage
E.1/1	Opaque primer	Pigmented primer, solvent-borne (typically alkyd) or water-borne (typically vinyl acetate or acrylic), for general use under paints	Primers of this type are suitable for general use on wood, fibreboards and chipboards.
E.1/2	Opaque primers conforming to BS 7956, Type A[A)]	Solvent-borne (typically alkyd) or water-borne (typically acrylic) pigmented primers of E.1/1, but formulated for improved exterior durability	General purpose
E.1/3	Semi-transparent primers conforming to BS 7956, Type B[A)]	Solvent-borne or water-borne as E.1/2 using transparent pigments	Semi-transparent dual-purpose primers designed for overcoating with either stain finishes or paints. Often used as the factory-applied primer for joinery. They are generally of lower durability than E.1/2 primers and are overcoated with minimum delay.
E.1/4	Opaque primers conforming to BS 7956, Type C[A)]	Solvent-borne or water-borne primers as E.1/2 with stain-blocking properties	Primers that can be used directly over knots, resinous timbers and timbers pre-treated with preservatives, such as metallic naphthenates, known to discolour subsequently applied paint films.
E.1/5	Ready-mixed aluminium primers	Solvent-borne drying-oil/resin type binder with aluminium pigment	An alternative to conventional solvent-borne wood primer more suitable for woods that are resinous or have been treated with creosote. Relatively impermeable to moisture. Application of an additional coat of undercoat/finish might be required to obliterate grey primer colour.
E.1/6	Preservative primers	Unpigmented or lightly pigmented solution of resins and fungicides in water or organic solvent	First coat of some proprietary wood coating systems, intended to seal porous and weather exposed surfaces and inhibit fungal colonization. Beneficial for treating weathered wood surfaces after mechanical preparation.

[A)] It is recommended that conforming primers meet the specified standard of exterior durability.

E.3.2 Coatings for interior use

E.3.2.1 Water-borne paints

Water-borne latex paints have long been accepted in wall painting but their adoption for internal woodwork has been hindered by their inferior flow and initial gloss properties compared with the traditional solvent-borne alkyd. They have significant application advantages however, in particular,

low odour and rapid rate of drying which can permit the complete system to be applied in the working day.

E.3.2.2 Transparent and semi-transparent finishes

The provision of a clear seal or varnish finish to interior wood is a relatively straightforward operation and a wide variety of coating systems is available for this purpose. The traditional solvent-borne oil and alkyd resin still find application commonly based on de-aromatized white spirit. The wood colour can be equalized or altered by the application of a dye or stain before sealing, or this might be achieved by the use of an interior wood stain. A full range of gloss levels is achievable, and where necessary coating materials with good resistance to mechanical damage or staining can be obtained. Water-borne varnishes have advanced considerably and in appearance and wear resistance properties are now almost equivalent to the established solvent-borne types. Table E.2 and Table E.3 give some uses for transparent and semi-transparent wood finishes and general coating systems for interior wood.

Table E.2 — *Transparent and semi-transparent finishes for interior wood*

Ref.	Description	General composition	Characteristics and usage
E.2/1	Solvent-borne clear varnish, general purpose	Typically drying-oil/alkyd, urethane or urethane/alkyd resin	Used as a sealer on both softwood and hardwood surfaces. Available in a range of gloss from matt to full gloss. Some types might be sufficiently abrasion resistant for use on hardwood and softwood floors, counters and similar hard-wearing locations.
E.2/2	Water-borne clear varnish, general purpose	Water-borne acrylic copolymer	Fast-drying, durable protective coating for most interior wood
E.2/3	Water-borne clear floor varnish	Water-borne acrylic with polyurethane dispersion	High durability interior clear wood lacquer. Ideal for hard-wearing interior wood surfaces especially traditional floors. Resistant to common chemicals and hot water
E.2/4	Semi-transparent interior wood stain/dye	Coloured pigments or dyes, with or without drying-oil, water or solvent-borne	Used essentially to modify or enhance the appearance of interior wood without obscuring its grain and is usually overcoated with a clear finish.
E.2/5	Solvent-borne two pack varnish	Typically oil, alkyd or polyol cured with aliphatic isocyanate	Limited pot life, some additional safety precautions required. Used in hard-wearing areas, such as flooring. See A.2.7 for details on safety precautions handling these products.

Table E.3 — *Coating systems for interior wood*

Application (end-use)	**Coating type** (see Note 1)	**Priming options for new and bare areas of wood**	**Typical life to first maintenance** (see Note 2)
Opaque systems			
Internal surfaces of door and window joinery, wood trim, plywood and wood-based boards	General purpose pigmented finishes as described in Table B.5	Opaque primer E.1/1 optionally overcoated with undercoats B.2/1 or B.2/2	Over 5 years[A)]
Transparent and semi-transparent systems			
Internal surfaces of door and window joinery, wood trim, plywood and wood-based boards	Varnish, clear or semi-transparent in wood tone of choice. Build and gloss level of choice. Abrasion-resistant binder, e.g. polyurethane, for hard- wearing situations (see Table E.2)	Often primed with a suitably diluted coating of the finishing coat. Wood stains may be used to enhance grain	Variable according to type and service conditions but typically up to 5 years in average wear conditions
	Interior wood stain in wood tone of choice, possibly overcoated with clear varnish	–	Variable according to type and service conditions but typically up to 5 years in average wear conditions. Might give lifetime service in some situations
Flooring	Varnishes with good abrasion resistance. See E.2/1 and E.2/3. Specialist application might be required	Often primed with a suitably diluted coating of the finishing coat. Wood stains may be used to enhance grain	Long life in domestic situations but will require maintenance in high traffic areas

NOTE 1 Wood coatings are described by many terms including colour, build and opacity; BS EN 927-1 gives an account of terminology. Systems that do not fully obliterate the colour or grain of wood are sometimes described as natural finishes. Coating systems can be based on different chemistries, e.g. alkyds and acrylics, and can be carried in either water or solvent.

NOTE 2 Interior coatings do not require frequent maintenance unless mechanically damaged. Transparent wood coatings could have some colour change.

[A)] Solvent-borne finishes in light colours are prone to yellowing in a shorter time frame than 5 years, especially in the absence of daylight.

E.3.3 Coating systems for exterior use

E.3.3.1 General

Although decorative effect is important for exterior wood coatings, the function that is of vital importance is the protection of the wood substrate against deterioration by weathering agencies, principally sunlight and water, and biological attack. Exterior wood is moreover a very challenging substrate, in that any adventitious entry of water can lead to dimensional movement in the substrate, biological deterioration, and adverse effects on coating adhesion.

In order to aid the selection of suitable coating materials, considerable effort has been devoted to the development of performance standards. BS EN 927-1 specifies a system for the classification

of coating materials and coating systems for exterior wood surfaces by categories of end use, appearance and exposure conditions. BS EN 927-2 is a performance specification, based on a natural exposure test as given in BS EN 927-3. The natural exposure test has also been incorporated in a British Standard for undercoat and gloss paints, BS 7664. BS 7956 is a performance standard covering the performance evaluation of all classes of wood primers, namely solvent-borne, water-borne, aluminium and stain basecoats. Table E.4 and Table E.5 give some uses for transparent and semi-transparent finishes and general coating systems for exterior wood.

Table E.4 — *Transparent and semi-transparent finishes for exterior wood*

Ref.	Description	General composition	Characteristics and usage
E.4/1	Clear varnish, solvent-borne	Typically drying-oil/phenolic or alkyd resin	This provides a tough water-resistant coating, used principally as a clear protective finish for exterior hardwood. The usual mode of eventual failure is by cracking and flaking, and in exposed situations it demands frequent maintenance.
E.4/2	Solvent-borne two pack varnish	Typically oil, alkyd or polyol cured with aliphatic isocyanate with added UV absorber	Limited pot life. This is used primarily on hardwoods. It is similar to some yacht varnishes. It can give superior performance on hardwoods. See A.2.7 for details on safety precautions handling these products.
E.4/3	Semi-transparent exterior wood stain, low-build, solvent-borne	Resins, pigments and fungicides in organic solvent	This is a relatively thin coating that normally imparts a noticeable sheen to the surface. It has relatively high moisture vapour permeability and the wood is likely to be subject to dimensional movement and surface splitting. It is not best suited to dimensioned components such as joinery.
E.4/4	Semi-transparent exterior wood stain, low-build, water-borne	As for E.4/3 minimizing the use of organic solvents	This is a relatively thin coating that normally imparts a noticeable sheen to the surface. It has relatively high moisture vapour permeability and the wood is likely to be subject to dimensional movement and surface splitting. It is not best suited to dimensioned components such as joinery.
E.4/5	Semi-transparent exterior wood stain, medium-build, solvent-borne	Generally as for E.4/3 but higher resin content	This is often used as a topcoat for E.4/3. Because of its higher resin content this type of stain will confer a higher build and offers better control of moisture and dimensional movement.
E.4/6	Semi-transparent exterior wood stain, medium-build, water-borne	An alternative to E.4/5 minimizing the use of organic solvents	This is often used as a topcoat for E.4/4. Because of its higher resin content this type of stain will confer a higher build and offers better control of moisture and dimensional movement.

Table E.5 — *Coating systems for exterior wood*

Application (end-use)	**Coating type** (see Note 1)	**Priming options for new and bare areas of wood**	**Typical life to first maintenance** (see Note 2)
Opaque systems			
Exterior door and window joinery	1 or 2 coats general-purpose alkyd-based gloss paint over recommended undercoat	Opaque solvent-borne or water-borne (E.1/2 or E.1/4), or clear preservative primer (E.1/6)	3 to 5 years
	1 or 2 coats flexible exterior alkyd-based paint over recommended primer. Gloss level and colour of choice	Opaque solvent-borne or water-borne (E.1/2 or E.1/4), or clear preservative primer (E.1/6). Special primer/ undercoats may be specified.	Over 5 years
	1 or 2 coats exterior water-borne paint (B.1/3). Gloss level and colour of choice	Opaque solvent-borne or water-borne (E.1/2 or E.1/4), or clear preservative primer (E.1/6)	Over 5 years
Softwood and plywood for cladding, bargeboards, soffits and fascias (See Note 3)	1 or 2 coats flexible exterior alkyd-based paint over recommended primer. Gloss level and colour of choice	Opaque solvent-borne or water-borne (E.1/2 or E.1/4), or clear preservative primer (E.1/6)	Over 5 years
	1 or 2 coats exterior water-borne latex paint (B.1/3). Gloss level and colour of choice	Opaque solvent-borne or water-borne (E.1/2 or E.1/4), or clear preservative primer (E.1/6)	Over 5 years
Transparent and semi-transparent systems (see Note 4)			
Exterior softwood door and window joinery	Exterior wood stain Medium build (E.4/5 or E.4/6)	E.1/6 or E.1/3	Depends on product type, unlikely to exceed 2 to 3 years on full exposure
Exterior hardwood door and window joinery (see Note 5)	Exterior wood stain Medium build (E.4/5 or E.4/6)	E.1/6 or E.1/3	Typically 3 to 5 years depending on exposure
Exterior grade plywood, e.g. door panels	Exterior wood stain Medium build (E.4/5 or E.4/6)	E.1/6 or E.1/3	Depends on product type, unlikely to exceed 2 to 3 years on full exposure. Efflorescence is a risk factor
External softwood boarding, cladding, bargeboards, soffits, fascias (See Note 3)	Exterior wood stain Low-build (E.4/3 or E.4/4) Medium build (E.4/5 or E.4/6)	E.1/6 or E.1/3	3 to 5 years depending on exposure
External hardwood boarding, cladding, bargeboards, soffits, fascias (See Note 3)	Exterior wood stain Medium build (E.4/5 or E.4/6)	E.1/6 or E.1/3	4 to 5 years depending on exposure
External grade plywood boarding, cladding, bargeboards, soffits, fascias (See Note 3)	Exterior wood stain Medium build (E.4/5 or E.4/6)	E.1/6 or E.1/3	Typically 3 to 5 years depending on exposure. Efflorescence is a risk factor

Table E.5 *(continued)*

Application (end-use)	**Coating type** (see Note 1)	**Priming options for new and bare areas of wood**	**Typical life to first maintenance** (see Note 2)
Gates, fences, handrails, decking and garden furniture (see Note 6)	Exterior wood stain Medium build (E.4/5 or E.4/6) Low build (E.4/3 or E.4/4) (see Note 4)	E.1/6 or E.1/3	3 to 5 years

NOTE 1 Wood coatings are described by many terms including colour, build and opacity; BS EN 927-1 gives an account of terminology. Systems, which do not fully obliterate the colour or grain of wood, are sometimes described as natural finishes or exterior wood stains. Coating systems can be based on different chemistries, e.g. alkyds and acrylics, and can be carried in either water or solvent.

NOTE 2 Life expectancies shown assume application to dry, sound timber which, if necessary, has received preservative treatment and are based on performance in moderate environments as defined in Table 3. Lifetime expectations are expressed as an average and a distribution (standard deviation) around the average can be expected in real situations. BS EN 927-3 provides a performance specification for exterior wood coatings.

NOTE 3 All sides and edges of joinery or boards require painting to achieve expected maintenance cycles.

NOTE 4 The final appearance of transparent and semi-transparent coatings depends on the number of coats. Two is the usual minimum; an additional coat increases service life but can darken the appearance. Penetrating low-build stains are primarily used on rough sawn timber where one or two coats are required.

NOTE 5 Commercial systems designed for hardwood might have a different composition to their softwood counterparts.

NOTE 6 Commercial variants might include different degrees of water repellence.

E.3.3.2 Exterior wood stains

E.3.3.2.1 General

Whereas the task of protecting and enhancing natural wood indoors is a relatively straightforward matter, the task of preserving the natural appearance of the wood outdoors is beset with difficulties. Clear and semi-transparent coating materials lack the opaque protective pigments that are present in paints, and are in consequence less durable than opaque coating materials so that maintenance intervals are shorter and overall costs higher. Crucially any breakdown of the coating exposes wood to weathering and biological attack, and often consequent discoloration cannot be masked by fresh application of the natural finish.

E.3.3.2.2 Solvent-borne exterior wood stains

Solvent-borne exterior wood stains are generally based on alkyd resins dissolved in white spirit. They can be grouped into two broad classes, low-build and medium-build. The low-build products are typically of low viscosity and the most penetrative type of wood stain. They deposit relatively thin films on the surface, possibly only 10 µm to 15 µm for a three-coat application, so the natural features of the wood are less obscured. Low-build stains weather by erosion rather than by flaking, and require a minimum of preparation prior to recoating. On the other hand in exposed situations, erosion is relatively rapid and maintenance intervals of about three years might be appropriate. Low-build stains have high moisture permeabilities, and exert relatively poor control on wood moisture content. There is a risk of significant dimensional movement and possibly surface splitting, especially as erosion of the stain occurs during weathering.

Low-build stains possess additional technical advantages. They are very tolerant of imperfections such as splits, knots and nail holes, and their good penetrative properties enable them to cope well with weather-degraded surfaces. Resin in knots can exude through the very thin surface film without

causing disruption; when the resin acids have hardened, the residue can be removed from the surface by light scraping.

Medium-build stains contain a higher proportion of resin and apply a higher film thickness of the order of 30 μm to 40 μm for the complete system. They are less permeable than low-build types and exert better moisture control on the timber, thus reducing the degree of dimensional movement and risk of surface splitting. They are more resistant to erosion, and require less frequent maintenance than the low-build types.

E.3.3.2.3 Water-borne wood stains

Water-borne acrylic and alkyd resins or alkyd-acrylic blends are increasingly being used in the formulation of medium-build wood stains and can give good durability. However, they penetrate less deeply into wood and may therefore be used over a solvent-borne priming stain.

E.4 Wood-based panel products

E.4.1 Plywood

Plywood has many of the general characteristics of solid timber, including susceptibility to the effects of moisture although the method of construction gives it greater dimensional stability with changes in moisture content.

Checking varies in severity according to the species of timber used for the outer veneer. It is less severe, for example, with African mahogany and gaboon, while Douglas fir (British Columbian pine) and Finnish birch are prone to severe checking. It can be assumed, however, that the species in general usage are all liable to check when used outside.

Checking affects only the surface layer of the outer veneer but, if the surface is painted, the cracks are communicated to the coating, allowing entry of moisture and failure of the paint film.

Plywood for external use is manufactured with weatherproof adhesive but not necessarily with durable species of timber throughout; if non-durable species are incorporated, it is recommended that a preservative treatment is applied.

Plywood is available with a resin-impregnated paper overlay which prevents checking and provides a satisfactory base for painting; the use of this type of material is recommended for external plywood cladding and similar applications when a paint finish is required, especially with species prone to severe checking. Exterior wood stains, especially those of the low-solids type, are less likely to give trouble and are more suitable than paint or varnish for use externally on plywood without a paper overlay.

However, because of the low resistance of low-solids wood stains to water vapour, fluctuations in moisture content can result in water-soluble salts, present in the adhesive, being brought to the surface. These are normally removed by rain but, if the surface is sheltered from direct rainfall, a white deposit can build up and mar the appearance. The salts can be washed off but will reappear until they are depleted.

E.4.2 Fibre building board

Painting of fibre building board and wood chipboard usually has a mainly decorative function, but it might be necessary for protection in some circumstances, e.g. with boards used externally or in conditions of prolonged high humidity.

There are four main types of fibre building board.

a) *Hardboard.* This is of a high density and presents a smooth, slightly absorbent surface upon which a satisfactory standard of finish can be obtained with most types of paint including gloss finishes. Hardboard is available in standard and tempered grades. Tempered hardboard is impregnated with oils or resins and heat-treated during manufacturing to improve its water resistance. Some impregnation treatments can slightly retard the drying of solvent-borne paints, but this is rarely serious.

b) *Mediumboard.* This is less dense and usually slightly more absorbent than hardboard but has a similarly smooth surface upon which a satisfactory finish can be obtained with most paints including gloss finishes.

c) *Medium density fibreboard (MDF).* This is manufactured by a dry process in which the primary bond is derived from a bonding agent. A smooth, slightly absorbent surface is presented upon which a satisfactory finish can be obtained with most types of paint, including gloss finishes. Edges tend to be more absorbent and where exposed (e.g. by machining) and requiring a decorative finish, an additional coat of primer or sealer might be required (see Table E.2).

d) *Softboard.* This is of low density and unless specially treated, e.g. surfaced or laminated, has a rough, highly absorptive surface upon which it is difficult to achieve a high standard of finish, especially with gloss finishes.

In addition to factory-applied decorative treatments, including coating materials and laminates, there are other treatments for fibre building boards which might affect painting. Typical treatments, and the types of boards to which they apply, are described as follows:

1) *Pulp or ivory surface.* A surface layer of finely-ground wood fibre is incorporated during manufacturing and gives a uniform, light-coloured surface of low porosity. This facilitates direct application, without priming or sealing, of water-borne paints. The treatment is available on mediumboard and softboard.

2) *Sealed.* A treatment which reduces absorption and might obviate the need to apply a primer or sealer on site. The treatment is available with standard hardboard.

3) *Primed.* The board is supplied primed with a pigmented primer ready for site coating. The treatment is available with standard hardboard and softboard.

4) *Flame-retardant treatment.* Chemical impregnation can render most boards flame retardant according to class 1 of BS 476-7, but see **D.3**. Boards are also available with a flame-retardant coating on one or both sides. Some impregnation treatments can affect the appearance or behaviour of paint systems. The treatment is available with hardboard, mediumboard and softboard.

5) *Perforated.* Boards might be perforated during manufacturing to increase sound absorption as in acoustic tiles, or for other reasons, e.g. for decorative effect or to provide ventilation. When perforated boards or tiles are used for their acoustic properties, it is important that the holes do not become blocked with paint; to prevent this, spray or roller application of thin coats is recommended. Perforated hardboard, mediumboard and softboard are available.

Where a reduction in the number of site-applied coats is necessary or a higher standard of finish is desired, fibre building boards and wood chipboards supplied with a factory-applied primer or sealer on one or both faces is recommended.

E.4.3 Wood chipboard

Like timber, chipboard can be attacked by wet-rot fungus if its moisture content is above the critical level for lengthy periods; the physical properties of the board can also be affected. Moisture-resistant

grades are available for use in highly humid conditions and ought to be installed in accordance with manufacturer's recommendations regarding design detailing and fixing methods.

NOTE Preservative treatment, as recommended for wood in 9.2.2.4, is not usually suitable for wood chipboard.

Wood chipboard is composed of chips or particles of wood, mainly softwood, in a synthetic resin binder. It is sometimes described as particleboard. Fungicidal, insecticidal and fire-retardant chemicals can be incorporated. Small amounts of paraffin wax can be added to give limited protection against moisture absorption and consequent swelling of the wood chips.

Other factory-applied treatments, in addition to decorative finishes such as surface coating materials, laminates and veneers, include the following.

a) *Primed/filled.* A paste filler/primer, off-white or grey in colour, is applied to one or both sides of the board. It provides a smooth, hard surface, receptive to most types of paint. Boards treated in this way and flame retardant according to class 1 of BS 476-7 are available.

b) *Primed.* A semi-transparent or opaque primer is applied to one or both sides of the board and obviates the need for site priming.

c) *Sealed.* A clear sealer, usually polyurethane-based, is applied to one or both sides of the board. This gives protection against moisture penetration and also serves as a base for site-applied clear and pigmented coating systems.

d) *Paper-faced.* Special resin-impregnated papers are applied to one or both sides of the board and provide a satisfactory base for painting.

Table E.6 gives options for priming fibre building board and wood chipboard.

Table E.6 — *Site priming of fibre building board and wood chipboard (not factory-primed or sealed)*

Type of board or sheet	Primers and references in Table E.1 and Table B.3	
	With solvent-borne finishes	**With water-borne finishes[A)]**
Hardboard, medium board, medium density fibreboard (MDF) and softboard	Primer-sealer (B.3/3) Water-borne primer (B.3/2) Aluminium wood primer (E.1/2)	Not usually required, but for absorbent board, first coats might need additional thinning
Flame retardant treated	Alkali-resisting primer (B.3/1)	Alkali-resisting primer (B.3/1)
Softboard, bitumen-impregnated	Aluminium wood primer (E.1/2)	Not usually required
Wood chipboard	Solvent-borne wood primer (E.1/1) Primer-sealer (B.3/3) Water-borne primer (B.3/2) Aluminium wood primer (E.1/2)	Not required (see Note) but the first coat of paint applied to plasterboard is usually either a mist coat or a dry-wall primer
Oriented Strand Board (OSB)	As wood chipboard	As with solvent-borne finishes if a high quality finish is required
Cement-bonded particleboard	Water-borne primer (B.3/2) Alkali-resisting primer (B.3/1)	Water-borne primer (B.3/2) Alkali-resisting primer (B.3/1)

NOTE See plasterboard manufacturer's recommendations on priming for use with water-borne finishes.

[A)] Water-borne multi-colour finishes (B.4/9) are usually applied over a special basecoat.

Annex F (informative)
Interior and exterior masonry and plaster

F.1 General characteristics

F.1.1 General

Interior and exterior masonry and plaster, including external rendering, concrete, brick and stone have a number of characteristics in common and, to avoid repetition, these are considered in this annex.

F.1.2 Moisture content

Water, often in large quantities, is used with all the materials referred to and can also be absorbed as a result of storage of materials in the open without protection. Excessive moisture affects the adhesion of most types of paints, causes blistering and flaking and encourages the growth of moulds. Additionally, in combination with alkalis and salts contained in many wet materials of construction, it is the cause of other difficulties in relation to painting, including efflorescence, alkaline attack and staining.

Until the contained moisture has substantially dried out, there is some degree of risk in applying most types of coating materials. Drying out can take a long time even in favourable conditions, a rough estimate being one week of good drying conditions for each 5 mm thickness of wet construction (typically 4 to 6 weeks). Further information on drying out buildings is given in BRE Digest 163 [50].

The first column in Table F.1 and Table F.2 refers to four stages of drying of walls, i.e. dry, drying, damp, and wet, and gives corresponding equilibrium humidity percentages.

F.1.3 Calcium carbonate deposits

Thin, hard film known as lime bloom cannot be wiped off but can usually be softened and removed with a steam gun and scraper. Lime bloom can be over-painted without much risk of disruption provided the substrate is substantially dry, though the glazed surface might impair adhesion.

F.1.4 Alkalinity

Materials containing Portland cement (CEM1) or lime are strongly alkaline; gypsum plasters are not usually alkaline themselves but might become so if they are gauged with lime or if lime is brought forward from backings during drying. Alkalinity diminishes with ageing, but the process can take several years with cement-based products.

Drying oil/resin paints are likely to be saponified (softened or liquefied) by alkalis in the presence of moisture. Most water-borne paints are not attacked in this way but can be weakened or bleached by strong alkalis. Some special purpose paints, notably those based on chlorinated rubber or epoxy resins, are not attacked but might only be applied to dry substrates, and this usually precludes their use on new work. Cement-based paints are also resistant to alkaline attack. Some pigments are attacked by alkalis, causing fading or discoloration, but paints intended for use on substrates that might contain alkalis are usually formulated with resistant pigments.

F.1.5 Staining

Brown stains with no appreciable surface deposit sometimes appear on coatings of water-borne paint but do not normally affect solvent-borne paints. They are usually derived from substrates, notably

certain types of brick, render, mortar, hollow clay pot or clinker block, containing soluble salts or colouring materials such as ferrous oxide, or from sands containing biological matter that reacts with alkali.

F.2 Specific characteristics — plaster

F.2.1 General

The plasters in general use for internal work comprise one or more of the following:

a) calcium sulfate (gypsum) types, other than lightweight plasters, conforming to BS EN 13279-1;

b) calcium sulfate (gypsum) lightweight plasters conforming to BS EN 13279-2;

c) thin-wall plasters;

d) cement plasters; and

e) lime plasters.

BS EN 13279-1 distinguishes four grades of gypsum plasters, only two of which are in common usage:

- Grade A. Plaster of Paris. This is not normally used for plastering but is sometimes used for repairs and might be gauged with lime or lime and sand. For painting purposes, it might be considered with grade B.
- Grade B. Retarded hemihydrate plasters. These have a smooth, hard but moderately porous surface to which paint adhesion is good, but absorption is sometimes variable and can cause patchiness of water-borne paints.

Grade B plasters are generally neutral in reaction and, even if gauged with lime, do not affect paint unless there is a source of alkali in the backing. Over-wetting during application can produce a powdery surface. In damp conditions (e.g. from prolonged heavy condensation or moisture penetration from behind), sweat out can occur, resulting in softening of the plaster and consequent paint failure.

BS EN 13279-2 describes lightweight gypsum undercoat and finish plasters based on grade B plasters with lightweight aggregates. Premixed lightweight cement plaster undercoats can be used in some circumstances, and these are strongly alkaline. Lightweight plasters initially hold more water than other types and can take longer to dry out, particularly in winter.

F.2.2 Calcium sulphate (gypsum) plasters

Used neat and when fully dry and set, calcium sulfate (gypsum) plasters can be painted without difficulty with most types of paint. Added lime (or cement in backing coats), in the presence of moisture, might cause alkalinity which would require use of an alkali-resistant coating material or primer.

F.2.3 Thin-wall plasters

Thin-wall plasters are based on organic binders and are used in thin layers to dry out rapidly. They normally present no difficulties in painting when used on dry backings but sometimes appear underbound and can show excessive absorbance which requires correcting prior to painting.

F.2.4 Cement plasters

Cement:sand or cement:sand:lime plasters are generally used where strong, hard or moisture-resistant surfaces are needed. Such plasters are strongly alkaline but can be painted once substantially dry provided the paints used are resistant to alkali.

F.2.5 Lime plasters

Non-hydraulic lime plasters made with high-purity lime and clean sand are free from soluble salts and caustic alkali but can react with salts from backing to form caustic alkalis which attack drying oil/resin paints and some water-borne paints if they are applied before the plaster has substantially dried out. Hydraulic lime plasters are variable in caustic alkali content and can attack paints severely. Such plasters are strongly alkaline but can be painted once substantially dry provided the paints used are resistant to alkali.

F.3 Coating systems for interior use

F.3.1 Mid-sheen and matt water-borne paints

Water-borne paints of matt to mid-sheen finish are permeable, reasonably resistant to alkali attack and therefore suitable for use on substrates that are not completely dry. However, they are not on this account to be misused, e.g. applied to damp surfaces within a few days of plastering.

Permeability is generally proportionate to the level of sheen; the matt contract types are the most permeable although they are less resistant to wear and frequent washing than the other types.

Water-borne paints applied to reasonably dry substrates usually provide a satisfactory base for most of the types of paint that might be required for maintenance painting.

F.3.2 Scrubbable matt and sheen water-borne paints

Scrubbable matt paints and wall paints of medium to high-sheen finish are fully bound and have low permeability. Therefore, although they can give a more hard-wearing finish, they are only to be used on substrates which are substantially dry. If in doubt, it is recommended that a moisture meter is used (see 9.3.1.2).

F.3.3 Water-borne gloss and semi-gloss finishes

Water-borne wall paints with high gloss can deliver resistance to wear and frequent washing which is close to that achieved by solvent-borne paints which cannot meet the VOC limits required for interior broad wall application. Despite greater tolerance of substrate moisture than solvent-borne paints, they are still only to be used on substrates which are substantially dry. If in doubt, it is recommended that the moisture content is determined (see 9.3.1.2).

F.3.4 Textured coating materials

Textured coating materials can be used for their decorative effect, to hide surface defects or irregularities and as an alternative to plastering or rendering. Coating materials of this type include plastic-textured paints and water-borne, heavy-textured masonry paints (see Table B.1). They are usually relatively permeable and moderately resistant to alkali attack and can be suitable for direct application to surfaces not completely dry, but reference ought to be made to the manufacturer's recommendations.

F.3.5 Multi-colour finishes

Multi-colour finishes are very hard-wearing and especially suitable for use on walls in circulating areas, cloakrooms and similar locations. Generally, they are to be applied only to substantially dry substrates, usually over special primers or basecoats, but the manufacturer's recommendations regarding surface conditions and systems ought to be followed.

Table F.1 gives guidance on coating systems for internal plaster, concrete, brick, block and stone.

Table F.1 — *Coating systems for internal plaster, concrete, brick, block and stone*

Substrate condition	Finish type and reference in Table B.1	Primer and reference in Table B.3	Coating system and references in Table B.1 and Table B.2
DRY r.h. below 75% (see Note 3)	Gloss, mid-sheen or matt (B.1/1, B.1/2, B.1/3)	Alkali-resisting primer (B.3/1) or, plaster only, water-borne primer (B.3/2)	Gloss finish: 1 coat water-borne (B.2/2) undercoat; 1 coat water-borne finish (B.1/2)
			Mid-sheen finish: 2 coats water-borne finish (B.1/2)
			Matt-finish: 2 coats water-borne finish (B.1/3, B.1/4)
	General purpose water-borne paint (B.1/4, B.1/5)	Primer not usually required but see F.1. A well-thinned first coat of water-borne paint might be required on surfaces of high or variable porosity	Matt or mid-sheen finish: 2 or 3 coats general purpose water-borne paint, matt or mid-sheen (B.1/4)
			Matt, high-opacity finish: 2 coats contract water-borne paint (B.1/5) 1 coat, spray-applied, might suffice in some situations
	Multi-colour (B.4/9)	Primer or basecoat as recommended by manufacturer	Usually 1 coat multi-colour finish (B.4/9) spray-applied but see manufacturer's instructions
	Textured (B.4/10)	Primer not usually required but see manufacturer's instructions	Plastic texture paint (B.4/10): Normally 1 coat but might require over-painting
			Water-borne masonry paint, heavy-texture (B.1/7): Normally 1 coat but see manufacturer's instructions

Table F.1 *(continued)*

Substrate condition	Finish type and reference in Table B.1	Primer and reference in Table B.3	Coating system and references in Table B.1 and Table B.2
DRYING Some damp patches might be evident, r.h. 75% to 90%	Water-borne paint (B.1/4, B.1/5)	As for DRY substrates	Matt or mid-sheen finish: 2 or 3 coats general purpose water-borne paint, matt or mid-sheen (B.1/4)
			Matt, high-opacity finish: 2 coats contract water-borne paint (B.1/5) 1 coat, spray-applied, might suffice in some situations
	Multi-colour finishes (B.4/9) possible but consult manufacturer	As for DRY substrates	Usually 1 coat multi-colour finish (B.4/9) spray-applied but see manufacturer's instructions
	Textured paints (B.4/10) possible but consult manufacturer	As for DRY substrates	Plastic texture paint (B.4/10): Normally 1 coat but might require over-painting
			Water-borne masonry paint, heavy-texture (B.1/7): Normally 1 coat but see manufacturer's instructions
			If overcoating is necessary, water-borne paint is to be used
DAMP Obvious damp patches, r.h. 90% to 100%	Water-borne paint (B.1/4, B.1/5) possible, but consult coating manufacturer	Primer not recommended	Matt or mid-sheen finish: 2 or 3 coats general purpose water-borne paint, matt or mid-sheen (B.1/4)
			Matt, high-opacity finish: 2 coats contract water-borne paint (B.1/5) 1 coat, spray-applied, might suffice in some situations
			Contract types (B.1/5) are usually more permeable than general purpose (B.1/4) types and less prone to failure on damp substrates
WET Moisture visible on surface, r.h. 100%	Cement paint (B.4/8) (not on gypsum plaster)	Primer not required	1 or 2 coats cement paint (B.4/8)

NOTE 1 For information on the repair of concrete structures, see BS EN 1504-2 and BS EN 1504-10.

NOTE 2 For information on the selection of coating systems for exterior masonry and concrete, see BS EN 1062-1.

NOTE 3 r.h. refers to the relative humidity in equilibrium with the surface. See 9.3.1.2 for method of measuring moisture content.

F.4 Coating systems for exterior use

F.4.1 Mid-sheen and matt finishes

Water-borne masonry paints are most commonly used on masonry substrates. Coating materials can be microporous to resist water penetration whilst allowing a degree of breathability to the substrate. However, it is recommended the substrate including any repairs is substantially dry before painting.

Some water-borne masonry paints offer early rain resistance. However, the manufacturer's guidance ought to be followed with respect to climatic conditions during application and drying.

Solvent-borne alkyd mid-sheen and matt finishes are not suitable for external walls as the alkaline conditions frequently associated with such substrates rapidly degrades the paint. Solvent-borne masonry paints can offer advantages for painting in conditions of low temperature and high humidity which would impair drying of water-borne paints.

Solvent-borne masonry paints are unlikely to be microporous. Hence it is more important to ensure that the substrate, including any repairs, is substantially dry. The moisture content can be determined if in doubt (see 9.3.1.2).

F.4.2 Textured finishes

Textured finishes are wide ranging from a fine sand or stone texture to heavy-texture coating materials containing coarse aggregate or deriving their texture from the method of application. Examples of the types available are given in Table B.1.

Textured coating materials can be used where a higher film build is needed. The thicker or more heavily textured coating materials also help to hide surface irregularities, fill fine surface cracks and contribute to the rain resistance of external walls. They do not enhance the acoustic or thermal insulation properties of walls as they are too thin. They can reduce rain penetration, which would then minimize degradation of the thermal insulating properties of the wall. In polluted atmospheres the heavier textures can pick up dirt although the rough texture tends to promote an evenness of soiling that might be less apparent than on a smooth surface.

Some thick, textured sprayed coating materials are applied by specialist applicators and might be offered with a warranty as to their durability.

F.4.3 Gloss finishes

Gloss finishes are seldom used on external walls except in repainting work on smooth renderings. If solvent-borne gloss finishes are used, it is recommended that the substrate is dry and an alkali-resistant primer applied.

Water-borne gloss finishes are to be used in suitable conditions of temperature and humidity for satisfactory film formation and drying.

F.4.4 Cement paints

On external exposure, algal growth is prone to develop on cement paints applied to surfaces that are persistently damp although some paints incorporate a fungicide. Cement paints are not recommended for use in acidic exposure conditions.

F.4.5 Silicate-based masonry coating materials

Silicate-based masonry coating materials (mineral paints) are available in grades suitable for exterior and interior surfaces. These materials provide inert non-flammable films that do not support fungal or algal growth and are compatible with all mineral building materials. Compositions of high water vapour permeability are available.

Exterior surfaces to be painted need to be free from dirt and all previous paint coatings. Application can be by brush, roller or spray. The drying coating can be susceptible to rain damage.

The liquid paints are highly alkaline and therefore precautions ought to be taken during application.

F.4.6 Cement renderings

The renderings in general use are cement-based and might incorporate hydrated lime. They might not require painting when new, although this might eventually be necessary for appearance or if repairs are carried out. Bell casting can ensure that the render is not in direct contact with the ground. Such renders are strongly alkaline but can be painted once substantially dry provided the paints used are resistant to alkali.

F.4.7 Stucco

Stucco can be lime/sand-based (pre-1790), Roman or Portland cement-based (dating from about 1790) or oil mastic-based (1790 to 1820). Repainting might be undertaken where deterioration or removal of the paint coating exposes the original surface.

F.4.8 Concrete

Concrete does not usually require painting for protection although this might be necessary to prevent long-term deterioration in aggressive atmospheres. Protective painting using chemical-resistant paints might also be necessary to prevent further penetration of carbon dioxide, water and salts after repair of deteriorated concrete, or even on new concrete if the thickness and integrity of concrete over reinforcement is insufficient to provide protection. In most circumstances, however, concrete is painted to improve its appearance, especially on large areas.

F.4.9 Brick and stone

F.4.9.1 General

Where external brickwork and stonework are exposed to severe weathering conditions, e.g. in parapet, freestanding and retaining walls and below ground level damp-proof courses, it is difficult to ensure that moisture does not penetrate the substrate.

F.4.9.2 Clay bricks

Most clay bricks contain soluble salts and these, in combination with water and the alkalis in cement mortars, can promote efflorescence. Clay bricks can be classified in general terms, by type, as common, facing and engineering bricks.

a) *Common bricks.* These are usually plastered or rendered, but painting can be considered as a low-cost alternative especially for interior walls. Paints of all types are liable to failure by loss of adhesion when applied to common fletton bricks externally. Failure occurs initially over kiss marks in the bricks, often within two years, and increases progressively. After four or five years, the paint on the whole of the brick surface can be affected. Sand-faced and rustic fletton bricks are not subject to paint adhesion failures to any great extent. BRE Information Paper 22/79, *Difficulties in painting Fletton Bricks* [51], recommends that external walls built with the intention of painting are of either sand-faced or rustic clay bricks or of calcium silicate or concrete bricks. It also gives recommendations for alternative treatments in situations where the extent of paint failure on walls already painted makes it not worth attempting to maintain them in the painted state.

b) *Facing bricks.* These are made or selected for their appearance, e.g. colour or texture. Adhesion of paint is usually satisfactory.

c) *Engineering bricks*. These are dense, strong bricks made to defined limits of strength and water absorption. The adhesion of conventional paints to the virtually non-porous surface of bricks of this type is generally poor and, if painting is necessary, paints of the types recommended for glazed bricks (see 9.7.1) need to be used.

F.4.9.3 Calcium silicate (sandlime or flintlime) bricks

The surface of calcium silicate bricks is usually smoother than that of clay bricks although textured facing bricks are available. Paint adhesion is generally satisfactory. If a new building is intended to be painted (e.g. to blend in with other adjacent buildings) then the use of concrete bricks is favourable as they have less variability than facing bricks which might have a number of potential problems to be overcome when painting.

F.4.9.4 Stone

The many varieties of natural stone differ considerably in hardness and porosity, e.g. from virtually non-porous granite or marble to porous limestone or sandstone. There might also be differences in surface texture according to the method by which the stone is dressed or finished. Paint adhesion to porous stone surfaces is generally satisfactory but adhesion to non-porous stone surfaces is generally poor.

F.4.10 Concrete blocks

F.4.10.1 General

Precast concrete blocks are described in BS EN 772-2 and BS EN 772-3. Their essential constituents are cement (usually ordinary or rapid-hardening Portland cement), a wide variety of aggregates and water. The main types of blocks are as follows.

a) Aerated concrete blocks, which are usually made from mixtures of cement and siliceous materials, such as sand or pulverized fuel ash or a mixture of these, together with an aerating agent.

b) Dense and lightweight blocks, which are made from cement and dense or lightweight aggregates, moulded and compacted by vibration or pressure.

The aggregates used and the manufacturing process employed affects the physical properties, surface texture and colour of the blocks. Surfaces can vary from coarse and open to fairly smooth and fine-textured. Colour is derived from the aggregates used, but pigments can be incorporated. Blocks are also available with a factory-applied coloured glaze that is resistant to staining and chemical attack.

Provided that types having the appropriate properties are selected, concrete blocks are durable in most interior and exterior situations and are normally painted for aesthetic reasons or to facilitate cleaning. However, painting protection might be required where blockwork is exposed to severe driving rain. The natural appearance of some blocks might be acceptable without further treatment although clear coating materials can be used to prevent staining or soiling.

Concrete blocks are strongly alkaline (see F.1.4).

F.4.10.2 Precast concrete blocks

Concrete blocks vary considerably in porosity and absorption according to their manufacturing process, density and the nature of the aggregate used, but even the densest blocks are usually sufficiently porous to afford satisfactory adhesion for paint.

F.4.11 Cement-based sheets, boards and components

F.4.11.1 General

The sheets, boards and components to which F.4.11 refers are manufactured from cementitious materials reinforced with fibres. They comprise:

a) asbestos and fibre-cement goods;

b) cement-based insulating boards, ceiling tiles and planks; and

c) glass fibre-reinforced cement (GRC) cladding.

F.4.11.2 Asbestos and fibre-cement goods

WARNING Asbestos is extremely hazardous. Materials containing asbestos are subject to legislation that requires precautions to be taken in handling them to ensure that they do not constitute a health hazard. See A.2.4 for appropriate precautions to be taken.

Asbestos-cement is a reasonably durable material, resistant to most forms of attack, and does not require painting for protection except in highly acidic atmospheres. In other situations, painting is mainly for appearance, to facilitate cleaning or to seal degraded surfaces to prevent loss of fibres. Asbestos-cement sheets and components supplied with factory-applied coatings have good chemical resistance. Asbestos is no longer used in construction due to its hazardous nature. However, maintenance of buildings pre-dating 2000 might involve materials containing asbestos.

Fibre-cement has been developed as an alternative to asbestos-cement and shares many of the properties associated with asbestos-cement.

Fibre-cement goods include roofing and cladding materials, lining sheets, decking tiles, rainwater goods and other components. They are manufactured from Portland cement (CEM 1), fibre and water, compressed to a fairly high density.

Fibre-cement is strongly alkaline when new and, if damp when painted or becomes so later, paints susceptible to alkali attack (see F.1.4) are affected.

If impermeable paint systems are applied to one side only of flat sheets or profiled sheets with large flat areas, differential carbonation can cause distortion and cracking of the sheets. This can be prevented by back-painting the sheets.

Cement-based insulating boards, tiles and planks can be made from Portland cement and glass or other fibres (superseding asbestos, which might still be found in older material). Calcium silicate can also replace Portland cement in some types.

Cement-based insulating materials are less dense and more porous than asbestos and fibre-cement roofing and exterior cladding materials and are used principally as interior wall and ceiling linings. In the situations in which they are normally used, painting is essentially for appearance and to facilitate cleaning.

Cement-based insulating materials, especially the types employing calcium silicate as a binder, are usually less alkaline than asbestos and fibre-cement goods for exterior use. Differential carbonation is not a problem, and back-painting is not therefore necessary.

F.4.11.3 Glassfibre reinforced concrete (GRC) components

Most GRC consists of Portland cement matrix reinforced with glass fibre. There are a variety of GRC components, a major use being in sheets and composite cladding panels, many with a factory-applied coating. The general requirements for site painting are as for other cement-based products.

Table F.2 gives guidance on coating systems for external renderings, concrete, brick, block and stone.

Table F.2 — *Coating systems for external renderings, concrete, brick, block and stone*

Substrate condition	**Coating type**	**Primer and reference in Table B.3**	**Coating system and references in Table B.1 and Table B.2**	**Typical life to first maintenance** (see Note 2)
DRY r.h. below 75% (see Note 1)	Masonry paints, solvent-borne (B.1/8 or B.1/9)	Alkali-resisting primer (B.3/1) or as recommended by manufacturer	Smooth or fine-textured (B.1/8) types, solvent-borne 2 coats	5 years or more
			Thick, textured (B.1/9) types, solvent-borne Usually 1 or 2 coats applied by spray, often by specialist applicators	10 years or more
	Water-borne masonry paints (B.1/6, B.1/7)	Primer not usually required with B.1/6 types but see **9.3.1.5**	Smooth or fine-textured (B.1/6) water-borne types 2 coats	5 years or more
		Primer not usually required with B.1/7 types but see manufacturer's recommendations	Heavy-textured (B.1/7) water-borne type Usually 1 coat applied by roller	10 years or more
	Masonry paint, mineral type (B.1/10)	Check with manufacturer	Check with manufacturer	Over 15 years
	Cement paint (B.4/8)	Primer not required	2 coats cement paint (B.4/8)	3 to 5 years
	Solvent-borne alkyd gloss and modified alkyd gloss (B.1/1)	Alkali-resisting primer (B.3/1)	1 coat solvent-borne undercoat (B.2/1); 1 or 2 coats solvent-borne gloss finish (B.1/1)	3 to 5 years
DRYING Some damp patches might be visible, r.h. 75% to 90%	Water-borne masonry paints (B.1/6 or B.1/7)	As for DRY substrates	Smooth or fine-textured (B.1/6) water-borne type, 2 coats; or Heavy-textured (B.1/7) water-borne types Usually 1 coat applied by roller	Potentially as for DRY substrates but some risk of earlier failure at higher moisture levels
	Masonry paint, mineral type (B.1/10)	Check with manufacturer	Check with manufacturer	Over 15 years
	See manufacturer's recommendations for use of solvent-borne masonry paints (B.1/8 or B.1/9)	As for DRY substrates	Smooth or fine-textured (B.1/8) types, solvent-borne 2 coats; or Thick, textured (B.1/9) types, solvent-borne Usually 1 or 2 coats applied by spray, often by specialist applicators	Potentially as for DRY substrates but some risk of earlier failure at higher moisture levels

Table F.2 *(continued)*

Substrate condition	**Coating type**	**Primer and reference in Table B.3**	**Coating system and references in Table B.1 and Table B.2**	**Typical life to first maintenance** (see Note 2)
DAMP Obvious damp patches, r.h. 90% to 100%	Masonry paint, mineral type (B.1/10)	Check with manufacturer	Check with manufacturer	Over 15 years
	Cement paint (B.4/8)	Primer not required	2 coats cement paint (B.4/8)	As for DRY substrates
	See manufacturer's recommendations regarding use of water-borne masonry paints (B.1/6 or B.1/7)	Primer not required	Smooth or fine-textured (B.1/6) water-borne types 2 coats; or Heavy-textured (B.1/7) water-borne types Usually 1 coat applied by roller	Potentially as for DRY substrates but high risk of earlier failure
WET Moisture visible on surface r.h. 100%	Cement paint (B.4/8)	Primer not required	2 coats cement paint (B.4/8)	As for DRY substrates but some risk of earlier failure

NOTE 1 r.h. refers to the relative humidity in equilibrium with the surface. See 9.3.1.2 for method of measuring moisture content.

NOTE 2 Life expectancies shown assume application to dry, sound substrates, qualified as indicated for other substrate conditions, and are based on performance in moderate external conditions as defined in Table 3. Aesthetic considerations might influence the need for maintenance.

NOTE 3 For information on the repair of concrete structures, see BS EN 1504-2 and BS EN 1504-10.

NOTE 4 For information on the selection of coating systems for exterior masonry and concrete, see BS EN 1062-1.

Annex G (informative) Ferrous and non-ferrous metal substrates and metallic coatings

G.1 Ferrous substrates

G.1.1 Causes of corrosion

Most forms of iron and steel, if not protected, tend to revert to their oxides by gradual combination with oxygen and moisture to form rust. In clean atmospheres, significant corrosion is unlikely unless the relative humidity exceeds about 70% but, if there are sulfur compounds or other soluble salts (e.g. sea salt) in the atmosphere or on the surface, severe corrosion can occur at lower levels of relative humidity.

Corrosion is likely to be more severe in humid industrial areas and near the coast rather than in rural or urban areas.

The micro-climate and factors such as orientation, degree of exposure and the flow of air over the surfaces immediately surrounding the structure or component can increase or reduce the rate of corrosion. The frequency and extent to which condensation occurs, as a result of the difference in temperature between the metal and the air, can also be relevant; in this respect, the thickness of the metal can be a significant factor.

G.1.2 Surfaces of ferrous substrates

All hot-rolled ferrous substrates display a thin surface layer of iron oxides, called mill scale. The mill scale would usually be removed prior to painting mild steel to ensure good paint adhesion. Shedding of this mill scale can occur before the steel has been painted, leading to accelerated corrosion and pitting of the steel substrate. If the scale becomes detached after painting is completed, costly preparation and repainting is necessary.

The scale formed on cast iron is more adherent than the mill scale on mild steel and has some protective value. If the scale is removed, cast iron corrodes at about the same rate as mild steel. This might not be immediately apparent because the corrosion process leaves behind a non-metallic residue which largely retains the appearance of the original metal although its mechanical strength is negligible.

In respect of painting wrought iron, this is similar in characteristics to mild steel although its corrosion rate might differ slightly according to its composition.

G.1.3 Structural considerations

The effectiveness of paints in protecting iron and steel can be increased, and the risks of corrosion diminished, by good structural design. BS EN ISO 12944-3 and BS EN ISO 14713 (all parts) give detailed guidance on designing for the prevention of corrosion, but the following aspects are recommended.

a) All surfaces of exposed metal that need regular maintenance painting are fully accessible. Surfaces such as back-to-back angle-iron trusses are spaced far enough apart to permit painting or be treated with mastic or anti-corrosive paste before being butted together. Sealing gaps with gun, trowel or pouring grade sealants is an accepted method of protecting surfaces inaccessible for painting. Pipework, especially when sited externally, are spaced from walls far enough to admit a paintbrush.

b) Drainage of trough sections is arranged, e.g. by drilling holes, to prevent retention of water. This is especially important in salt-laden atmospheres. Water traps are avoided where steel stanchions enter the ground or are embedded in a concrete base. Measures are taken to prevent discharge of waste steam and liquids on to steelwork.

c) Sharp, internal angles, crevices and cavities are avoided or, if unavoidable, are filled with weld metal or mastic.

d) Galvanic corrosion can occur at contact surfaces between dissimilar metals in the presence of an electrolyte, e.g. rainwater. If possible, direct contact is prevented by measures such as placing plastic sheets between the contact surfaces or applying coatings to them. Alternatively, electrolytes are excluded by making joints watertight and applying an impermeable coating. Failure to prevent galvanic corrosion can result in accelerated corrosion.

G.2 Non-ferrous substrates

NOTE Non-ferrous substrates found in buildings are mainly composed of zinc or aluminium.

G.2.1 Chemical pre-treatments

Zinc, aluminium and some other non-ferrous metals can be pre-treated to improve paint adhesion. It is important that such pre-treatment (e.g. phosphate) is carried out under controlled, factory conditions. Site-applied treatments with proprietary washes can be less effective and can present difficulties in use, especially if final rinsing is required. Mordant solution, a material for the pre-treatment of galvanized surfaces, blackens zinc surfaces when properly applied. If this does not occur, the surface can be thoroughly cleaned and the treatment repeated. Excessive application of the wash (which, on horizontal surfaces can lead to ponding) and excessive thickness of coating is to be avoided.

G.2.2 Weathering

Exposure of zinc and galvanized surfaces to weathering can improve paint adhesion, but the process is likely to take several months, even in conditions conducive to weathering, and the surface rarely weathers uniformly, making it difficult to determine whether the surface has weathered sufficiently to be painted. Also, surfaces are likely to become soiled or contaminated especially in severe or very severe exposure conditions, e.g. industrial and marine, and washing (and degreasing if necessary) is recommended before paint is applied. Weathering is unnecessary if the correct pre-treatments and/or primers are used.

G.2.3 Anodizing

This is an electrolytic process used on aluminium in which a corrosion-resistant oxide film is deposited on the surface. Anodizing can provide a satisfactory surface for painting, but the process is expensive and is rarely used solely to facilitate painting. The advice of the paint manufacturer is recommended.

G.2.4 Galvanized steel sheet

Unless otherwise specified (i.e. oiled or untreated), virtually all galvanized sheet produced in the UK is passivated to prevent wet storage staining (white rusting) during storage. Such a treatment is likely to prevent pre-treatment primers reacting fully with the zinc and it might also be incompatible with phosphate treatments. Galvanized sheet steel, and components manufactured from such sheet steel, might need treatment with proprietary chemicals before pre-treatment or painting. Abrasion may be used to remove the original passivation treatment but care needs to be taken to avoid excessive removal of the zinc coating, which would reduce the protective value of the system.

G.3 Primers for metallic substrates

Table G.1 gives typical examples of primers for metal and paint systems for iron and steel.

Table G.1 — *Primers for metal*

Ref.	Description	General composition	Characteristics and usage
G.1/1	Pre-treatment, wash or etching primer, two-pack	Typically, polyvinyl butyral resin solution with phosphoric acid (as separate component) and a pigment	The main function of these primers is to improve adhesion of paint systems to non-ferrous metals. They can also be used to provide temporary protection to blast-cleaned steel and sprayed-metallic coatings. The two-pack types generally give superior performance but might be less convenient to use.
G.1/2	Pre-treatment, wash or etching primer, one-pack	Typically, polyvinyl butyral/phenolic resin solution with tinting pigment	Application of primers of this type does not usually obviate the need for the application of a normal type of primer subsequently. Most pre-treatment primers can be used in conjunction with conventional and specialist coating systems.
G.1/3	Mordant solution	Pre-treatment for galvanized and non-ferrous metals	This solution contains an indicator which darkens the surface of galvanized steel indicating that it has reacted.
G.1/4	Adhesion promoter	Pre-treatment for non-ferrous metals and stainless steel	This is a pre-treatment with low VOC content designed to improve adhesion of subsequent coating system to non-ferrous metals and stainless steel.
G.1/5	Zinc phosphate primer (see also G.1/8 and B.3/4)	Typically, drying-oil/resin type binder with zinc phosphate as the main inhibitive pigment. Other tinting pigments can be incorporated.	Zinc phosphate offers advantages over other inhibitive pigments in being neutral in colour. Zinc phosphate primers are fairly quick-drying and can afford protection without finishing coats for reasonable periods. Established usage is for priming steelwork, but some types might be suitable for non-ferrous metals; see manufacturer's recommendations.
G.1/6	Chromate primer (highly hazardous mixtures) for specialist use See A.2.8 for more details.	Typically, drying-oil/resin type binder with zinc chromate as the main inhibitive pigment. Red oxide or other pigments can be incorporated.	These can vary according to formulation, but chromate primers are usually fairly quick-drying and suitable for use on ferrous and non-ferrous metals.
G.1/7	Zinc-rich primer[A)] conforming to BS 4652 (two-pack), solvent-borne	Based on epoxy resin and supplied in two-pack form (zinc paste and curing agent)	This is a quick-drying metallic-grey primer for iron and steel with rust-inhibiting properties. It can be applied to well-prepared (e.g. blast-cleaned) steel only. It is often used for touching up damaged zinc coatings, e.g. zinc-sprayed or galvanized surfaces or as a prefabrication primer. Spray application is recommended, except on small areas.
G.1/8	Zinc-rich primer (one-pack)	Based on a non-saponifiable medium, e.g. chlorinated rubber	This is a quick-drying metallic-grey primer for iron and steel with rust-inhibiting properties. It is often used for touching up damaged zinc coatings, e.g. zinc-sprayed or galvanized surfaces.

Table G.1 *(continued)*

Ref.	Description	General composition	Characteristics and usage
G.1/9	Zinc phosphate primer, water-borne	Water-borne. Based on an acrylic resin dispersion in water and typically containing a zinc phosphate anti-corrosive pigment	This is a quick-drying primer for iron and steel as well as non-ferrous metals including galvanizing. Some versions are described as universal primer (B.3/4) and can be used on timber surfaces.
G.1/10	Two-pack epoxy primer	Based on epoxy resin and usually polyamide and supplied in two-pack form	This is a surface tolerant primer, sometimes containing a leafing aluminium pigment. It is suitable for application not only to manually prepared steel surfaces, but also over existing sound paintwork.

[A)] It is recommended that advice is sought when drying-oil/resin type paints are to be used over zinc-rich primers.

G.4 Metallic coating materials

Zinc and aluminium are used extensively as components in protective coating materials, both individually and as alloys, for iron and steel structural members, sheets and components. It is recommended that consideration is given to their use in moderate and severe exposure conditions and where long-term protection is required.

NOTE BS EN ISO 14713 (all parts) gives guidance on the selection and specification of metallic coatings.

The different forms of coated product have a thickness of coating which, depending on the product chosen, are selected to suit the expected severity of exposure or service requirements.

The application of zinc and aluminium coating materials to iron and steel are as follows:

a) hot-dip galvanizing (zinc) for general steelwork and fittings [for further information see BS EN ISO 14713 (all parts)] and claddings (for further information see BS EN 10346);

b) hot-dip aluminizing for the application of aluminium to steel;

c) sherardizing (zinc) mainly for fittings, fasteners and small items (for further information see BS 7371-8);

d) electroplating (zinc) by electrolytic deposition of zinc from zinc salt solutions for small items (for further information see BS EN ISO 2081 or BS 7371-3), as well as for sheet components; and

e) metal spraying (zinc, aluminium or their alloys, sprayed in a semi-molten form) for structural steelwork and plates after abrasive blasting [for further information see BS EN ISO 2063 (all parts)] to be undertaken in the factory, or when conditions permit on site.

Metallic coatings may be painted under certain circumstances, such as for appearance or for added protection in some exposure conditions. Appropriate sealer or paint systems usually adhere satisfactorily to sprayed non-ferrous coatings if they are applied soon after the sprayed coatings.

Special preparation or pre-treatment, or the use of primers of specific type, is essential in order to ensure satisfactory adhesion of paint, and it is recommended that the advice of the coatings manufacturer is followed for these varied and complex substrates.

G.5 Coating systems

Primers for non-ferrous substrates can contain anti-corrosive pigments or can act purely as a barrier coat, e.g. micaceous iron oxide paints can be used to provide added protection to galvanized and metal-sprayed steel in moderate and severe conditions.

However, certain anti-corrosive pigments which are used for ferrous substrates might not be suitable for non-ferrous substrates and can even promote corrosion, e.g. graphite pigments can accelerate pitting on aluminium.

Annex H (informative)
Paper and wallcoverings

H.1 General

Papers and other wallcoverings comprise, firstly, those that are supplied uncoloured and that are intended to be painted and, secondly, existing coloured materials that might be suitable for painting in order to restore their appearance or change their colour. The main types in each category are as follows:

a) new and intended to be painted:
   1) lining papers;
   2) woodchip papers;
   3) relief wallcoverings;
   4) natural hessians (painting optional);
   5) blown vinyl wallcoverings;
   6) non-woven backed wallcoverings;
   7) woven glass fibre paper.

b) existing coloured materials:
   1) wallpapers;
   2) paper-backed and sheet vinyls;
   3) coloured hessians;
   4) non-woven backed wallcoverings.

No problems arise with materials in the first category under a) in respect of painting, but problems can be experienced with some of those in the second category under b), as indicated in 9.5.1.1 and 9.5.1.2.

H.2 Plasterboard

Plasterboard is widely used in dry-lining systems in which paint or wallcoverings are applied directly to the board surface after fixing. Dry-lining systems usually involve special treatment of the joints between the boards.

Dry lining generally involves a woven tape being applied over the joint with subsequent application of filler over and impregnated into the tape. Tapered-edge plasterboard allows the tape and filler to sit in the recess, which is sanded flat after drying and hardening. However, although the surface might have been sanded suitably flat, there is still a difference in texture and porosity between the sanded filler and the surface of the boards.

Annex I (informative) Plastics

Identifying the type of plastic, or type of plastic coating on the metal, is necessary to be able to provide the correct recommendation for which coating system to use. For certain difficult plastic substrates, e.g. those with low surface tensions, a specialist primer with the appropriate adhesion promoting technology might be needed to ensure a successful result.

When identification is not possible, a site adhesion test can be undertaken with the range of primers available and also a direct application. A mock-up can also be conducted. The test ought to be done on cleaned areas and in accordance with the coating materials and the manufacturer's instructions. Adhesion can be determined by the cross cut peel test in accordance with BS EN ISO 2409 or the pull-off test in accordance with BS EN ISO 4624, or by instruments, such as a pull-off adhesion tester. It is recommended the adhesion figure is in excess of 1 N/mm^2. This might involve leaving the overcoating systems for up to 7 days to allow adhesion to develop via plasticizer linkage on PVC for example.

Typical examples of plastics in buildings that might need to be painted include unplasticized polyvinyl chloride (PVC-U) cladding, rainwater goods and window frames; GRP cladding and mouldings; expanded polystyrene and a variety of plastic-coated metal articles.

A wide variety of organic coating materials, classifiable as plastics, are present on metal cladding and other components, usually industrially applied by coil coating. These can be overcoated (post-applied coating) for aesthetic or maintenance purposes at or near end of life. The individual types vary and include polyvinyl chloride (PVC) plastisol, polyvinylidene fluoride (PVF2 or PVDF), polyester and polyurethane. Powder coating materials such as epoxy, polyurethane, polyester or silicone modified versions are also found.

These materials generally have good durability, but the effects of weathering, soiling and mechanical damage over a number of years might mean painting is needed as a means of restoring the original appearance. Occasionally, premature deterioration occurs, and painting can then prove cheaper than replacement or, in the case of plastic coatings, can be necessary to prevent deterioration of the substrate. However, probably the most frequent reason for painting is to change the colour, especially with components, such as PVC-U rainwater goods, available in a very limited range of colours.

Paints of conventional type can perform satisfactorily on PVC-U, but subsequent maintenance painting at intervals of 3 years to 5 years might be necessary, thus negating an important advantage of plastics, i.e. a reduction in the frequency of maintenance.

Annex J (informative) Anti-graffiti treatments

J.1 General

All substrates are vulnerable to disfigurement by graffiti and present different types of problem for graffiti protection or removal. Masonry and concrete have characteristics that include porosity, which render removal particularly difficult, thus protective measures are important. New products are constantly emerging to protect surfaces but specialist advice might also be needed.

The main technical options for graffiti control on masonry and concrete can be classified under:

a) removal:
   1) physical means;
   2) chemical means;
b) prevention:
   1) new surfaces;
   2) established surfaces;
   3) cleaned surfaces;
c) obliteration:
   1) by "normal" coating materials;
   2) by selected graffiti resistant coating materials.

J.2 Removal

The choice of materials and methods to remove graffiti depends on many factors including the nature of the marker and the substrate.

The range of graffiti markers used is potentially very wide and could in principle include the most durable coating types. Although some markers resist removal (e.g. leather dyes), the majority appear to be commercially available aerosol spray paints and felt permanent marker pens. The latter however are used more on smooth and already coated surfaces. In the case of paints, the ease of removal depends on whether they are thermoplastic or cross-linked. The cross-linking element is typically alkyd-based. A range of commercial cleaners is available which includes solvents as well as acidic and alkaline solutions. Within this range there is usually at least one that is effective against commercial spray paints on smooth surfaces. Many of the traditional more effective substances are now subject to restrictions or have been prohibited under European chemicals legislation in recent years.

The effectiveness of graffiti removal depends on the contact time of the solvent and is aided by mechanical methods including scrapers and abraders. The use of water jet sprays can be effective, especially when hot (including steam), and can be further enhanced with various abrasives. Unfortunately with friable substrates such as concrete, this also removes the surface leaving a clean patch, which would contrast strongly with adjacent uncleaned areas. High-pressure spraying brings in additional health and safety considerations, as well as operational factors. The use of abrasive methods might only achieve the desired restoration effect if the whole area is cleaned. Economics and practicality might limit this option.

In summary, while there are physical/chemical means for removing most common graffiti markers, the porosity of untreated masonry and concrete surfaces allow penetration which renders total removal near impossible. The adage "prevention is better than cure" applies and in vulnerable areas, surfaces need to be treated to resist application and aid removal.

J.3 Prevention and damage limitation — anti-graffiti coating materials

J.3.1 General

The objective of an anti-graffiti coating is to discourage disfigurement by markers in the first place and also to aid removal. If the coating is effective then graffiti is discouraged if markers are continually and easily removed. Discrete signs that such treatment has been carried out might also

aid this. A more obvious lack of surface wetting would also be a discouragement, and this might become more common as spray paints become water-borne. In principle, inhibitors could retard drying of alkyd paints, and extend the period of relatively easy removal. However, currently, the main purpose of anti-graffiti coatings is to aid removal.

Anti-graffiti paints are usefully divided into three groups:

- sacrificial;
- semi-permanent; and
- permanent.

In principle, such coatings could be clear or opaque, but in general the sacrificial are transparent. Permanent coatings are more likely to be opaque and high build but can also be transparent. There is no sharp distinction between the products, which to varying degrees embody two major mechanisms. The first is to reintroduce the bane of good adhesive performance, namely a weak boundary layer. The second is to lower the interfacial surface energy such that separation takes place readily. In the latter case it might be advantageous to make the coating very tough mechanically so that graffiti can be removed without damaging the coating.

J.3.2 Sacrificial coating materials

Typically, these are based on wax emulsions which are blended with siloxane acrylate or fluoro compounds such as polyvinylidine chloride. Surfactants aid removal of the wax carrier, which can be removed by hot water jet. Some commercial systems have a special removal solvent. Systems based on solubilized resins can be removed with mild alkali. Although these coatings are nominally colourless, they darken the substrate to a degree, since surface penetration reduces light scattering.

Sacrificial coatings require recoating after cleaning.

J.3.3 Semi-permanent coating materials

These have a greater integrity than the sacrificial group and contain typical acrylic resins as well as wax. The greater film integrity allows removal of the sacrificial coating with various removers, along with the offending graffiti. The slightly higher build helps to physically block pores and prevent penetration by the graffiti marker.

J.3.4 Permanent coating materials

Permanent coating materials overlap with conventional masonry paints but are chosen to have greater resistance to abrasion and chemical cleaning methods. They therefore include high performance fluoro-acrylics and two-component polyurethanes and epoxies. Such coating materials need to meet the various criteria for masonry coatings in terms of permeability and durability. An obvious disadvantage is that if they do become marked, by persistent graffiti or constant cleaning, then they are likely to be difficult to restore, and continual overcoating would be impractical. On the other hand, opaque permanent coating materials (e.g. anti-graffiti paint), might be a viable option for obliterating graffiti without the need for removal.

Conventional masonry paints can also be used for obliteration but are not so readily cleaned if subject to further attack.

The use of multi-colour finishes (see B.4/9) might help to disguise residual graffiti marking.

As an alternative to the high-build opaque treatment, some permanent low-build transparent systems are available which give long-term protection by lowering the surface energy.

J.3.5 Application of anti-graffiti coating materials

Some anti-graffiti treatments need specialist application. Reference needs to be made to suppliers or independent sources that provide expertise on substrate suitability, selection of appropriate products, application and maintenance.

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