KENYA STANDARD

2791 :2018
ICS 85.080.01

Painting of buildings — Code of practice

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TECHNICAL COMMITTEE REPRESENTATION

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Kenya Bureau of Standards — Secretariat

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KENYA BUREAU OF STANDARDS (KEBS)

Head Office: P.O. Box 54974, Nairobi-00200, Tel.: (+254 020) 605490, 602350, Fax: (+254 020) 604031
E-Mail: info@kebs.org, Web:http://www.kebs.org

Coast Region
P.O. Box 99376, Mombasa-80100
Tel.: (+254 041) 229563, 230939/40
Fax: (+254 041) 229448

Lake Region
P.O. Box 2949, Kisumu-40100
Tel.: (+254 057) 23549, 22396
Fax: (+254 057) 21814

Rift Valley Region
P.O. Box 2138, Nakuru-20100
Tel.: (+254 051) 210553, 210555

Foreword

This Kenya Standard was prepared by the Technical Committee under the guidance of the Standards Projects Committee, and it is in accordance with the procedures of the Kenya Bureau of Standards.

Painting of buildings — Code of practice

1 Scope and field of application

1.1 This Kenya Standard gives recommendations for good practice in initial painting and maintenance painting of buildings internally and externally, e.g. dwellings, offices, light industrial buildings, schools, hospitals, hotels and public buildings generally, in which decoration is a significant and often the major factor. The code takes into account the need to protect many building materials against the weather or other forms of attack normally encountered.

NOTE 1 Further guidance on the protection of steel structures, is given in ISO 12944.

1.2 The coatings referred to in this code are principally of conventional type, as defined in A.2, but limited reference is made to specialist coatings (A.3) and factory-applied coatings (A.4). In respect of materials generally, the code does not cover in detail the wide and constantly increasing range available. 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.

NOTE 2 Product references are indicated in the text by figures in parentheses, e.g. (3/2), and refer to the products listed and described in Table 3 to Table 11.

1.3 The code does not cover:

a) decorative processes and other work usually carried out by specialists;

b) the particular requirements of listed or historic buildings

NOTE 3 Buildings which are listed or which lie within a conservation area are protected by law. This does not mean that you can never alter or demolish one, but carrying out relevant work without the appropriate consent is a criminal offence.

c) lime wash and distemper coatings;

d) preservative treatments for structural timber;

e) coatings for fire protection; and

f) general safety hazards of access for painting (Annex C).

The recommendations made in the code are intended to facilitate achievement of standards of finish likely to be acceptable in most cases in the 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 the code might be necessary and should be specified accordingly.

2 Normative references

The following referenced documents are indispensable for the application of this standard. 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 1070, Specification for black paint (tar-based)

BS 1191-1, Specification for gypsum building plasters — Part 1: Excluding premixed lightweight plasters

BS 1191-2, Specification for gypsum building plasters — Part 2: Premixed lightweight plasters

BS 1336, Specification for knotting

BS 2015, Glossary of paint and related terms

BS 2992, Specification for painters' and decorators' brushes for local authorities and public institutions (excluding quality of fillings)

BS 3416, Specification for bitumen-based coatings for cold application, suitable for use in contact with potable water

BS 3761, Specification for solvent-based paint remover

BS 3900 (all parts), Methods of test for paints

BS 4072, Copper/chromium/arsenic preparations for wood preservation

BS 4652, Specification for zinc-rich priming paint (organic media)

BS 4756, Specification for ready-mixed aluminium priming paints for woodwork

BS 4764, Specification for powder cement paints

BS 5262, Code of practice for external renderings

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

BS 5589, Code of practice for preservation of timber

BS 5707, Specification for preparations of wood preservatives in organic solvents

BS 6949, Specification for bitumen-based coatings for cold application excluding use in contact with potable water

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

BS 7664, Specification for undercoat and finishing paints

BS 7956, Specification for primers for woodwork

BS 8000-12, Workmanship on building sites — Part 12: Code of practice for decorative wall coverings and painting

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

BS 8417, Preservation of timber — Recommendations

BS EN 350-2, Durability of wood and wood-based products — Natural durability of solid wood — Part 2: Guide to natural durability and treatability of selected wood species of importance in Europe

BS EN 927-1:1997, Paints and varnishes — Coating materials and coating systems for exterior wood — Part 1: Classification and selection

BS EN 971-1, Paints and varnishes — Terms and definitions for coating materials — General terms

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

BS EN ISO 2409, Paints and varnishes — Cross-cut test

BS EN ISO 4624, Paints and varnishes — Pull off test for adhesion

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

DD ENV 927-2, Paints and varnishes — Coating materials and coating systems for exterior wood — Part 2: Performance specification

3 Terms and definitions

For the purposes of this Kenya Standard, the terms and definitions given in (Insert equivalent ISO), and the following apply.

3.1
thixotropy
property of changing reversibly from a gel or semi-liquid state when at rest to a more liquid consistency when shearing forces are applied at a constant rate over a period of time

NOTE Shearing forces include for example brushing or stirring.

3.2
flow
extent to which a coating is able to flow out to a film of uniform thickness free from brush marks and similar irregularities produced by the method of application

3.3
undercoat
relatively highly pigmented matt or mid sheen materials, applied to primed or previously painted surfaces before the application of finishing coats

3.4
ancillary materials
materials other than coatings used in the painting of buildings

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

4 Design considerations

4.1 General

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 should be considered by the architect at the earliest possible stage. Specifiers need to consider design aspects from the perspective of coating 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 coating 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 be given to the factors described in Table 1. Of particular importance in relation to performances is the influence of design and detailing, proper organization and supervision and, in some circumstances, an effective inspection procedure. Exposure conditions are the consequence of construction and climatic factors (e.g. Table 2). The guidance on typical life to maintenance will be system specific and apply to mild and moderate exposure conditions as described in Table 2. Service life will be 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 B. Reference is also made to applicable legislation (see also Annex B). These aspects should 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 needs to be ensured.

All parts of a building to which coatings are to be applied should 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.

4.2 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 external repainting should be considered at the design stage. Where necessary, scaffolding should be provided

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

4.3 Control of moisture

Penetration of moisture is a common cause of the premature failure of coatings; it could 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 them 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 (see also C.2.6 and 8.3.3).

NOTE Condensation is likely to occur in most buildings both externally and internally. External condensation (i.e. dew) will 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. The latter includes surface moulds and in the case of interstitial condensation an increased risk of decay.

Measures to prevent or minimize condensation should be incorporated at the design stage but choice of coating can also make a contribution (see 4.6.4.2 and 4.6.4.3).

4.4 Profiles

Coatings have a tendency to recede from sharp edges during application and this could 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 usually being sufficient: sills and thresholds might need a 3 mm rounding. Sharp edges of metal, e.g. burrs and nibs, should be removed before painting.

4.5 Selection of materials

4.5.1 General

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

a) pigmented coatings, e.g. primers, undercoats, paints and wood stains;

b) unpigmented coatings, e.g. varnishes;

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

Materials should be selected from Tables 3 to Table 11 in accordance with 7.1 to 7.3 for coatings and in accordance with 7.4 for ancillary materials.

4.5.2 Volatile organic compounds

When selecting coatings, the volatile organic compound (VOC) content of coatings and its effect on the environment should be taken into account.

4.6 Selection of coating systems

4.6.1 General

A number of factors should be considered when selecting coating systems. Selection is often be made on a qualitative basis, judging the relative importance of the factors in relation to particular circumstances. If more than one type of system meets the specification, then selection might be made on the basis of relative cost, availability or individual preference.

NOTE 1 Care should be taken to ensure that factors are comparable; lower initial costs might well be more than outweighed by 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.

Factors, which should be considered when selecting coating systems, are listed in Table 1. There is a considerable degree of interaction between factors involved, and they should not be considered in isolation. The selection of coating systems and their suitability for substrates or groups of substrates should be determined using Tables 12 to 18.

NOTE 2 Information is given in the relevant tables on the expected life to first maintenance in mild or moderate exposure conditions, which have been categorized in Table 2.

Possible paintwork defects that might be encountered and the recommended remedial treatment for these should be determined using Table 19 and Table 20.

4.6.2 Exposure conditions

General and local exposure conditions and the conditions of service are major factors in the selection of coating systems. Reference should be made to 4.6.4 for information on special conditions that could influence selection.

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 attack or rigours of service, 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.

Table 2 indicates the broad categories of external and internal exposure conditions that might be encountered and illustrates factors that should be considered. It 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.

4.6.3 Substrates and coating systems

The properties of substrates and their influence on the selection of coating systems should be considered at the design stage (see Clause 8).

NOTE 1 For new build there are dominant economic and operational factors for the choice of substrates and methods of construction. Coatings may be required for aesthetic and/or protective reasons but cannot be expected to upgrade the performance of incorrectly specified building materials. The nature of the substrate will have a major impact on the suitability of specific coating systems.

Building materials to which coatings 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 coatings to upgrade the performance of inherently unsuitable materials, especially in circumstances where frequent maintenance is likely to be impracticable or uneconomic.

Alternative or supplementary treatments, e.g. galvanizing or sprayed metallic coatings (see 8.4.1.2), are available, as are ancillary treatments such as wood preservatives (see 8.1.5), to enhance the protection afforded by coatings.

NOTE 2 Where possible it is advantageous to undertake initial painting under controlled conditions, e.g. factory. This is often more satisfactory than site application and can offer a wider choice of systems.

4.6.4 Special conditions and requirements

4.6.4.1 General

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

4.6.4.2 High humidity

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

NOTE 1 This will include most solvent-borne paints and some water-borne paints (7/1, 7/2, 7/3 and 7/4).

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 where such conditions might prevail include swimming baths, laundries 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 coatings should be used.

Acrylated rubber paints (11/5), especially high-build types, have good moisture resistance and are available in a wide range of colours. Where colour is not important, bituminous coatings (see Table 10), including coal tar epoxies, can be used. Bituminous coatings can be used to provide semi-drying protective coatings with good moisture resistance which are suitable for use on surfaces not subject to handling or abrasion.

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

NOTE 2 Many moisture-resistant protective coatings need to be applied at a thickness of 100 mm or more

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

NOTE 3 Most condensation in buildings is caused by warm, moist air coming in 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

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. They usually contain aggregates with insulating or absorptive properties. Some coatings 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 to be expected that condensation will be followed by conditions favourable to drying out of absorbed moisture.

Where the function of a building gives rise to conditions of constant or frequent high humidity and the measures to prevent or reduce condensation in the preceding paragraphs are impracticable or not fully effective, priority should be given to the protection of substrates vulnerable to moisture attack by using specifically moisture-resistant coatings, as described in 4.6.4.2.

4.6.4.4 Mould growth

NOTE 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 (X10 or higher) when the filaments or hyphae characteristic of most moulds might be seen.

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 4.6.4.3; or

b) applying moisture-resistant protective coating (see 4.6.4.2) 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 before painting, should be treated in accordance with 11.5.8.

NOTE 5 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.

4.6.4.5 Chemical attack

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

In mildly acidic industrial exposure conditions, alkyd gloss and drying-oil/resin micaceous iron oxide paints can be used and should be applied to prepared and primed surfaces in systems of adequate thickness to achieve a defect-free film. Where there is a need for resistance to heavy fume attack or direct contact with chemicals, chemical-resistant coatings should be used.

NOTE Chemical-resistant coatings include acrylated rubber, two-pack epoxy and polyurethane, coal-tar epoxy and bituminous types (see Table 10 and Table 11).

The resistance of any of the coatings described in Table 11 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, specialist advice should be sought unless there is previous experience of the satisfactory performance of a particular type of coating in similar circumstances.

4.6.4.6 Fire

For further information on fire, see Annex D.

4.6.4.6.1 Painted surfaces

A painted surface should be considered as a thin film of flammable material in close contact with a substrate. The potential for the release of flammable volatiles (and therefore for a fire to occur) is a function of the nature of the paint film itself and the nature of the substrate. Paints would not normally affect the flame-spread rating of the unpainted surfaces(see 4.6.4.6.2.)

4.6.4.6.2 Resistance to surface spread of flame

NOTE Attention is drawn to the Building Regulations which require that, in certain types of buildings, the materials of which walls and ceilings are constructed conform to specified minimum requirements in relation to the spread of flame across the surfaces.

Paints should either be of conventional type conforming to specified minimum requirements in relation to the spread of flame across the surfaces. Flame-retardant paints can be conventional paints containing flame-retardant additives or types that intumesce (swell on heating). They should be applied as recommended by the manufacturer. The flame spread rating of paint cannot be expressed in isolation but only in relation to its performance on a specified substrate. Reference should be made to the manufacturer's details of the ratings of their paints when applied to specified substrates.

The flame spread rating of a painted surface can worsen with increasing film thickness or in situations where conventional paints are applied over flame-retardant types. In the latter event, compatibility problems can also arise. To avoid such difficulties, details of systems applied, including dates of application and types or brands of paints used, should be recorded for future reference. It can also be helpful to label surfaces to which flame-retardant paints have been applied.

NOTE Where Building Regulations require the materials of which walls or ceilings are constructed to have a specified flame- spread rating, flame-retardant paints applied on site cannot be used to upgrade materials that do not meet Building Regulation requirements.

4.6.4.7 Resistance to abrasion

NOTE Coatings 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 watt 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 coatings 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 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 (7/14) can be used for walls in many interior hard wear situations.

4.6.4.8 Anti-graffiti treatments

Paint graffiti is an increasing problem in buildings and any organization with buildings that are vulnerable to attack should have a policy on removal or protection. New or undamaged surfaces should be assessed for the likely risk and cost of countermeasures. Choices for the prevention include sacrificial, semi-permanent and permanent coatings (see E.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. Physical and chemical methods are available but the choice of method will depend on the nature of the marker and the substrate. Specialist manufacturers should be consulted and preliminary testing carried out on small areas (see E.1 and E.2).

NOTE For further information on anti-graffiti treatments, see Annex E.

Table 1 — Selection of coating systems

Issue	Question	Action
Exposure conditions	What is the general atmospheric exposure conditions, external and internal?	Consider location and functions of buildings
	What localized or intermittent conditions (e.g. fumes, condensation, heat, vulnerability to abrasion or wear) exist or are to be expected?	Refer to 7.1, Table 2 and 4.6.4. Consider possible future developments or changes in usage, which might alter the local exposure conditions
Function	What are the functional requirements (e.g. of protection, decoration, hygiene or special function)?	Refer to 7.1 and 4.6.4. Design remit and experience. Consider substrate. Consider exposure conditions (see 4.6.2)
	Are there any relevant statutory requirements (e.g. under the Building Regulations or Factories Act) affecting selection?	Relevant legislation (see also Annex B)
Substrate	What substrates are involved?	Design, remit, specification or inspection
	Do their characteristics influence the selection of coating systems?	Refer to 8.1 to 8. 15
Special constraints on selection	Are there constraints relating to the composition of the coatings in some situations (e.g. in food factories because of the risk of toxicity or tainting)?	Consult client, industry association or supplier
	Are the materials chosen to minimize solvent content and the systems of working specified compliant with legislation?	Refer to Clause 10 and Annex B
	Are any constraints imposed by the conditions under which the work has to be carried out (e.g. requiring the use of coatings which dry very quickly)?	Consult client, contractor or supplier. Refer to 9.1
	Are there constraints imposed on colour choice by reason of solar gam?	Refer to 8.1.4.2
	Does the condition of the substrate (e.g. its high moisture content) impose constraints on the selection?	Ascertain condition, expected or actual, at time of treatment. Refer to 8.1 to 8.15
Coatings	Which coating systems are available?	Consider answers to preceding questions. Refer to Tables 3 to 11 and 8.1 to 8.15. Consult suppliers
	Are the coatings readily available from the usual sources or is special order or manufacture required?	Consult suppliers
	Are the coatings suitable for site or factory application?	Consult suppliers
	Are there any restrictions on methods of application on site?	Consult suppliers. Refer to Clause 9 for information on application methods

Issue	Question	Action
	Is application by specialist contractors required?	Consult supplier. Refer to Tables 3 to 11
	Has the environmental impact of the chosen system been considered?	Consult supplier. Refer to Tables 3 to 11
Cost 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. Consult contractors and suppliers
	What is the expected life of the system to first maintenance?	Experience of similar systems. Refer to Tables 12 to 17
	Does the system provide a satisfactory base for maintenance type perhaps with coatings of different type?	See 11.3

Table 2 — Exposure condition categories

Severity of Exposure	Corrosivity category (see ISO 12944-2) (To be adopted)	Exterior	Other exterior factors	Interior	Other interior 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), nonindustrial 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, laundries, breweries, dairies	Moderate soiling, abrasion and handling of surfaces
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) Find equivalent Standard)	Exposure conditions subject to frequent high humidity or heavy condensation, especially if pollutants, e.g. sulfur dioxide or	Exposure conditions in which heavy soiling or hygiene requirements necessitate frequent cleaning of surfaces.

Severity of Exposure	Corrosivity category (see ISO 12944-2) (To be adopted)	Exterior	Other exterior factors	Interior	Other interior factors
				ammonia, are present. Chemical plants, swimming pools	Surfaces subject to heavy abrasion or impact
Very severe	C5-I (very high industrial) C5-M (very high marine)	Industrial areas with high humidity and aggressive atmosphere Coastal and offshore areas with high salinity	-	Buildings or areas with almost permanent condensation and with high pollution	Surfaces in contact with chemicals, chemical solutions, process liquors and other aggressive agents
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. (NWI proposal)					

Table 3 — Primers for wood

Ref.	Description	General composition	Characteristics and usage
3/1	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, fibre boards and chipboards
3/2	Opaque primers conforming to BS 7956, Type AA) (NWI proposal)	Solvent-borne (typically alkyd) or water-borne (typically acrylic) pigmented primers of 3/1, but formulated for improved exterior durability	General purpose
3/3	Semi-transparent primers conforming to BS 7956, Type BA) NWI PROPOSAL)	Solvent- or water-borne as 3/2 using transparent pigments	Semi-transparent dual-purpose primers designed for over coating with either stain finishes or paints. Often used as the factory-applied primer for joinery. They are generally of lower durability than 3/2 primers and should be over coated with minimum delay
3/4	Opaque primers conforming to BS 7956, Type CA)	Solvent-borne or water-borne primers as 3/2 with stain blocking properties	Primers that can be used directly over knots, resinous timbers and timbers pretreated with preservatives, such as metallic naphthenates, known to discolour subsequently applied paint films
3/5	Ready-mixed aluminium primers conforming to BS 4756 (NWI proposal)	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 copper naphthenate wood preservative or creosote. Relatively impermeable to moisture. Application of an additional coat of undercoat/finish might be required to obliterate grey primer colour
3/6	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

Ref.	Description	General composition	Characteristics and usage
			treating weathered wood surfaces after mechanical preparation

Table 4 — Primers for metal

Ref.	Description	General composition	Characteristics and usage
4/1	Pretreatment, wash or etching primer, two-pack	Typically, polyvinyl butyral resin solution with phosphoric acid (as separate component) and a pigment (chromate containing primers now largely superseded by chromate-free primers)	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. 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
4/2	Pretreament, wash or etching primer, one pack.	Typically, polyvinyl butyral/phenolic resin solution with tinting pigment	
4/3	Mordant solution	Water-borne pre-treatment for galvanized and non-ferrous metals	Contains an indicator which darkens the surface of galvanized steel indicating that it has reacted
4/4	Adhesion promoter	Water-borne pre-treatment for non-ferrous metals and stainless steel	Pretreatment with low VOC content designed to improve adhesion of subsequent coating system to non-ferrous metals and stainless steel
4/5	Zinc phosphate primer (see also 4/8 and 5/4)	Solvent-borne. 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 less toxic and 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; refer to manufacturer's recommendations
4/6	Chromate primer (limited availability) for specialist use	Solvent-borne. Typically, drying oil/ resin type binder with zinc chromate as the main inhibitive pigment. Red oxide or other pigments can be incorporated	Vary according to formulation, but chromate primers are usually fairly quick-drying and suitable for use on ferrous and non-ferrous metals

Ref.	Description	General composition	Characteristics and usage
4/7	Zinc-rich Primer A) conforming to BS 4652 (two-pack), (NWI proposal) solvent-borne	Solvent-borne. Based on epoxy resin and supplied in two-pack form (zinc paste and curing agent)	A quick-drying metallic-grey primer for iron and steel with rust-inhibiting properties. Apply to well-prepared (e.g. blast-cleaned) steel only. 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
4/8	Zinc-rich primer (one-pack)	Solvent-borne. Based on a nonsaponifiable medium, e.g. chlorinated rubber	A quick-drying metallic-grey primer for iron and steel with rust-inhibiting properties. Often used for touching up damaged zinc coatings, e.g. zinc sprayed or galvanized surfaces
4/9	Zinc phosphate primer, waterborne	Water-borne. Based on an acrylic resin dispersion in water and typically containing a zinc phosphate anticorrosive pigment	A quick-drying primer for iron and steel as well as non-ferrous metals including galvanizing. Some versions described as universal primer (5/4) and can be used on timber surfaces
4/10	Two pack epoxy primer	Solvent-borne. Based on epoxy resin and usually polyamide and supplied in two-pack form	Surface tolerant primer, usually containing a leafing aluminium pigment, is suitable for application not only to manually prepared steel surfaces, but also over existing, sound paintwork
Advice should be sought when drying-oil/resin type paints are to be used over zinc-rich primers.			

Table 5 — Miscellaneous primers

Ref.	Description	General composition	Characteristics and usage
5/1	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
5/2	Primer or primer undercoat	Water-borne (typically based on an acrylic polymer). Might be identical in composition to 4/9 or 6/2	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 4/9 or 6/2)
5/3	Primer-sealer Other descriptions include stabilizing primer or solution, penetrating primer or masonry sealer	Traditionally solvent-borne and lightly pigmented, or semitransparent with a marker pigment, to assist even application. May 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. Too much reliance should not be placed on the ability of this type of material to penetrate unsound coatings of substantial thickness, and as much as possible of the old material should 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. Reference should be made to the manufacturer's recommendations
5/4	Universal primer (see also 5/2) 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

Ref.	Description	General composition	Characteristics and usage
			formulated for specific substrates are generally to be preferred

Table 6 — Undercoats

Ref.	Description	General composition	Characteristics and usage
6/1	Solvent-borne Traditionally drying-oil/resin type This type of undercoat provides a matt or low sheen undercoat		
6/2	Water-borne undercoat or primer undercoat	Based on acrylic or other polymers pigmented as in 6/1. Might be identical in composition to 5/2.	These undercoats are quicker drying than 6/1 and, in normal conditions permit same-day recoating. General usage as 6/1. As primers they might be suitable for priming dry plaster, building boards and wood. Only types conforming to BS 7956 should be used for priming exterior woodwork.

Table 7 — General pigment finishes

Ref.	Description	General composition	Characteristics and usage
7/1	Solvent-borne gloss or midsheen finish Other descriptions include hard-gloss enamel and high gloss for gloss finishes; and eggshell, satin, silk and semi-gloss for midsheen 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, colored 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. Advice should be sought from the manufacture regarding the suitability of mid-sheen finishes for exterior use on different substrates. 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)
7/2	Water-borne gloss or mid-sheen finish Descriptive terms for sheen can be described as for 7/1	Typically based on acrylic dispersions. Might contain other modifying resins. Pigmented with titanium dioxide and/or light-fast, coloured pigments	
7/3	Solvent-borne matt or flat finish	Generally as for 7/1 adjusted to provide a matt finish	Essentially, this is a decorative finish for interior use only. Drying and recoating characteristics are usually similar to those of 7/1. Special purpose types, both water- and solvent-borne designed for renovating surfaces which might be weak, liable to cause staining of subsequent coatings, or subject to further drying (see also 7/5)
7/4	Water-borne matt or flat finish Other descriptions include emulsion paint, latex, vinyl or acrylic paint (see F.2.3)	Composition of binder typically based on vinyl or acrylic polymers or combinations of these, with titanium dioxide and/or coloured pigments	Water-borne are often less resistant than their solvent-borne counterparts, but the wear-resistance and washability of some might approach those of the 7/1 mid-sheen finishes. They have advantages over the latter in ease of application to large areas, speed of drying (same-day

Ref.	Description	General composition	Characteristics and usage
			recoating is usually possible), absence of solvent odour and ease of clean-up. They are widely used for ceilings and walls, mainly internally although some might be suitable for use on exterior walls. Choice of sheen level depends largely on location and aesthetic considerations but, in general terms, washability and resistance to soiling increase proportionately to the degree of sheen. Water-borne paints are generally more permeable to moisture than drying oil/ resin finishes and only some are suitable for use in situations where humidity is high for long periods, e.g. in kitchens and bathrooms (see manufacturer's recommendations)
7/5	Contract and general purpose paint	Water-borne. Composition, typically, is similar to that of 7/4 but with higher pigment content and giving a matt finish	Higher pigment gives increased opacity, compared with 7/4 type, 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 drying-out of contained moisture
7/6	Aluminium paint, general purpose (NWI proposal)	Traditionally, solvent-borne. Typically, drying-oil/alkyd resin binder pigmented with flake aluminium	The laminar nature of the pigment (see F.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, but their widest application is on structural steelwork, storage vessels and heated metal surfaces
7/7	Micaceous iron oxide paint, general purpose (NWI)	Solvent-borne. Typically, drying-oil or drying-oil/resin type binder pigmented with micaceous iron oxide. Small amounts of other pigments can be incorporated to modify the natural colour (dark grey) of the main pigment	Because of the laminar nature of the pigment (see F.4.6) and the substantial thickness of the film, micaceous iron oxide paints provide good protection and are widely used extensively on structural steel, bridges, harbour installations and electricity transmission towers. On

Ref.	Description	General composition	Characteristics and usage
			weathering, the coating develops a metallic sparkle. The dark colour of the pigment restricts the range of colours available, but over coating with alkyd gloss finish is often possible
7/8	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 lime resistant coloured pigments. Some types are smooth; others contain fibre, sand or other agent to give a fine texture. Most contain an additive to inhibit mould and algal growth	These are essentially decorative coatings but have the weather-resistance and durability required in coatings 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 not generally suitable for application to wood and metal. Formulations containing fibre, sand, etc. usually provide thicker films than the smooth types. The manufacturer should be consulted regarding the use on interior surfaces of masonry paints containing additives to inhibit mould and algal growth because of the possible toxic hazard
7/9	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 7/8 and mould/algal inhibitors might be incorporated	Coatings 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, coatings of this type might be suitable for internal walls where a hard-wearing textured finish is required
7/10	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 the 7/8 types, 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 should be applied to dry substrates. Brush

Ref.	Description	General composition	Characteristics and usage
			application will generally be slower than with 7/8 types. It is more tolerant of poor drying conditions than water-borne types
7/11	Masonry paints, solvent-borne, thick, textured	Composition variable 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. Coatings of this type are usually applied by spray or roller, often by specialist contractors. Material and application costs are likely to be high
7/12	Silicate-based masonry coatings	Water-borne. Based on water soluble silicates with possible addition of minor quantities of organic resins	The coatings 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 than organic coatings by fungal and algal growth and are compatible with all mineral building materials. External surfaces to be painted should be 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 should be taken during application. Resistance to moisture penetration can be improved by use of a hydrophobic impregnation treatment (e.g. silane, siloxanes)
7/13	Cement paint to BS 4764 ((NWI)	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	Low-cost coatings giving a rough finish and used mainly for exterior wall surfaces, although they can be used inside except on gypsum plaster: not recommended for application over other types of paint. On lengthy outside exposure, pastel shades can tend to lighten and darker colours to become patchy. Can be used as a primer on uncoated exterior wall surfaces prior to finishes of type 7/9 or 7/10
7/14	Multi-colour finish	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, so	These are quick-drying, hard-wearing finishes for interior wall surfaces, often used in circulating areas, cloakrooms and similar hard-wear locations. Application

Ref.	Description	General composition	Characteristics and usage
		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 in which are suspended multi-coloured flakes of solid material	is usually by spray, but materials of the third type might be suitable for brush or roller application
7/15	Plastic texture paint	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 may 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 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 8 — Transparent and semi-transparent finishes for interior wood

Ref.	Description	General composition	Characteristics and usage
8/1	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 wear locations
8/2	Water-borne clear varnish, general purpose	Water-borne acrylic copolymer	Fast drying, durable protective coating for most interior wood
8/3	Water-borne clear floor varnish	Water-borne acrylic with polyurethane dispersion	High durability interior clear wood lacquer. Ideal heavy wear interior wood surfaces especially traditional floors. Resistant to common chemicals and hot water
8/4	Semitransparent 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 over coated with a clear finish
8/5	Solvent-borne two pack varnish	Typically oil, alkyd or polyol cured with aliphatic isocyanate	Limited potlife, some additional safety precautions required. Used in hard wearing areas, such as flooring

Table 9 — Transparent and semi-transparent finishes for exterior wood

Ref.	Description	General composition	Characteristics and usage
9/1	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. Usual mode of eventual failure by cracking and flaking, and in exposed situations demands frequent maintenance
9/2	Solvent-borne two pack varnish	Typically oil, alkyd or polyol cured with aliphatic isocyanate with added UV absorber	Limited potlife. Used primarily on hardwoods. Similar to some yacht varnishes. Can give superior performance on hardwoods
9/3	Semitransparent exterior wood stain, low-build, solvent-borne	Resins, pigments and fungicides in organic solvent	Relatively thin coating that normally imparts a noticeable sheen to the surface. Relatively high moisture vapour permeability and wood likely to be subject to dimensional movement and surface splitting. Not best suited to dimensioned components such as joinery
9/4	Semitransparent exterior wood stain, low-build, water-borne	As for 9/3 minimizing the use of organic solvents	Relatively thin coating that normally imparts a noticeable sheen to the surface. Relatively high moisture vapour permeability and wood likely to be subject to dimensional movement and surface splitting. Not best suited to dimensioned components such as joinery
9/5	Semi-transparent exterior wood stain, medium build, solvent borne	Generally as for 9/3 but higher resin content.	Often used as top coat for 9/3. Because of its higher resin content this type of stain will confer a higher build and offers better control of moisture and dimensional movement
9/6	Semi-transparent exterior wood stain, medium-build, water-borne	An alternative to 9/5 minimizing the use of organic solvents.	Often used as top coat for 9/4. 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 10 — Bituminous and tar-based coatings

Ref.	Description	General composition	Characteristics and usage
10/1	Black paint (tar based) conforming to BS 1070, types A and B	Coal-tar or water gas-tar solutions	Moisture-resistant protective coatings for general use on metal and other surfaces where decorative appearance is unimportant. Both types are suitable for cold application, e.g. by brush. Type A is required to dry in 8 h and type B in 4 h
10/2	Bitumen-based coatings conforming to BS 6949, types 1 and 2	Bitumen solutions, type 2 with fillers	Generally as for 10/1. Type 1 without fillers, type 2 with, permitting greater film thickness per coat. Not suitable for use in contact with drinking water (see 10/3 for suitable types)
10/3	Bitumen-based coatings conforming to BS 3416, types 1 and 2	Bitumen solutions, type 2 with fillers	Generally as for 10/2, but suitable for use in contact with drinking water. Has to be certified under the Water Regulations Advisory SchemeA) in order to comply with EEC Directive 80/778/EEC (as amended) [7]
10/4	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

Table 11 — Specialist coatings

Ref.	Description	General composition	Characteristics and usage
11/1	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 MIO pigments. Both solvent-borne and water-borne epoxy coatings 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 coatings of conventional type are inadequate. Should be 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 should be observed. High humidity during application and curing can also affect the coatings
11/2	Two-pack coal tar epoxy coatings Replaced by hydrocarbon epoxies	Binder blended with hydrocarbon resins and mineral extenders	General characteristics as 11/1 but lower resistance to solvents. Main use is for protection in conditions of very high humidity or immersion in fresh or seawater
11/3	Two-pack polyurethane pigmented coatings, principally finishes	Acrylic modified polyester resin binder with polyisocyanate curing agent and white or coloured pigments	General characteristics as 11/1, but low temperature curing is usually better and sensitivity to moisture curing 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
11/4	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 coatings of conventional type are inadequate. Apply only to stable, well prepared surfaces. Blast-cleaning of steelwork is essential. Might not be suitable for application on gypsum plaster; a

Ref.	Description	General composition	Characteristics and usage
			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. Observe the manufacturer's recommendations in respect of humidity and temperature. Most formulations can tolerate traces of surface moisture
11/5	Acrylated rubber primers, undercoats and finishes	Acrylated rubber, pigmented according to end use, as 11/1. 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 coatings, although their chemical resistance might be lower. As for solution binders (see F.2.5), drying is essentially by evaporation and is less affected by low temperatures than is that of drying-oil/ resin, epoxy and polyurethane coatings. Brush or roller application to large areas might be difficult, and spraying is recommended (see 9.3)
11/6	Cellulose coatings, clear or pigmented, other than cellulose multicolor types (7/14)	Nitrocellulose/synthetic resin solutions clear or pigmented	Quick-drying coatings, having a limited application in the painting of buildings. As with other lacquers (see F.2.5) cellulose coatings are best applied by spray, although some types can be modified to allow brush applications to small areas. The most frequent usage is of clear and pigmented coatings, including "gold" and "bronze" lacquers for shop fronts, lift doors, ornamental metalwork and similar items, work usually carried out by specialists. NOTE This material has a high fire risk

Table 12 — Coating systems for interior wood

Application (enduse)	Coating type (see Note 1)	Priming options for new and bare areas of wood (see also 8.1.6.3, 8.2.2.3, and Table 3)	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 7/1, 7/2, 7/3 and 7/4	Opaque primer 3/1 optionally over coated with undercoats 6/1 or 6/2	Over 5 years
Transparent and semi-transparent systems			
Internal surfaces of door and window joinery, wood trim, plywood and woodbased boards	Varnish, clear or semitransparent in wood tone of choice. Build and gloss level of choice. Abrasion resistant binder, e.g. polyurethane, for hardwear situations (Table 8)	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 8/1 and 8/3. Specialist application may 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. For interior use the latter are being phased out in response to environmental legislation.

NOTE 2 Interior coatings will not require frequent maintenance unless mechanically damaged. Transparent wood coatings could have some colour change.

Table 13 — Coating systems for exterior wood

Application (end use)	Coating type (see Note 1)	Priming options for new and bare areas of wood (see also 8.1.6.3, 8.2.2.3, and Table 3)	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 (3/2 or 3/4), or preservative primer (3/6)	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 (3/2 or 3/4), or preservative primer (3/6). Special primer/undercoats may be specified.	Over 5 years
	1 or 2 coats exterior waterborne paint (7/3). Gloss level and colour of choice	Opaque solvent-borne or water-borne (3/2 or 3/4), or preservative primer (3/6)	Over 5 years
Softwood and plywood for cladding, bargeboards, soffits and fascias	1 or 2 coats flexible exterior alkyd-based paint over recommended primer. Gloss level and colour of choice	Opaque solvent-borne or water-borne (3/2 or 3/4), or preservative primer (3/6)	Over 5 years
	1 or 2 coats exterior waterborne paint (7/3). Gloss level and colour of choice	Opaque solvent-borne or water-borne (3/2 or 3/4), or preservative primer (3/6)	Over 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 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. For interior use the latter are being phased out in response to environmental legislation.

NOTE 2 Interior coatings will not require frequent maintenance unless mechanically damaged. Transparent wood coatings could have some colour change.

Table 13 — Coating systems for exterior wood (continued)

Application (end use)	Coating type (see Note 1)	Priming options for new and bare areas of wood (see also 8.1.6.3, 8.2.2.3, and Table 3)	Typical life to first maintenance (see Note 2)
Transparent and semi-transparent systems (see Note 3)			
Exterior softwood door and window joinery	Exterior wood stain Medium-build (9/5 or 9/6)	3/6 or 3/3	Depends on product type, unlikely to exceed 2 to 3 years on full exposure
Exterior hardwood door and window joinery (see Note 4)	Exterior wood stain Medium-build (9/5 or 9/6)	3/6 or 3/3	Typically 3 to 5 years Depending on exposure
Exterior grade plywood, e.g. door panels	Exterior wood stain Medium-build (9/5 or 9/6)	3/6 or 3/3	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	Exterior wood stain Low build (9/3 or 9/4) Medium build (9/5 or 9/6)	3/6 or 3/3	3 to 5 years depending on exposure
External hardwood boarding, cladding, bargeboards, soffits, fascias	Exterior wood stain Medium-build (9/5 or 9/6)	3/6 or 3/3	4 to 5 years depending on exposure
External grade plywood boarding, cladding, bargeboards, soffits, fascias	Exterior wood stain Medium-build (9/5 or 9/6)	3/6 or 3/3	Typically 3 to 5 years depending on exposure. Efflorescence is a risk factor
Gates, fences, handrails, decking and garden furniture (see Note 5)	Exterior wood stain Medium-build ((9/5 or 9/6) Low-build (9/3 or 9/4) (see Note 3)	3/6 or 3/3	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 2. 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 The final appearance of transparent and semi-transparent coatings will depend on the number of coats. Two is the usual minimum; an additional coat will increase service life but may darken the appearance. Penetrating low-build stains are primarily used on rough sawn timber where one or two coats are required.

NOTE 4 Commercial systems designed for hardwood might have a different composition to their softwood counterparts.

NOTE 5 Commercial variants might include different degrees of water repellence.

Table 14 — Paint systems for iron and steel except heated surfaces

Surface condition, primer and reference in Table 4	Finishing system and references in Table 6 and Table 7	Total film thickness µm	Typical life to first maintenance in exposure conditions indicated (see Note 1)
Manually cleaned			
2 coat primer, e.g. 4/5	2 coats aluminium paint (7/6); or 1 coat solvent-borne undercoat (6/1) and 1 coat alkyd gloss finish (7/1) or 2 coats of gloss finish; or 2 coats micaceous iron oxide (MIO) paint (7/7 high-build type) (see Note 3)	125 to 150	Interior Up to 10 years
1 coat primer, e.g. 4/5	2 coats aluminium paint (7/6); or 1 coat solvent-borne undercoat (6/1) and 1 coat alkyd gloss finish (7/1) or 2 coats of gloss finish; or 2 coats micaceous iron oxide paint (7/7 high-build type) (see Note 3)	85 to 115	Interior Up to 5 years Exterior Not recommended
Blast-cleaned			
2 coats oil-primer, e.g. 4/5	1 coat solvent-borne undercoat (6/1) and 2 coats alkyd gloss finish (7/1) or 2 undercoats and 1 coat of gloss finish (see Note 2); or 2 coats micaceous iron oxide	170 to 205	Interior Over 10 years

Surface condition, primer and reference in Table 4	Finishing system and references in Table 6 and Table 7	Total film thickness µm	Typical life to first maintenance in exposure conditions indicated (see Note 1)
	paint (7/7 high-build type) (see Note 3)		Exterior Up to 10 years
1 coat primer, e.g. 4/5	1 coat solvent-borne undercoat (6/1) and 2 coats alkyd gloss finish (7/1); or 2 undercoats and 1 coat of gloss finish (see Note 2); or 2 coats micaceous iron oxide paint (7/7 high-build type) (see Note 3)	115 to 145	Interior Up to 10 years
			Exterior Up to 5 years for film thicknesses exceeding 125 µm

NOTE 1 Life expectancies are based on performance in moderate exposure conditions as defined in Table 2. NOTE 2 Mid-sheen alkyd finish (7/3) can be used in mild interior exposure conditions.

NOTE 3 MIO paint can be covered with alkyd gloss finish (if manufacturer approves) to provide specific colour.

NOTE 4 Zinc rich primers (e.g. 4/7) are also used but problems can arise with many or drying-oil/resin systems, advice needs to be sought regarding compatible top coats (see also 11.3.2).

Table 15 — Site pre-treatment and priming of non-ferrous metals and stainless steel (not factory pre-treated)

Substrate	Surface preparation and pretreatment/priming
Aluminium, smooth surfaces, e.g. sheets, extrusions and aluminized steel	Degrease (see 8.4.2.2). Abrade (see 8.4.2.7) and/or apply treatment primer (4/4). Then prime using zinc phosphate (4/5)
Aluminium, rough surfaces, e.g. castings and sprayed metallic coatings	Abrade lightly (see 8.4.2.7) remove dust and dirt. Sprayed metallic coatings might require washing (see 8.4.2.3). With sprayed metallic coatings, pre-treatment primer (4/4) should be applied immediately following application of the coating (see 8.4.3.4). Then prime using zinc phosphate (4/5)
Zinc sheet, zinc (hot-dip galvanized, sherardized and electroplated) coated steel, zinc aluminium alloy (hot dip) coated steel	Degrease (see 8.4.2.2); abrade coated sheet metal components as necessary (see 8.4.3.3); apply pre-treatment primer (4/4) or treat with mordant solution (4/3). With sherardizing or if suitable primer is used on other coatings, weathering or application of pre-treatment primer is not needed. Some hot dip coatings might need de-nibbingA) and careful abrasion to remove surface deposits and sharp points
Zinc and zinc aluminium alloy, sprayed	Sprayed metallic coatings might require washing (see 8.4.2.3). Apply pre-treatment primer (4/4) or treat with mordant solution (4/3). With sprayed metallic coatings, this should immediately follow application of the coating (see 8.4.3.4). If painted at a later time first remove dust and dirt; wash surface if necessary
Copper, brass, bronze	Degrease (see 8.4.2.2). Abrade lightly (see 8.4.2.7) or apply pretreatment primer (4/4)
Lead	Abrade WET (see 8.4.2.7 and for health and safety guidance, see B.1.2). Apply pre-treatment primer (4/4)
Cadmium coatings	Degrease (see 8.4.2.2). Abrade lightly (see 8.4.2.7). Apply pretreatment primer (4/4)
Tin coatings	Degrease (see 8.4.2.2). Abrade lightly (see 8.4.2.7)
Chromium and nickel coatings (if corroded)	Abrade (see 8.4.2.7) to remove corrosion products. Apply pretreatment primer (4/4)
Stainless steel (see 8.3.2.2)	Degrease (see 8.4.2.2). Abrade (see 8.4.2.7). Apply pre-treatment primer (4/4)

A) De-nibbing should take place before delivery to site. If this does not happen, it is essential that de-nibbing takes place prior to painting.

NOTE 1 For specialist advice on substrates listed in this table, check with the coatings manufacturer.

NOTE 2 Abrasion of metals may detract from the aesthetic appearance of the overall finish.

Table 16 — Coating systems for internal plaster, concrete, brick, block and stone

Substrate condition	Finish type and reference in Table 7	Primer and reference in Table 5	Coating system and references in Table 6 or Table 7
DRY r.h. below 75% (see Note 1)	Gloss, mid-sheen or matt (7/1, 7/2, 7/3)	Alkali-resisting primer (5/1) or, plaster only, water-borne primer (5/2)	Gloss finish: 1 coat solvent-borne (6/1) or water-borne (6/2) undercoat; 1 coat alkyd gloss finish (7/1) or 1 coat water-borne (7/2)
			Mid-sheen finish: 2 coats alkyd mid-sheen finish (7/1) or 2 coats water-borne (7/2)
			Matt-finish: 2 coats alkyd matt finish (7/3) or 2 coats water-borne (7/4)
	General purpose emulsion paint (7/4, 7/5)	Primer not usually required but see 8.5.1.4 and 8.5.1.5. A well thinned first coat of water-borne paint might be required on surfaces of high or variable porosity (see 8.6.2.4)	Matt or mid-sheen finish: 2 or 3 coats general purpose water-borne paint, matt or mid-sheen (7/4)
			Matt, high-opacity finish: 2 coats contract water-borne paint (7/5) 1 coat, spray applied, might suffice in some situations
	Multi-colour (7/14)	Primer or basecoat as recommended by manufacturer	Usually 1 coat multi-colour finish (7/14) spray-applied but refer to manufacturer's instructions
	Textured (7/15)	Primer not usually required but refer to manufacturer's instructions	Plastic texture paint (7/15): Normally 1 coat but might require over-painting
			Water-borne masonry paint, heavy-texture (7/9): Normally 1 coat but refer to manufacturer's instructions
	Masonry paint, mineral type (7/12)	Check with manufacturer	Check with manufacturer
	Cement paint (7/13) (not on gypsum plaster)	Primer not required	1 or 2 coats cement paint (7/13)

Substrate condition	Finish type and reference in Table 7	Primer and reference in Table 5	Coating system and references in Table 6 or Table 7
DRYING Some damp patches might be evident, r.h. 75% to 90%	Water-borne paint (7/4, 7/5)	As for DRY substrates	Matt or mid-sheen finish: 2 or 3 coats general purpose water-borne paint, matt or mid-sheen (7/4)
			Matt, high-opacity finish: 2 coats contract water-borne paint (7/5) 1 coat, spray applied, might suffice in some situations
	Multi-colour finishes (7/14) possible but consult manufacturer	As for DRY substrates	Usually 1 coat multi-colour finish (7/15) spray-applied but refer to manufacturer's instructions
	Textured paints (7/15) possible but consult manufacturer	As for DRY substrates	Plastic texture paint (7/15): Normally 1coat but might require overpainting
			Water-borne masonry paint, heavy texture (7/9): Normally 1 coat but refer to manufacturer's instructions
			If over coating is necessary, water-borne paint should be used
	Masonry paint, mineral type (7/10)	Check with manufacturer	Check with manufacturer
	Cement paint (7/11) (not on gypsum plaster)	Primer not required	1 or 2 coats cement paint (7/13)
DAMP Obvious damp patches, r.h. 90% to 100%	Water-borne paint (7/4, 7/5) 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 (7/4)
			Matt, high-opacity finish: 2 coats contract water-borne paint (7/5) 1 coat, spray-applied, might suffice in some situations
			Contract types (7/5) are usually more permeable than general purpose (7/4) types and less prone to failure on damp substrates

Substrate condition	Finish type and reference in Table 7	Primer and reference in Table 5	Coating system and references in Table 6 or Table 7
	Masonry paint, mineral type (7/12)	Check with manufacturer	Check with manufacturer
	Cement paint (7/13) (not on gypsum plaster)	Primer not required	1 or 2 coats cement paint (7/13)
WET Moisture visible on surface, r.h. 100%	Cement paint (7/13) (not on gypsum plaster)	Primer not required	1 or 2 coats cement paint (7/13)

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 8.5.1.1 for method of measuring moisture content.

Table 17 — Coating systems for external renderings, concrete, brick, block and stone

Substrate condition	Coating type	Primer and reference in Table 5	Coating system and references in Table 6 or Table 7 and use	Typical life to first maintenance (see Note 2)
DRY r.h. below 75% (see Note 1)	Masonry paints, solvent-thinned (7/10 or 7/11)	Alkali-resisting primer (5/1) or as recommended by manufacturer	Smooth or fine-textured (7/10) types, solvent-thinned 2 coats	5 years or more
			Thick, textured (7/11) types, solvent-thinned 10 years or more Usually 1 or 2 coats applied by spray, often by specialist applicators	10 years or more
	Water-borne masonry paints (7/8, 7/9)	Primer not usually required with 7/8 types but see 8.5.1.4 and 8.5.1.5	Smooth or fine-textured (7/8) water-borne types 2 coats	5 years or more
		Primer not usually required with 7/9 types but refer to manufacturer's recommendations	Heavy-textured (7/9) waterborne type Usually 1 coat applied by roller	10 years or more
	Masonry paint, mineral type (7/12)	Check with manufacturer	Check with manufacturer	Over 15 years
	Cement paint (7/13)	Primer not required	2 coats cement paint (7/13)	3 to 5 years
	Alkyd gloss and modified alkyd gloss (7/1)	Alkali-resisting Primer (5/1)	1 coat solvent-borne undercoat (6/1); 1 or 2 coats alkyd gloss finish (7/1)	3 to 5 years
DRYING Some damp patches might be visible, r.h. 75% to 90%	Water-borne masonry paints (7/8 or 7/9)	As for DRY substrates	Smooth or fine-textured (7/8) water-borne type 2 coats; or Heavy-textured (7/9) waterborne 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	Check with manufacturer	Check with manufacturer	Over 15 years

Substrate condition	Coating type	Primer and reference in Table 5	Coating system and references in Table 6 or Table 7 and use	Typical life to first maintenance (see Note 2)
	(7/12)			
	Refer to manufacturer's recommendations for use of solventborne masonry paints (7/10 or 7/11)	As for DRY substrates	Smooth or fine-textured (7/10) types, solvent-borne 2 coats; or Thick, textured (7/11) 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
DAMP Obvious Damp patches, r.h. 90% to 100%	Masonry paint, mineral type (7/12)	Check with manufacturer	Check with manufacturer	Over 15 years
	Cement paint (7/13	Primer not required	2 coats cement paint (7/13)	As for DRY substrates
	Refer to manufacturer's recommendations regarding use of water-borne masonry paints (7/8 or 7/9)	Primer not required	Smooth or fine-textured (7/9) water-borne types 2 coats; or Heavy-textured (7/10) waterborne 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 (7/13)	Primer not required	2 coats cement paint (7/13)	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 8.5.1.1 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 2. 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.

Table 18 — Site priming of fibre building board, wood chipboard and plaster board (not factory-primed or sealed)

Type of board or sheet	Primers and references in Table 3 and Table 5	
	With solvent-borne finishes	**With water-borne finishes A)**
Hardboard, medium board, medium density fiberboard (MDF) and soft board	Primer-sealer (5/3) Water-borne primer (5/2) Aluminium wood primer (3/2)	Not usually required, but, for absorbent board, first coats might need additional thinning
Flame retardant treated	Alkali-resisting primer (5/1)	Alkali-resisting primer (5/1)
Soft board, bitumen-impregnated	Aluminium wood primer (3/2)	Not usually required
Wood chipboard	Solvent-borne wood primer (3/1) Primer-sealer (5/3) Water-borne primer (5/2) Aluminium wood primer (3/2)	Not usually required except possibly that solvent-borne primer (3/1, 3/2 or 5/3) is recommended for single layer boards (see 8.2.1.3) to prevent swelling of chips
Plasterboard	Primer-sealer (5/3) Water-borne primer (5/2)	Not usually required (see Note)
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 (5/2) Alkali-resisting primer (5/1)	Water-borne primer (5/2) Alkali-resisting primer (5/1)
Water-borne multi-colour finishes (7/14) are usually applied over a special base coat. NOTE Refer to the plasterboard manufacturer's recommendations on priming for use with water-borne finishes.		

Table 19 — Paint film defects arising during, or shortly after application

Ref	Defect name	Possible cause	Cure
1	Bleeding	Solvent or water reactive 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
2	Blooming, or milky appearance usually 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 re-coat
3	Ropiness (brush marks)	Poor flow of the paint, over brushing, rapid drying, etc.	Abrade and re-coat
4	Cissing (separation of paint film whilst wet)	Surface contamination, wax, grease, sometimes occurs when applying water-borne paint over poorly prepared oil-based paint	Remove as much contamination as possible, degrease, use a silicone digester, abrade and re-coat. Ensure application tool is also free from contamination
5	Sleepy gloss (low sheen)	Sinkage into substrate, due to incorrect or insufficient primer or undercoat, medium density fibre board paraffin wax contamination	For medium density fibre board, abrade and then apply acrylic primer conforming to BS 7956, then re-coat. Other surfaces may simply require re-coating
6	Flashing (halo effect where two edges of paint meet)	Losing the wet edge of the paint during application, trying to “touch up” areas, especially sheen paints, but can occur with all paints	Re-paint to the nearest whole elevation, ensuring the wet edge is maintained
7	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 re-coat
8	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 may require lining paper
9	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 may be required

Ref	Defect name	Possible cause	Cure
10	Wrinkling, rivelling, shrivelling	Application too thick, usually gloss paints, the paint layer skins over but remains wet underneath. Can also be caused by over coating before previous layer is dry	Allow affected areas to harden, abrade with wet and dry abrasive paper to smooth, and re-coat
11	Rain spotting (also known as pitting)	Rain/water attack during the drying phase	Wet abrade to smooth, re-coat
12	Bittiness	Contaminated paint, dusty atmosphere, substrate not clean, application tool not clean	Abrade, re-coat, ensure application tools are clean, strain the paint
13	Orange peel effect	Application by roller without laying the paint off with a brush (such as applying gloss to doors). Poor atomization when spraying	Wet abrade to smooth, re-coat using correct method and adjustment

Table 20 — Paint film defects arising after a period of exposure

Ref	Defect	Typical causes	Remedial treatment
1	Adhesion failure	a) 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 11.5.2) and any damaged substrate repaired (see 8.1.4.2). Biological growths should be removed (see 11.5.8). Where moisture is the cause, it should be ensured that the substrate is dry before repainting. See 8.1.3 in relation to sources of moisture in woodwork
		b) Failure to prepare or pre-treat nonferrous metals	Defective material should be removed. See 8.4.2 for preparation of non-ferrous metals
		c) Omission of primer or use of unsuitable primer	Defective material should be removed. Refer to appropriate substrate in Clause 8 for information on priming
		d) Application to powdery or friable substrates	Defective material should be removed. Application of a penetrating primer or sealer might be necessary (see 11.5.5)
		e) Application to hard, dense substrates, e.g. glass or glazed surfaces	Defective material should be removed. See 8.14 for subsequent preparatory treatment
		f) Apparent loss of adhesion on iron and steel, might be due to detachment of millscale	Removal of millscale, 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 millscale as it loosens, but this might extend over several repaints
2	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	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 8.1 in relation to sources of

Ref	Defect	Typical causes	Remedial treatment
		recommended differential permeability system. Resinous knots might also cause localized blistering	moisture in woodwork.) Blistering on resinous external woodwork might be influenced by choice of finishing colour
3	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; c) incorrect or unsuitable formulation	In 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 11.5.5)
4	Colour defects, e.g. fading, staining, bleeding, or other forms of discoloration	a) Some loss of colour of paint 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 manufacturer regarding selection of colours or types of finish for repainting
		b) Solvent-borne finishes tend to yellow in situations where direct daylight is excluded. This is more obvious with white and light-coloured finishes	Yellowing is not usually sufficiently marked to be significant. If freedom from yellowing is important, consult manufacturer for guidance on selection of oil-free coatings
		c) Apparent colour change might be due to masking of colour by surface chalking (item 3 of this table) to efflorescence (see 8.5.1.2) especially on external rendering or, on external plywood treated with wood stain, to diffusion of water-soluble salts contained in adhesives	Normal cleaning usually removes surface deposits. Efflorescence and diffusion of salts on plywood might recur until source is exhausted
		d) Failure of clear finishes on external woodwork might result in 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

Ref	Defect	Typical causes	Remedial treatment
		e) Constituents of the substrate or previous coatings can cause discoloration (see 8.5.1.5 and 11.5.9)	See 8.5.1.5 and 11.5.9
5	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 coatings over soft coatings. It might also be the initial stage in adhesion failure (item 1 of this table). 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
6	Damage to coating	a) Mechanical damage, e.g. by abrasion, impact or vigorous cleaning b) Graffiti	Where surfaces are subject to hard wear, specialist coatings might be required (see 4.6.4.6.2). Consideration should also be given to the use of wear-resistant materials, e.g. ceramic tiles or plastics, where practicable. In relation to graffiti, see 4.6.4.8
7	Gloss, loss of	Some loss of gloss is to be expected after lengthy exposure, especially externally, and might be the first stage in chalking (item 3 of this table). Where it occurs prematurely, possible causes are as described for premature chalking	Loss of gloss in the absence of other defects is not usually significant in relation to maintenance treatment
8	Biological growths, i.e. moulds, algae, lichen, moss, blue stain	See 4.6.4.4 and 11.5.8	See 4.6.4.4 and 111.5.8. Consider modifications to design or environment which might eliminate or reduce causes of failure
9	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 (see F.4.5 and Table 4)	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 8.3). 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

5 Organization of work

5.1 General

Where applicable, painting work should be planned in relation to the work of other trades (see 5.3), to ensure that surfaces are in a fit condition to be painted and that completed work is not damaged by subsequent building operations; in particular, time should be allowed for drying out of plaster and similar surfaces 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. In such circumstances, it might be necessary to erect temporary partitioning to isolate the areas where painting is in progress.

5.2 Health and safety

The recommendations of Annex B should be followed, concerning the manner of dealing with typical hazards to health and safety that might be encountered in the painting of buildings.

Information on the properties or constituents of coatings or other materials that affect health and safety should be obtained from the manufacturer or supplier and the precautions set out in their safety data sheets and container labels should be followed. All preservatives should be handled with care in accordance with the manufacturer's specific instructions. Potential health and safety hazards include but are not limited to the following:

a) inhalation, absorption through the skin or ingestion of toxic substances, including fumes, vapours and dusts;

b) injury to eyes and skin;

c) fire and explosion;

d) noise;

e) lack of personal hygiene.

5.3 Order of working

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 external surfaces or when painting is carried out from the scaffolding as it is struck. However, the determining factor is often weather or the time of year at which work is done.

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

5.4 Scaffolding and equipment

Scaffolding should be adequate in quantity and type to permit safe working and avoid delays. Hazards can be created by the use of unsuitable or defective scaffolding and the guidance should be followed. Equipment should be suitable for the type of work being undertaken and in good condition. Mechanical equipment, e.g. for spraying, should be of a capacity or rating appropriate to the work and should operate efficiently. Allowance should be made for the provision of temporary heating or drying equipment where necessary.

5.5 Supply of materials

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. Manufacture of materials not normally held in stock can take several weeks, and orders should be placed well in advance to avoid delay.

Usually, placing of orders for materials is the responsibility of the contractor, but early issue of painting schedules by specifiers reduces the risk of delay in supply that could cause work to be delayed.

5.6 Storage of materials

5.6.1 On large projects, facilities should be provided for the storage of materials, having regard to security, avoidance of hazards and maintenance of materials in good condition.

5.6.2 Some coatings, other than water-borne types, are flammable in the liquid state; precautions to prevent accidental ignition should be taken and emergency fire-fighting equipment provided. If the total quantity of flammable paints, etc. in storage exceeds 50 l at any one time, special provisions in should be taken avoid accidents.

5.6.3 Containers of highly flammable liquids (flash points below 32 °C), which include certain solvents and specialist coatings, usually carry a warning label but, in case of doubt, reference should be made to the manufacturer.

5.6.4 To maintain coatings 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. Attention should be paid to the storage of coatings containing volatile solvents, as temperatures exceeding 30 °C can create excessive pressure within containers and increases the risk of fire. Water-borne coatings should be protected from frost.

5.6.5 On contracts of long duration, 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. If batch numbers are missing or illegible, the containers should be marked with the date of receipt.

5.7 Protection of components on site

5.7.1 General

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 be protected against damage and soiling.

5.7.2 Joinery

Where possible, joinery, primed or unprimed, should not be kept in external storage, especially when it is to be installed in a centrally heated building. If external storage cannot be avoided, the components should be protected against moisture and other adverse climatic conditions. Components, whether stored indoors or outdoors, should not be in direct contact with the ground.

If stacking is necessary, spacers should be placed between the components to permit air circulation and, in the case of primed joinery, to prevent sticking at contact surfaces.

5.7.3 Metal components

Where possible, 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 external storage cannot be avoided they should be protected and stacked as described in 5.7.2.

5.7.4 Structural steel members

Primed structural steel members, if stored externally, should be stacked in such a manner that they do not retain water even if no cover is provided. The bottom layer in the stack should be laid on timber packings to raise it above the ground and the rainwater splash zone. Spacers should be placed between subsequent layers to permit air circulation and prevent sticking.

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.

5.8 Off-site work

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

5.9 Workforce and supervision

5.9.1 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. On extensive ceiling and wall areas, there should be a sufficient number of operatives to ensure working wet edges are maintained (see 9.3.2.3) and should take into account working conditions and the characteristics of the coatings to be applied.

5.9.2 Operatives should be skilled and experienced in the types of work involved and with the materials, methods and equipment to be used. With novel materials, methods or equipment, special training might be necessary.

5.9.3 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, or have ready access to, test equipment, e.g. moisture meters, film-thickness gauges and flow cups, when the nature of the work requires it.

5.10 Inspection procedures

Inspection procedures should be carried out in accordance with Clause 10, which may necessitate the sampling and testing of materials on a regular basis (see 5.11 and 10.3).

Note For large contracts, specific stages of the work might be subject to inspection and approval by a nominated person or specialist inspection organization to ensure compliance with the specification. Inspection does not remove or diminish the contractor's responsibility for proper supervision of the work.

5.11 Materials sampling and testing

The routine sampling and testing of materials should be carried out as described in Clause 10.

NOTE Sampling and testing procedures can be time-consuming and expensive and are effective only if they are properly implemented.

6 Exchange of information

6.1 General

Specifications and other documents needed in respect of initial or maintenance painting should be prepared in sufficient detail to afford proper guidance in the preparation of estimates and the execution of the work.

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 affect or be affected by painting.

A painting project can involve several parties, including 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.

6.2 Specification

6.2.1 General

A specification should be clear, concise and unambiguous. 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;

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

6.2.2 Surface preparation

For initial and factory painting, many substrates will benefit from specific surface treatments and preparation, which should be discussed with the coating 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 (see 11.5.2.1). 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 (see 8.3.4.2.4), the choice lies between selecting a more effective method or accepting a lower standard of preparation which will lead to a shorter life expectancy for the coating system.

6.2.3 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, a check should be made to ensure they are compatible (see 7.3.5). Materials should be used strictly in accordance with the manufacturer's instructions, including guidance on whether thinning is permissible (see F.3.1). 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 (see also 6.4).

6.2.4 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 (see 9.1 and 11.4).

6.2.5 Inspection procedure

Where the work is to be subject to inspection, the intended inspection procedure should be described in the specification (see 5.10).

6.3 Bills of quantities

Bills of quantities should be prepared in accordance with a document such as Code of procedure for the measurement of building work SMM7 measurement code [14]. It is essential that the relevant edition, or any other method of measurement adopted, is stated.

6.4 Schedules

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.

6.5 Drawings

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

6.6 Records

Painting and decorating work is usually carried out at regular intervals as a part of an overall maintenance schedule and so a planned approach is essential. Planning is dependent on availability of information, and therefore, where expenditure on maintenance painting is significant, accurate records should be maintained.

The essential information to be recorded includes dimensions, details of initial and maintenance coating systems (including preparation) and costs. 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, as recommended in Clause 11, any observations should be recorded. 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.

7 Materials

7.1 Functions of coatings

7.1.1 General

In situations where the requirements of coating systems are specialized, the advice of a consultant or experienced paint manufacturer should be sought.

7.1.2 Protection by coating systems

The level of protection the 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, especially its thickness, and the severity of attack. Where possible, particularly in severe conditions, consideration should be 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 (see 4.6.2).

7.1.3 Decoration

Even where the main emphasis is on protection or some other function, coatings should 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 and should be selected in accordance with the overall design specification.

7.1.4 Hygiene

Where specified, the coating should have the ability to withstand regular cleaning; where high standards of hygiene or sterile conditions have to be maintained, this might be the most important function. The coating should 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, coatings having anti- microbial properties can be helpful, although too much reliance should not be placed on the ability of coatings alone to prevent mould or bacterial growth and, where possible, they should be supplemented by other measures as described in 4.6.4.4.

7.1.5 Special functions

The coatings should be selected so that they are appropriate to the conditions of their use, e.g. of resistance to high humidity or direct chemical attack, reduction of fire hazard including surface spread of flame and inhibition of mould or bacterial growth (see 4.6.4).

7.2 General properties of coatings

7.2.1 General

Most of the coatings 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 will have a direct influence on the application properties, flow and the final film thickness of the dry film. Coatings should therefore be selected according to the exposure conditions in which they are to be used

7.2.2 Viscosity

For most coatings, 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 thixotropic and other Theological effects (see 7.2.3).

7.2.3 Flow

Although good flow is a desirable attribute in a finish, excessive flow can make the material difficult to control hi application and cause running and sagging, therefore, flow properties should be determined before work commences. Coatings with good flow tend to recede from external angles and sharp edges, reducing the thickness and protective value of the film at these points. In these circumstances primers and undercoats should be used as they are usually formulated to flow less freely than finishes.

NOTE The consequences of poor flow are uneven film thickness such as with thin areas (e.g. brush-marks, spray mottle) that are below the average film thickness. These will confer less protection to the substrate. Poor flow will also adversely affect the reflectance properties and in gloss paint show poor distinctness of image.

7.2.4 Film thickness

NOTE 1 Film thickness is determined essentially by the proportion of non-volatile solids (e.g. pigment or resin) present in the coating and its flow characteristics.

The method of application should be considered as it can affect film thickness (see 9.3), and the protective properties of a coating are generally in direct proportion to its film thickness which can also influence the filling and levelling properties.

NOTE 2 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 coatings have a build determined by the application and other characteristics. For most general purpose building paints, this should be in the order of 20 um to 35 um per coat dry film thickness. Some special purpose coatings, such as low-build wood stains or two-pack pre-treatment primers, should have dry film thicknesses of 10 um or less. In addition, depending on type, high-build coatings can yield films in the range 60 um to 3 mm (e.g. textured masonry paints), although 100 um to 250 are more typical.

7.3 Components of coating systems

7.3.1 General

A coating system comprises at least two coats either of the same material or a sequence of coats of differing type (e.g. primer, undercoat, finish, as described in 7.3.2 to 7.3.4). Coats should be selected according to the type of surface to which it will be applied and the nature and function of the coating required. Where the coating system provides a protective function, more than two coats might be required. Where the coating system consists of a sequence of coats of differing type, the compatibility of the individual coats (see 7.3.5) should be taken into account in the selection of coats.

7.3.2 Primers and sealers

An essential function of a primer is to secure good adhesion to the surface to which it is applied and, in turn, to provide a base to which the succeeding coats will adhere; other functions might include:

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

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

c) the inhibition of corrosion on metal, especially iron and steel;

d) a reduction of 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) the provision of protection 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.

NOTE 1 Sealer is a term often loosely applied to coatings 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.

Examples include:

- aluminium-pigmented primers that can be used as wood primers and also as sealers for bituminous surfaces other than wood (see 8.15);
- primer-sealers for powdery or friable surfaces (see 11.5.5) or for plaster and similar surfaces of high or variable porosity (see 8.6.2.4);

— protective coatings, usually unpigmented, e.g. clear sealers for metal sprayed steel (see 8.4-1.2) and some multi- coloured finishes (see Table 7).

NOTE 2 Well-thinned first coats of water-borne paint might be needed on plaster of high or variable porosity (see 8.6.2.4). These are sometimes referred to as sealing or mist coats.

7.3.3 Undercoats

The essential function of undercoats is to provide a uniformly opaque base of a colour appropriate to that of the finish, but they also contribute to the thickness, filling properties and cohesion of the paint system.

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

NOTE Some manufacturers may restrict the use of general purpose undercoats to interior use, and will have more specific proprietary materials for external use.

7.3.4 Finishes

The finish is the final coat in the system and should be selected to provide the required colour, degree of gloss, texture or other attributes, including resistance to weather, chemical attack and mechanical damage. In this respect, the finish is the most important coat in the system since its appearance and performance in service are frequently the criteria by which the coating system as a whole is judged. However, the finish should not be used to compensate for deficiencies in preceding coats in the system, whether these relate to quality, suitability or application.

7.3.5 Compatibility of coatings

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 coatings 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.

NOTE For example, a coating based on a solution binder (see F.2.5) might be unsuitable for use over a drying-oil/resin type coating, because its solvents can soften or disrupt the latter, although no problem might arise if the sequence of coats is reversed. Similarly, application of a hard coating over a softer one can result in cracking of the composite film while application of the softer coating over the harder one can be satisfactory.

Compatibility problems are less likely to arise with systems comprising coatings of similar composition and properties but, even with these, slight variations in the same types of coatings from different manufacturers can adversely affect the performance of the system. It is advisable, therefore, to ensure that all the coatings in a system are from the same manufacturer and are used in accordance with the manufacturer's recommendations regarding the sequence and number of coats.

7.4 Ancillary materials

7.4.1 Cleaning agents

Surface cleanliness is essential to the performance of coating systems. Detergent solutions or sugar soap 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, proprietary solvent-emulsion cleaners should be used (see 11.5.3).

7.4.2 Sterilizing washes

Surfaces contaminated with mould or algal growths should be treated before coatings are applied. Household bleach solutions are often effective in killing the growths but, in severe cases, proprietary mould-inhibitive washes provide a measure of protection against their reappearance (see 11.5.8). All residues, including chemicals and dead mould/algal spores should be completely removed prior to applying the coating system.

7.4.3 Knotting

Sealers should be used to hold back resin, tannin and other stains, which could discolour wood coatings on some wood species (see 8.1.1). The problem is most acute with white water-borne finishes.

NOTE The most common problems are associated with knots in the wood. Traditional sealers based on shellac solutions are known as knotting.

Where knotting is used to retard discoloration of light-coloured opaque finishes, a quick-drying solution 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.

7.4.4 Stoppers and fillers

7.4.4.1 General

The distinction between stoppers and fillers has become less clear-cut with the widespread use of proprietary materials, many of which, although described as fillers, are used for both purposes. More meaningfully, the materials might be categorized as stoppers, general purpose stoppers/fillers and surface fillers. Methods of stopping and filling are described in 9.2.4.

7.4.4.2 General purpose stoppers/fillers

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

a) 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.

b) Water-borne fillers. These are usually based on vinyl or acrylic resin dispersions and are supplied in paste form, ready for use. Materials of this type vary considerably in characteristics and usage.

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 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 it is essential to use a grade supplied specifically for use on wood.

7.4.4.3 Surface fillers

Surface fillers formulated specifically for use on timber are preferred to the general purpose types 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. The types in general use are water-borne, but solvent-borne formulations are also available.

7.4.5 Mastics and sealants

Mastics and sealants are mainly used for the repair or replacement of external pointing between window or doorframes 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.

7.4.6 Water repellants

Water repellent solutions should be used when rain penetration of walls has caused internal dampness.

8 Substrates and coating systems

NOTE 1 Although concerned essentially with new work, surfaces that might not have been painted initially, such as external masonry or non-ferrous metal, come within the scope of this clause. Maintenance treatment is described in Clause 11, but much of the information given here is relevant.

NOTE 2 The coatings referred to in this clause are generally those of conventional type, as defined in A.2 and described in Tables 12 to 18, but 4.6.4 describes some functions and situations for which specialist coatings (see A.3 and Table 10) or modified conventional coatings might be necessary.

8.1 Wood

8.1.1 Extractive

8.1.1.1 General

The potential for extractives to cause problems should be taken into account during the preparation of wood for coating. Wood material contains typically 5% to 20% of soluble material (see F.2.5). Extractives confer desirable properties such as durability and colour to wood, but they may also disrupt or discolour surface coatings.
Extractives are manifested both as resins and in the form of soluble staining chemicals such as tannin. Knots often contain a disproportional 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 knot treatment or use of a purpose-designed stain-blocking primer (see also 7.4.3 and C.2.8).

8.1.1.2 Resinous and oily materials

Some hardwoods (e.g. gurjun, keruing and agba), and occasionally resinous pines (see C.2.5) 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 the sun. In such situations, dark coloured paints should be avoided.

Other woods, such as teak and some cedars, contain oil, which can impair the drying, hardening or adhesion of coatings. These woods should be washed down with methylated spirits immediately before priming or varnishing. However, they can usually be painted satisfactorily if an aluminium primer (3/5) is used.

8.1.1.3 Tannin and other extractives

Some species, notably Western red cedar and sequioa among the softwoods, and among hardwoods oak and chestnut, 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. Contact with steel tools should be minimized, non-ferrous fixings should be used, and under no circumstances should smoothing be carried out using steel wool.

8.1.2 Moisture content

Wood should be painted or varnished when its moisture content is near to that at which it will stabilize in service, generally 15 % to 19 %, but lower in buildings which are heated continuously, typically 9 % to 11 %.

NOTE Excessively dry timber swells as it takes up moisture (see C.2.3), imposing stresses on the coating; damp timber 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 damp timber.

8.1.3 Penetration of binder

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 under bound or weakened.

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

Ease of penetration of liquid (see C.2.4) should be taken into account before using preservative treatment

8.1.4 External influences

8.1.4.1 Moisture

The water-excluding efficiency of a wood coating is an important property that determines the extent of dimensional movement of coated wood in service, as well as influencing the risk of fungal decay. It should therefore be taken into account when selecting or specifying wood-coatings.

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. Coatings should be selected that relate to the expected end-use category. Thus highly permeably wood stains are suitable for fencing where free movement is acceptable. A less permeable coating is required for window joinery where movement should be controlled. For cladding an intermediate level of permeability is acceptable.

Moisture could gain entry through open joints, defective putties and sealants, and 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. Components that have their end grains sealed during manufacture should be selected where the reduction of wetting and the improvement in coating performance is desirable.

Moisture movement places a cyclic strain on the coating system that may eventually result in cracking. Some coating formulations offer higher film flexibility and should be used where good exterior durability is necessary. The use of such coating in no way reduces the need for good design and an appropriate preservative treatment should still be used.

8.1.4.2 Weathering

NOTE 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.

If it is desired to preserve the natural appearance of external woodwork, protective surface treatment is essential (see Table 9). Denatured wood should be removed back to a sound wood surface before application of a coating as weather-degraded wood is a very poor substrate. Even when wood is not obviously degraded, the paint holding properties could be severely compromised. Wood should therefore be protected from the elements, and for exterior exposure, will benefit from a penetrating treatment as the first coat of any coating system.

Solar heat gain causes shrinkage of wood and consequent cracking and opening of joints; it can also increase resin exudation, resulting in discoloration and disruption of coatings. Dark finishes should be avoided as they exacerbate this.

8.1.4.3 Fungal attack

NOTE 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 the 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 moderately durable species or better, but this classification applies only to the heartwood; all sapwood is vulnerable to decay.

Where timbers of a lower durability rating are used, or if appreciable quantities of sapwood are present, application of a preservative, where practicable by impregnation, should be undertaken to prevent fungal attack

8.1.5 Preservative treatments

Provided adequate drying of the treated wood is allowed prior to painting, preservation will not give rise to any adverse effects on paint performance. Preservative treatment of timber according to species, end use and desired service life should be in accordance with BS 8417 and BS 5589. The treatment of components, e.g. window joinery, which are to be subsequently coated should be as follows.

a) Treatments for window joinery and other external building timbers not in ground contact:

   1) Copper-based preservative formulations which are chromium and arsenic free can be used, but the long term performance of these formulations is not fully established by field trials.

   2) Organic solvent and micro-emulsion preservatives, e.g. conforming to BS 5707 and water-repellent types, containing waxes or resins, suitable for painting, can be used. These types of preservatives can be applied by immersion or the double vacuum process as specified in BS 5707. Application by brushing or spraying is not recommended except for site treatment of cut ends etc., or in remedial work. These preservatives are generally suitable for over- painting provided a minimum of 48 h in conditions of good ventilation is allowed for evaporation of solvent, but users should satisfy themselves as to the compatibility of the particular treatment with the coating system to be applied.

   3) Diffusion treatment with disodium octoborate . This treatment can be carried out on freshly felled timber and can be applied to seasoned timber. The salts remain water-soluble and can affect coatings if the timber becomes wet although, in practice, few difficulties appear to arise.

b) Treatments for fencing and gates in or out of ground contact:

Application of preservatives by brush is a less effective means of conferring resistance to biological attack than impregnation, because penetration of the fluid is limited and the protective zone relatively shallow. Nevertheless brush application should be used for treatment of component repairs prior to painting, and also in conferring resistance to blue stain disfigurement of paints and stains. Clear preservative primers are available, usually of solvent-borne type, 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.

Preservatives are also a useful adjunct in prior-to-painting repairs on external timber components. After remedy of defective timber using resin repair or traditional methods of timber inserts, wood which is sound but deemed to be vulnerable to decay should be protected by the insertion of preservative plugs to provide a latent reserve of fungicide.

8.1.6 Surface preparation, priming, stopping and filling

8.1.6.1 General

The moisture content of the timber should be measured before painting and should not exceed the expected equilibrium value (see 8.1.2). 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.

NOTE 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 octoborate.

If there is a delay between delivery to site and fixing or erecting of joinery, it should be protected against ingress of moisture (see 5.7).

If limber has received preservative treatment, time should be allowed for drying out or evaporation of solvent before priming (see 8.1.4).

8.1.6.2 Surface preparation

8.1.6.2.1 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.

8.1.6.2.2 Cleaning

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. If the surface is contaminated with oil or grease, solvent cleaning may be necessary (see 7.4.1).

8.1.6.2.3 Abrasion

Where necessary, abrasion should be used to clean the surface, reduce roughness and improve paint adhesion.

Wood can be sanded mechanically or manually using traditional glass paper or one of the more modern abrasive pads with incorporated grits. It is essential to use a grade of abrasive paper appropriate to the surface; 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 not to damage moulding and arris edges.

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

Surface preparation is particularly important for weather-degraded wood, and is best achieved by planing or mechanical sanding. An effective alternative is scraping the wetted denatured surface, followed when dry by thorough abrasion, and the application of a transparent preservative primer (e.g. 3/6).

8.1.6.2.4 Knot treatment

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 (see 8.1.5 and C.2.7). Discoloration may be minimized by the application of a knot treatment, e.g. knotting (see 7.4.3). Heavy applications and the use of knotting which has thickened through evaporation of solvent should be avoided; otherwise paint adhesion can be impaired. Knotting should not be used if finishing with semi-transparent wood stains.

In severe instances of resin exudation from knots, the knot may be removed by drilling, followed by filling of the hole.

8.1.6.3 Priming

Note Primers for wood are listed and described in Table 3, and typical applications are indicated in Table 12 and Table 13.

A good primer, applied to dry sound substrates, is the foundation of a durable paint system. Using components primed in the factory or works is recommended but 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 (see 8.1.2). Although single coats of primer retard surface degradation by sunlight (see 8.1.4.2), they provide only limited protection against moisture, (especially if the wood has not been treated with a water-repellent preservative) and therefore the full system should be applied as soon as possible. Primed joinery, if not fixed or erected immediately, should be properly stored (see 5.7).

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

8.1.6.4 Stopping and filling

Note Materials used for stopping and filling are described in 7.4.4 and the techniques are described in 9.2.4.

Drying-oil/resin stoppers and fillers should be used only on primed surfaces; otherwise oil is absorbed leaving the material underbound.

8.1.7 Coating systems for interior use

NOTE For information on coating systems for interior wood, see Table 8 and Table 12.

8.1.7.1 Solvent-borne paints

Internal use of solvent-borne paints should be restricted because of increasing environmental and legislative pressures aimed at eliminating health risks to painters and reducing volatile organic compounds (VOCs).

Note: The traditional solvent-borne system consists of three-coat application: primer, undercoat and gloss finish. However, mid-sheen and matt finish solvent-borne paints are sometimes applied coat-on-coat, or as two coats over the primed wood.

If it is necessary to capitalize on the speed of drying of the water-borne systems, water-borne primers and primer/undercoats should be employed under the final gloss finish.

8.1.7.2 Water-borne paints

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 water-borne paints, bare wood knots should be sealed to reduce the risk of tannin staining (see 8.1.1.1).

8.1.8 Coating systems for exterior use

Note: For information on coating systems for exterior wood, see Table 9 and Table 13.

8.1.8.1 General

Coating systems for exterior use should provide a flexible weather-resistant coating that maintains its integrity and protective effectiveness in the long term.

8.1.8.2 Paint systems

8.1.8.2.1 Solvent-borne exterior paints

NOTE Solvent-borne exterior paints are generally based on flexible alkyd resins and are available in a range of sheen levels. They generally adopt the traditional system approach of primer, undercoat and gloss, though in some low-sheen materials one product is applied in two coats over a primer, or even as three coats on bare wood. Solvent-borne exterior alkyd paints possess superior durability to general-purpose alkyds, but nevertheless lose flexibility during weathering. Solvent-borne exterior paints can be used over water-borne primers (see BS 7956).

Solvent-borne exterior paints should be used when a high quality appearance and a more tolerant application under adverse weather conditions is necessary.

8.1.8.2.2 Water-borne paints

NOTE 1 Water-borne paints possess a range of application benefits associated with the use of water as solvent-carrier, for example low-odour, low-VOC content, ease of clean-up and non-flammability.

Water-borne paints can be formulated to give high performance coatings for exterior wood and should be applied at a spreading rate in accordance with the manufacturer's recommendations to provide appropriate film thickness and so ensure long-term durability. Water-borne paints offer less resistance to being over-brushed and minimum film thicknesses should be specified.

NOTE 2 Initial gloss and flow properties of water-borne paints are presently inferior to those of solvent-borne alkyds. Cold, damp exterior conditions can affect the application of these products.

8.1.8.3 Solvent-borne and water-borne exterior wood stains

Clear varnishes (9/1, 9/2) perform very poorly on exterior wood in exposed situations and should not be used unless frequent maintenance is acceptable. Exterior high-build wood stains should be used on exterior wood as they contain resinous binders to resist moisture movement, pigments and ultraviolet absorbers to protect against degradation by sunlight, and often biocides to protect against fungal discoloration.

NOTE Modern exterior wood stains can be of solvent-borne or water-borne type, and are carefully formulated compositions designed to provide comprehensive protection to the wood under demanding conditions.

Low-build exterior wood stains should not be used for components such as exterior joinery where dimensional control is important (see 8.1.4).

Low-build stains should be used on components for which dimensional movement is to be expected, such as cladding, bargeboards, gates, fences, etc., and which often have a sawn finish.

NOTE The moisture permeability of the wood stain is unlikely to give rise to problems, though cladding which has been poorly fixed (without a movement allowance) or installed at an inappropriate moisture content can distort.

It is essential that maintenance of medium-build wood stains 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.

8.1.9 Flame-retardant treatments

8.1.9.1 General

Materials, either surface or impregnation treated, should be kiln dried to a maximum moisture content of 12% before application of a decorative coating system. It is important that the surface of the treated material is clean and dust free. Chemical or other surface deposits should be removed by light sanding.

Treated materials can be painted with clear, pigmented and opaque products, using conventional methods of application, but the manufacturer's recommendations should be observed. It is essential to establish that any coatings do not adversely affect the spread of flame characteristics or the treated materials.

Highly flammable coatings such as nitro-cellulose-based lacquers that can contribute to the risk of flame spread, should not be used.

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

8.1.9.2 Inorganic flame retardants

Inorganic flame-retardant treated materials should be protected at all tunes from the elements, both at the treatment plant and on site.

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

Providing these recommendations are followed, the presence of the flame-retardant chemicals in the wood should not affect the performance of the paint film hi dry exposure conditions.

8.1.9.3 Resin-based flame retardants

Resin-based flame retardants should be kiln dried after treatment, to cure the chemical within the timber.
Note: Resin-based flame retardants can be used externally or can be subjected to high humidity and under these conditions there is no loss of flame retardance or paint film integrity.

8.2 Wood-based panels products

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

8.2.1 Characteristics

8.2.1.1 Plywood

Plywood for external use is manufactured with weatherproof adhesive but not necessarily with durable species of timber throughout; if non-durable species are incorporated, preservative treatment should be applied (see 8.1.5).

The outer layers of plywood exposed to weather are prone to develop checking (fine surface cracks, defined in BS 2015) running parallel to the grain, even when painted. 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 (see 8.1.8.3), 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 should be washed off but will reappear until they are depleted.

8.2.1.2 Fibre building board, wood chipboard and plasterboard

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

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, sealer or surfacer on one or both faces should be selected.

NOTE C.3.1.2 describes the four main types and the typical treatment of fibre building board.

8.2.1.3 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 should be installed in accordance with manufacturer's recommendations regarding design detailing and fixing methods.

NOTE Preservative treatment, as recommended for wood in 8.1.5, is not usually suitable for wood chipboard.

The natural surface of chipboard varies according to the method of spreading the chips during manufacture. If the surface has a coarse or open texture, it should be filled before painting to obtain a satisfactory finish. Some methods produce a surface of finer texture requiring little or no filling before painting.

8.2.2 Preparation and coating systems

8.2.2.1 Surface preparation

Knots are rarely a problem on good-quality plywood, but any present should be treated with knotting before painting (see 8.1.6.2.4).

Except with the more open-surface grades of wood chipboard (see 8.2.1.3), 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.

Wood-wool 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).

8.2.2.2 Stopping and filling

If checking has occurred on external plywood and it is to be painted, it should be filled after pruning. 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.
Water-mixed stoppers and fillers can be used on either primed or unprimed surfaces. On unprimed surfaces and on factory-pruned or sealed boards, 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. If a water-mixed material is used for stopping-up after priming or on factory-pruned or sealed boards, it might be necessary to touch-in the stopping with primer to ensure a surface of uniform absorption. Drying-ou/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: Direct application of water-mixed fillers causes swelling of the wood chips; with drying-oil/resin fillers, the binder is absorbed.

8.2.2.3 Priming

NOTE Primers for painting plywood are as described for wood in Table 3. Table 1 gives general guidance on the selection of primers.

Varnish and wood stains are usually applied direct, but thinning of first coats might be necessary and the manufacturer's recommendations should be followed.

If not primed or sealed during manufacture, building boards should be primed before application of solvent-borne (e.g. alkyd) paint systems. Normal practice is to use primers of the types employed for wood or plaster (Table 3 and Table 5), but any specific recommendations of board or paint manufacturers should be followed.

Except as indicated in Table 18, priming is not usually needed when water-borne coatings are to be applied to building boards. Priming of boards that have received flame-retardant treatment [see C.3.1.2, 4)] is recommended to prevent efflorescence or discoloration caused by reaction between water-borne coatings and chemicals used in the treatment. 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.

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

Traditional practice, especially with fibre building boards, is to prime or paint (back-prime) unexposed faces of boards 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.

8.2.2.4 Finishing of internal work

The types of coating systems indicated in 8.5.2 and 8.5.3 as suitable for use on plaster, should also be used on building boards.

8.2.2.5 Finishing of external work

NOTE 1 Coatings suitable for use on plywood are shown in Table 5 and Table 7.

When installed in accordance with the supplier's recommendations, some types of hardboard and medium board 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 8.5.3 as suitable for external surfaces should be used.

NOTE 2 Typical coating systems for externally sited boards are indicated in Table 13.

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

8.3 Iron and steel

8.3.1 General

The painting of the ferrous metal surfaces normally encountered in buildings, in moderate external and internal exposure conditions (see Table 2) may be undertaken using paints of conventional type. For a more comprehensive treatment of iron and steel, especially in situations where the exposure conditions are classified as severe, the areas are extensive or long-life painting systems are required, the painting should be in accordance with KS ISO 12944 for steel structures (and BS 5493 for iron structures).

NOTE 1 Non-ferrous metals, notably zinc and aluminium, are frequently used as protective coatings on iron and steel, either alone or in conjunction with paints. Painting systems for metallic coatings are described in 8.4.

NOTE 2 For further information on iron and steel, see Annex H.

8.3.2 Characteristics

8.3.2.1 Mild steel

Hot-rolled mild steel bears a layer of millscale. Shedding of this millscale occurs before the steel has been painted, giving differences in electrical potential between the exposed surface and the surrounding adherent scale, corrosion cells can be created and result in severe attack on the bare steel. If the scale becomes detached after painting is completed, costly preparation and repainting is necessary. Millscale should be removed as described in 8.3.4 before the steel is painted; it is essential that this be done if high-durability or specialist coatings are to be applied.

8.3.2.2 Stainless steel

If painting of stainless steel is necessary, surfaces should be abraded and degreased before application of a pre-treatment primer.

NOTE Proprietary systems are available for application to stainless steel (see Table 15).

8.3.3 Design considerations

The effectiveness of paints in protecting iron and steel can be increased, and the risks of corrosion diminished, by good design.

KS ISO 12944-3 and BS 5493 give detailed guidance on designing for the prevention of corrosion, but the following aspects should be applied.

a) All surfaces of exposed metal that need regular maintenance painting should be fully accessible. Surfaces such as back-to-back angle-iron trusses should be 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, should be spaced from walls far enough to admit a paintbrush or paint glove.

b) Drainage of trough sections should be arranged, e.g. by drilling holes, to prevent retention of water. This is especially important in salt-laden atmospheres. Water traps should be avoided where steel stanchions enter the ground or are embedded in a concrete base. Measures should be taken to prevent discharge of waste steam and liquids on to steelwork.

c) Sharp, internal angles, crevices and cavities should be avoided or, if unavoidable, should be filled with weld metal or mastic.

d) Electrochemical corrosion can occur at contact surfaces between dissimilar metals in the presence of an electrolyte, e.g. rainwater. If possible, direct contact should be prevented by measures such as placing plastic sheets between the contact surfaces or applying thick bituminous coatings to them. Alternatively, electrolyte should be excluded by making joints watertight and applying an impermeable coating.

NOTE Rainwater run-off from copper to steel could also cause corrosion.

8.3.4 Surface preparation and priming

8.3.4.1 General

The effectiveness with which millscale and rust are removed depends upon the method employed; the methods in general use are described in 8.3.4.2.1 to 8.3.4.2.5. Removal of oil, grease and dirt is also important. If iron and steel have 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.

The effectiveness of coating systems in protecting iron and steel is dependent upon the following factors.

a) The nature and thoroughness of the preparatory method. The millscale and rust should be thoroughly removed to allow for an effective paint system to be applied. Preparatory methods are described in 8.3.4.2.

b) The type of primer used. Generally, primers for iron and steel should contain corrosion-inhibitive pigments (see F.4.5). The choice of primer is influenced by the preparatory method employed (see 8.3.4.2).

c) 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 (see Table 2). The minimum film thickness for satisfactory protection in moderate external exposure conditions is approximately 125 um but films of 250 um or more might be required in severe exposure conditions.

Whenever possible, steelwork should be prepared and primed off-site; this usually compares favourably in cost and effectiveness with site treatment. When practicable, it is advantageous to apply off-site one or more of the subsequent coats in the coating system, although this might result in divided responsibility for the work.

8.3.4.2 Surface preparation

8.3.4.2.1 Abrasive blasting

Note 1 This involves directing a stream of metal shot, grit or other abrasive particles at high velocity against the surface of the steel. The abrasive particles are propelled by compressed air or high-pressure water (or a combination of the two) or thrown by centrifugal force from an impeller wheel. For some purposes, high-pressure water without abrasive particles can be used.

Abrasive blasting is the most effective method of preparing steelwork for painting and is essential when specialist coatings 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.

In addition to its effectiveness in removing rust and millscale, abrasive blasting provides a roughened surface which improves paint adhesion. Excessive roughening, however, including the use of abrasive particles which are too coarse for the intended thickness of paint to be applied, can produce peaks which protrude through the paint film and form focal points for corrosion.
Abrasive blasted surfaces are extremely vulnerable to corrosion (flash rusting) and should be primed as soon as possible and in any case within 4 h of cleaning, (see 8.3.4.3).

8.3.4.2.2 Acid-pickling

Acid-pickling is a factory process involving immersion of iron and steel in hot acid solutions to remove millscale and rust but might not provide a satisfactory base for some specialist coatings and therefore the coating manufacturer should be referred to for advice.

For site treatment of steelwork, proprietary washes and pastes, usually based on phosphoric acid should be used. They 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 to not require washing-off, the manufacturer's recommendations should be followed.

8.3.4.2.3 Flame-cleaning

Flame cleaning is not recommended and is more suitable for use in maintenance painting than in the initial treatment of new steel. It does not remove all rust and scale and should in no way substitute for abrasive blasting. It should not be used on thin sheets or on sections less than about 0.5 mm in thickness because of the risk of distortion, or on steel which has been coated with non-ferrous metals such as zinc and cadmium. Flame-cleaning might not provide a satisfactory base for some specialist coatings.Flame-cleaned steel should be primed while it is still dry and warm but not hot.

8.3.4.2.4 Manual preparation

NOTE 1 Manual preparation includes the preparation of iron and steel using hand or powered tools such as wire brushes, chipping hammers, chisels, scrapers and vibratory-needle guns.

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 does not provide a satisfactory base for specialist coatings and therefore especially formulated coatings, which are tolerant of poorly prepared surfaces, should be used.

Manual preparation, whether with hand or power tools, is laborious and it is difficult to maintain a uniform standard for any length of time. Power tools usually give 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 burnished areas to which paint adhesion is poor.
Weathering should not be employed as an alternative to more effective methods, such as abrasive blasting, in situations where complete removal of rust and scale is essential.

NOTE 2 Reliance is often placed on weathering (i.e. exposure to the elements) to loosen millscale sufficiently to permit its removal by manual cleaning. However, weathering to the point where all the millscale has loosened can take many months, and it is rarely practicable to allow time for this. It is also unlikely that all the surfaces weather at the same rate, thus making it impossible to prepare the surface to a uniform standard. Also, in chemically polluted and marine atmospheres, lengthy exposure results in contamination of the surface and increased risk of corrosion.

8.3.4.2.5 Removal of oil, grease and surface deposits

In factory processes, oil and grease should be removed with hot alkali solutions, solvent emulsions or solvents, followed by thorough rinsing with water, or by steam cleaning or high-pressure water jets. Where possible, these methods should be used on site, but often all that can be done is to wipe the surface with a proprietary cleaning agent and a succession of clean swabs, taking care to avoid spreading the oil or grease over the surface.

Surfaces which are contaminated following exposure in marine or chemically charged 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.

8.3.4.3 Priming

NOTE 1 Table 4 lists and describes the primers for iron and steel in general use in conjunction with undercoats and finishes of conventional use. Typical applications are shown in Table 14.

Zinc-rich epoxy primers (4/8) can be over coated with most other coating types, including most specialist coatings. Advice should be sought from the coating manufacturer when drying-oil/resin coatings are to be used over zinc-rich primers.

Primers for iron and steel should be selected according to the type and standard of surface preparation and the conditions of exposure, including the time that is likely to elapse between pruning and completion of painting.

Abrasive blasting provides a satisfactory base for all types of primers. When less effective methods are employed, notably manual cleaning, more tolerant primers, e.g. 4/5, 4/8, or 4/10, should be used.

NOTE 2 When steelwork is blast-cleaned in the factory it is usual to combine this treatment with application of a prefabrication primer, e.g. a zinc-rich epoxy type (4/8).

It is essential that priming 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 should follow preferably within 1 h and certainly within 4 h; if it is likely to be delayed beyond this, a temporary protective or holding primer, e.g. 4/1 or 4/2, 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 has to afford some protection to the surface. Most prefabrication primers and the tolerant types (see Table 4) can be left uncoated for a maximum of about 9 months depending upon the conditions of exposure and the effectiveness of the preparatory work. Other types of primers (including surface tolerant primers, i.e. 4/10, can be equally effective, but the manufacturer should be consulted on this aspect.

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.

Oil, grease and surface deposits should be removed from primed surfaces as described in 8.3.4.2.5. Removal of salt deposits by washing from surfaces pruned with zinc-rich primers is especially important as the corrosion products formed by reaction between the salts and the zinc can affect the performance of subsequent coats.

With a single coat of primer, it is difficult to obtain films of uniform thickness and free from pinholes, the points at which corrosion starts. In all but mild interior exposure conditions, two coats of primer should be applied. However, where application of two coats cannot extend to the whole of the surface, a second coat should be applied to vulnerable points, e.g. along external angles and to bolts and rivet heads (stripe coating). When a factory-applied prefabrication primer has been used and a paint system of conventional type is to be applied, the second coat should be either a zinc phosphate (4/5), chromate (4/8) or water-borne acrylic (4/9) or a two pack surface tolerant primer (4/10).

8.3.4.4 Coating systems for interior and exterior use

8.3.4.4.1 General surfaces

The number and type of coats applied after priming is determined by the protection and appearance requirements as well as by the properties of the individual coatings. Generally, the combined thickness of priming and finishes should be a minimum of approximately 125 µm for good protection in moderate exterior exposure conditions; any significant increase or decrease affects the protective properties and life expectancy of the coating proportionately.Alkyd finish systems of adequate thickness afford good protection in mild exposure conditions and offer a wide choice of colour. For exterior surfaces, gloss finishes should generally be used.

NOTE 1 Aluminium paints (7/6), although giving rather thin films, have good protective properties and provide an economical finish for steel. They are also suitable for use on heated surfaces (see 8.3.4.4.2).

NOTE 2 Micaceous iron oxide (MIO) paints (7/7) provide good protection and are widely used in situations where the limited range of colours in which they are available is not a disadvantage. However, they can be overcoated with compatible gloss finishes (with the manufacturer's approval). MIO paints of normal type provide films of substantial thickness, and there are also high-build types, usually applied by airless spray, giving films of even greater thickness.

Bituminous and tar paints (see Table 10), if applied in thick films, provide good protection against fresh and salt water and some chemicals in situations where colour is not a requirement. When exposed to direct sunlight, they craze and chalk and should therefore be overcoated with bituminous aluminium paint. Generally, bituminous and tar paints should be applied over an inhibitive primer. The inhibitive primer should be allowed to harden (this can take several weeks) or a specially formulated primer should be used, as the solvents in some types of bituminous and tar paints can cause softening and lifting of the primer.

NOTE 3 Table 14 indicates some typical coating systems for iron and steel in moderate exterior and interior exposure conditions.

Specialist coatings, often in conjunction with metallic coatings, are usually necessary for severe conditions or where life expectancies in excess of those shown in Table 14 are required; in these circumstances, reference should be made to ISO 12944-5 and BS 5493.

8.3.4.4.2 Heated surfaces

In addition to providing protection, paint systems applied to flues, chimneys, radiators, heating panels and other heated surfaces should have the appropriate degree of heat-resistance in accordance with ISO 12944-5 or as follows.

a) Up to about 50 °C. Normal paint systems as described in 8.3.4.4.1 (except bituminous and tar-based paints) are usually satisfactory (see Note).

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 200 °C. Application of two coats of aluminium paint direct to clean bare metal is usually satisfactory although much depends upon the heating cycle. A coating that has withstood several months' exposure to temperatures at the higher end of the range can fail rapidly when the surface cools, especially if condensation occurs.

d) Above 200 °C. Specialist coatings are likely to be required, and reference should be made to coatings manufacturers.

Note: Resistance to heat is influenced mainly by the maximum temperature reached in service and the nature of the heating cycle, i.e. where 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.

8.4 Non-ferrous metals and metallic coatings

8.4.1 Characteristics

8.4.1.1 General

NOTE 1 Non-ferrous metals are more resistant to corrosion than iron and steel and, for this reason, are often used as alternatives. Some, notably zinc and aluminium, are used as protective coatings for iron and steel.

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 specific type, is always necessary to ensure satisfactory adhesion of paint. This is particularly so where thermally sprayed coatings are to be exposed externally where a sealer should be applied prior to priming and over coating with the specified paint system.

NOTE 2 Preparatory and pre-treatment methods are described in 8.4.2 and priming in 8.4.3

8.4.1.2 Metallic coatings

Zinc and aluminium are used extensively as protective coatings, both individually and as alloys, for iron and steel structural members, sheets and components and consideration should be given to their use in moderate and severe exposure conditions and where long-term protection is required.

Note ISO 14713 gives guidance on the selection and specification of metallic coatings.
The different forms of coated product have a thickness or mass of coating, which depending on the product chosen should be selected to suit the expected severity of exposure or service requirements.
The application of zinc and aluminium coatings to iron and steel should be as follows:

a) hot-dip galvanizing (zinc) for general steelwork and fittings (for further information see ISO 14713) and claddings (for further information see BS EN 10326 and BS EN 10327);

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 4921);

d) electroplating (zinc) by electrolytic deposition of zinc from zinc salt solutions for small items (for further information see BS EN 12329, BS EN 12330 or BS 3382), as well as for sheet components;

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 22063) 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.

Special preparation or pre-treatment, or the use of primers of specific type, is essential in order to ensure satisfactory adhesion of paint (see 8.4.2 and 8.4.3). Appropriate sealer or paint systems usually adhere satisfactorily to sprayed non-ferrous coatings ISO 12944 if they are applied soon after the sprayed coatings.

8.4.2 Surface preparation for non-ferrous metals

8.4.2.1 General

Preparation of new non-ferrous metal surfaces is concerned essentially with the removal of dirt, grease and corrosion products and treatment to improve paint adhesion, e.g. to galvanized surfaces and to aluminium sheets and extruded sections.

Sprayed metallic coatings and aluminium castings will provide satisfactory adhesion for paint, but the surfaces should be clean and free from corrosion products and might require light abrasion. Etch priming may be necessary to improve adhesion.

Non-ferrous metals are often left unpainted for many years, but painting might eventually be necessary for appearance or to arrest deterioration. If aluminium is left unpainted it can acquire a rough layer of corrosion products that should be removed before painting. Similarly, if erosion of metallic zinc coating from a galvanized substrate has exposed the steel, any rust should be removed. However, if erosion of a thermally metal sprayed surface has exposed the steel, then the complete thermal sprayed coating should be removed prior to any painting.

8.4.2.2 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 gross 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; 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, allowing absorption of the cleaning fluids which then remain trapped and can lead to premature breakdown of the paint coating.

8.4.2.3 Removal of corrosion products

Sprayed metallic coatings should be sealed (see 8.4.3.4) otherwise corrosion products can develop fairly rapidly, especially in damp or chemically-charged atmospheres. Corrosion products could 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 exposure can be difficult and abrasion might be necessary, e.g. with stainless steel wire wool or nylon pads, using water as a lubricant. Mild steel, brass, or copper wire should not be used, 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.

8.4.2.4 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.

Pre-treatment primers are 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.

The use of two-pack pretreatment primers (4/1) which are generally superior to one-pack types (4/2) is now being replaced by water-based adhesion primers (4/4) and mordant solutions (4/3, see 8.4.2.5) as ways of improving the adhesion of subsequent coating systems to zinc surfaces. 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.

NOTE The use of etch primers (either simple or two pack) for hot-dip galvanized steel is rare.

8.4.2.5 Chemical pre-treatments

Zinc, aluminium and some other non-ferrous metals can be pre-treated to improve paint adhesion. Such pre-treatment (e.g. phosphate) should be 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. A material for the pre-treatment of galvanized surfaces mordant solution (4/3), when properly applied, blackens zinc surfaces. If this does not occur, the surface should be thoroughly cleaned (see 8.4.2.3) and the treatment should be repeated. Excessive application of the wash (which, on horizontal surfaces can lead to ponding) and excessive thickness of coating should be avoided.

8.4.2.6 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 should be washed (and degreased if necessary) before paint is applied. Weathering is unnecessary if the correct pre-treatments and/or primers are used (see 8.4.3).

8.4.2.7 Abrasion

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. 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. It is important that a suitable, soft blast medium is used, with low blast pressures (< 276 MPa) and an optimized and controlled blasting angle and nozzle-to-work piece distance maintained.

8.4.2.8 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 should be sought.

8.4.3 Priming

8.4.3.1 General

Primers for non-ferrous metals should contain corrosion-inhibiting pigments (see F.4.5) but some such pigments which can be found in primers for iron and steel, e.g. graphite, are unsuitable as they can stimulate corrosion.

Film thickness, although it has to be adequate, need not be so 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 ram washing and the formation of 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.

Note: Recommendations in respect of primers for the non-ferrous metals in general use in buildings, assuming subsequent application of paints of conventional type, are described in 8.4.3.2, 8.4.3.3, 8.4.3.4, 8.4.3.5, 8.4.3.6 and 8.4.3.7. Surfaces, preparatory treatments and primers are correlated in Table 15.

8.4.3.2 Aluminium and its alloy

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

8.4.3.3 Zinc and zinc-coated (galvanized, sherardized 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 embrittled and lose adhesion. The zinc should therefore be primed with a non-oil based primer. Pre-treatment primers (4/1, 4/2) can be used except possibly on galvanized sheet.

NOTE Unless otherwise specified (i.e. oiled or untreated), virtually all galvanized sheet produced 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, 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

Water-borne acrylic (4/9) and two pack surface tolerant (4/10) can also be used to prime zinc. Primers formulated for direct application to zinc surfaces are satisfactory subject to the use of compatible topcoats.

8.4.3.4 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, especially if they are to be exposed to damp or corrosive atmospheres; in order to retard the development of corrosion products which can affect the adhesion or appearance of the paint. If this is not done and corrosion products have developed, they should be removed (see 8.4.2.3) 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.

8.4.3.5 Copper and its alloys (e.g. brass and bronze)

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. Indoors, direct application of alkyd gloss after abrasion is usually satisfactory. Special materials are available if a clear finish is required.

8.4.3.6 Lead

Abrasion as described for copper (see 8.4.3.5), or treatment with phosphating solutions (see 8.4.2.5) should be undertaken to improve adhesion of paint to lead surfaces. 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 surfaces.

8.4.3.7 Chromium, nickel, tin and cadmium (as coatings)

New chromium and nickel coatings 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.

Tin plate presents few difficulties in painting; most paints adhere after degreasing and light abrasion of the surface.

Cadmium should not be weathered prior to painting. Phosphate treatment (see 8.4.2.5) or a pre- treatment primer (after light abrasion if necessary) can improve adhesion of subsequent coats. Cadmium plated surfaces should not be abraded dry.

8.4.4 Coating systems for interior and exterior use

In most situations, alkyd finish systems can be used, but when they are to be applied to pruned galvanized surfaces, it should be ensured that the primer and succeeding coats are compatible, otherwise adhesion failure can occur, especially in wet conditions. Micaceous iron oxide paints can be used to provide added protection to galvanized and metal-sprayed steel in moderate and many severe conditions. Bituminous paints can be used for contact surfaces and where colour and appearance are not critical.

Coatings for aluminium should not contain graphite pigments, which stimulate corrosion, as the priming coat might not isolate them from contact with the metal.

Coating systems for non-ferrous metals are similar to those indicated for iron and steel in Table 14, except that film thickness tends to be less critical and fewer coats can be used. In many moderate exterior and interior exposure conditions, three-coat systems (including primer) having a total thickness of about 85 µm might be adequate; in some interior situations, thinner films should be used. The life expectancy of comparable paint systems on non-ferrous metals tends to be greater than on iron and steel.

For guidance on the selection of paint coatings for galvanized and metal-sprayed iron and steel in severe exposure conditions, reference should be made to BS 5493.

8.5 Plaster, external rendering, concrete (including lightweight and autoclaved aerated blocks), brick and stone — General considerations

Note: Plaster, external rendering, concrete, brick and stone have a number of characteristics in common and, to avoid repetition, these and general principles applying to the selection of paint for these substrate systems are considered here. For further information on the protection of concrete structures, see BS EN 1504-2 and BS EN 1504-10.

8.5.1 Characteristics

8.5.1.1 Moisture content

NOTE 1 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 coatings. 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 weeks to 6 weeks).

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 be determined, as there is less likelihood of soluble salts being present in wood and so readings are more reliable, especially if they are significantly lower for the wood.

NOTE 2 The first column in Table 16 and Table 17 refers to four stages of drying of walls, i.e. dry, drying, damp, and wet, and gives corresponding equilibrium humidity percentages.

8.5.1.2 Efflorescence

Efflorescence, usually sodium sulfate, is likely to disrupt relatively impermeable (e.g. solvent-borne) paints but can come through more permeable (e.g. water-borne) paints without much disruption although their adhesion might be impaired. It is undesirable, therefore, to apply even permeable paints until efflorescence has ceased. As it 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. A proprietary acid wash may also be used.

8.5.1.3 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. The glazed surface might impair adhesion and should be lightly abraded to prevent this.

8.5.1.4 Alkalinity

NOTE Materials containing Portland cement (CEM 1) or lime are strongly alkaline; gypsum plasters are not usually alkaline in themselves but might become so if they are gauged with lime or it 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. 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 may 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.

Alkali-resisting primers (5/1) provide a measure of protection against alkaline attack and should be used beneath solvent-borne systems applied to substrates in which alkalis might be present. However, it cannot be too strongly emphasized that the essential function of primers is to dimmish the risk of failure on substrates that are substantially dry, and they do not obviate the need to allow time for this condition to be reached.

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

8.5.1.5 Staining

NOTE Brown stains with no appreciable surface deposit sometimes appear on water-borne paints but do not normally affect solvent-borne paints. They are usually derived from substrates, notably certain types of brick, hollow clay pot or clinker block, containing soluble salts or colouring materials, or from sands containing biological matter that reacts with alkali.

If it is suspected that brown 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. The substrates should be substantially dry and, for the reason indicated in 8.5.1.4, the primer should be applied thinly.

8.5.2 Coating systems for interior use

8.5.2.1 General

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. 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.

8.5.2.2 Mid-sheen and matt water-borne paints

Mid-sheen and matt water-borne paints are permeable, reasonably resistant to alkaline attack and therefore suitable for use on substrates that are not completely dry, but they should not on this account 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 (7/5) 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.

8.5.2.3 Solvent-borne alkyd finishes

Solvent-borne alkyd finishes are less permeable and more susceptible to alkaline attack than their water-borne paint counterparts and should be applied to completely dry substrates over a primer. These have good resistance to wear and frequent washing but should be applied only to dry primed substrates. If the conditions of service warrant the use of a solvent-borne gloss finish and there is insufficient time for drying out, water-borne paint should be used as a temporary measure and the gloss finish system applied when drying out is complete. Use of solvent-borne finishes on large areas should be avoided as this can give rise to solvent vapour hazards. Breathing apparatus should be worn when using solvent-borne products.
Note: For further information on health and safety when working with solvent-borne products, see Annex B.

8.5.2.4 Water-borne acrylic gloss finishes

Water-borne wall paints have similar resistance to wear and frequent washing as their solvent-borne alkyd counterparts and minimize the health risks to the operator by reducing their exposure to solvent vapours. They have greater tolerance of substrate moisture and allow surfaces that are substantially dry (i.e. drying) to continue drying out.

8.5.2.5 Textured coatings

Textured coatings can be used for their decorative effect, to hide surface defects or irregularities and as an alternative to plastering or rendering. Coatings of this type include plastic-textured paints (7/15) and water-borne, heavy-textured masonry paints (7/9). They are usually relatively permeable and moderately resistant to alkaline attack and can be suitable for direct application to surfaces not completely dry, but reference should be made to manufacturer's recommendations.

8.5.2.6 Multi-colour finishes

Multi-colour finishes are very hardwearing and especially suitable for use on walls in circulating areas, cloakrooms and similar locations. Generally, they should be applied only to substantially dry substrates, usually over special primers or base-coats, but manufacturer's recommendations regarding surface conditions and systems should be followed.

8.5.2.7 Cement paints

Cement paints are permeable, resistant to alkaline attack and suitable for early application to most substrates except gypsum plaster, although their rough surface and limited colour range can preclude their use if ease of cleaning and decorative appearance is important. They can also impose limitations on the choice of maintenance paints. Cement paints should be applied directly without priming.

8.5.2.8 Silicate-based masonry coatings

The recommendations in 8.5.3.6 should be followed for silicate-based masonry coatings for coating systems for interior use.

8.5.3 Coating systems for exterior use

8.5.3.1 General

Coating systems for exterior use are painted principally to enhance their appearance by imparting colour and texture or, in some cases, to prevent rain penetration. A range of specialized coatings (11/1 to 11/4) can also be used, to protect the surface of concrete, etc. from potentially harmful agents, e.g. carbon dioxide, sulfur dioxide and salts and the manufacturer's recommendation 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 ram 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 8.10.1.1 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 11.5.8.

It is essential that masonry paint not be used as a cure-all coating for rising damp, walls affected by water ingress from failed rainwater gutters and downpipes and failed lead flashing. 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 coatings.

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

8.5.3.2 Gloss finishes

Gloss finishes are seldom used on external walls except in repainting work on smooth renderings or stucco. If solvent-borne gloss finishes are used, the substrate should be dry and an alkali-resistant primer should be applied.

Water-borne gloss finishes should be used in suitable conditions of temperature and humidity for satisfactory film formation and drying.

8.5.3.3 Mid-sheen and matt finishes

Alkyd mid-sheen and matt finishes, as used for internal surfaces, are not suitable for external walls, where water-borne masonry paints (7/8) or, on substantially dry substrates, solvent-thinned masonry paints (7/10) should be used.

8.5.3.4 Textured finishes

Note: Textured finishes are wide ranging from a fine sand or stone texture to heavy-texture coatings containing coarse aggregate or deriving their texture from the method of application. Examples of the types available are given in 7/8 to 7/11.

Textured coatings should be used where greater durability is needed. The thicker or more heavily textured coatings also help to hide surface irregularities, fill fine surface cracks and contribute to the rain resistance of external walls. They should not be used to improve the acoustic or thermal insulation properties of walls as they are too thin. They can be used to prevent reduction of the original thermal insulation value by reducing rain penetration.

Dirt pick-up could be a problem with the heavier textures in polluted atmospheres 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 coatings are applied by specialist applicators and might be offered with a warranty as to their durability; because of the wide range of types and compositions available, manufacturer's recommendations should be ascertained.

8.5.3.5 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 should not be used in acidic exposure conditions.

8.5.3.6 Silicate-based masonry coatings

Note: Silicate-based masonry coatings (mineral paints) have been used in continental Europe for a considerable time in grades suitable for external and internal surfaces. These coatings provide inert non-flammable films that do not support fungal and algal growth and are compatible with all mineral building materials. Compositions of high water vapour permeability are available.

External surfaces to be painted should be free from dirt and all previous paint coatings. Application should be by brush, roller or spray. The drying coating can be susceptible to rain damage. The liquid paints are highly alkaline and hence precautions should be taken during application.

8.6 Plaster

8.6.1 Characteristics

8.6.1.1 General

The plasters in general use for internal work should comprise one or more of the following:

a) calcium sulfate (gypsum) types, other than lightweight plasters, conforming to BS 1191-1 (see 8.6.1.2);

b) calcium sulfate (gypsum) lightweight plasters conforming to BS 1191-2 (see 8.6.1.2);

c) thin-wall plasters (see 8.6.1.3); d) cement plasters (see 8.6.1.4); e) lime plasters (see 8.6.1.5).

NOTE For further information on plaster, see Annex I. For further information on plasterboard, see Annex J.

8.6.1.2 Calcium sulfate (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, and therefore an alkali-resistant coating should be used.

8.6.1.3 Thin-wall plasters

Thin-wall plasters are based on organic binders and to dry out rapidly are used in thin layers. They normally present no difficulties in painting when used on dry backings but sometimes appear underbound and can be excessively absorbent; in these cases, treatment as described in 8.6.2.4 should be carried out.

8.6.1.4 Cement plasters

Cement: sand or cement: sand: lime 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 are strongly alkaline and likely to attack drying-oil/resin paints.

8.6.1.5 Lime plasters

Note: 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.
Lime plasters should not be painted until they have substantially dried out, as they are strongly alkaline and likely to attack drying-oil/resin paints.

8.6.2 Surface preparation and priming of plaster

8.6.2.1 Cleaning

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 8.5.1.2.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 11.5.8.3.

8.6.2.2 Treatment of stains

For the treatment of stains, the recommendation in 8.5.1.5 should be applied

8.6.2.3 Stopping and filling

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.

8.6.2.4 Priming

NOTE Recommendations for priming are given in Table 16.

Priming is essential when solvent-borne paint systems are applied to plaster; it is not usually necessary with water-borne paints, but see 8.5.1, in particular 8.5.1.4 and 8.5.1.5.

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 or specified as an additional coat in the system. Where this proves inadequate a coat of alkali-resisting primer (5/1) or primer-sealer (5/3) should be applied, but this should be done only if the substrate is substantially dry. The primer or primer-sealer might need thinning to ensure that it does not provide a glossy surface to which water-borne paint might not adhere satisfactorily.

8.6.3 Coating systems for plaster

The selection of coating systems for plaster should be in accordance with 8.5.2 and 8.5.3, and details of systems are incorporated in Table 16.

8.7 External renuenug

8.7.1 Characteristics

8.7.1.1 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. However, they should not be painted until they have substantially dried out, as they are strongly alkaline and likely to attack drying-oil/resin paints.

8.7.1.2 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. In order for repainting to be undertaken, the rendering should be sound and dry.

8.7.1.3 Repairs to renderings

If repairs to old renderings, including stucco, are necessary, they should be carried out in accordance with BS 5262, using cement-based mixes. The repaired portions should then be treated as for new work in respect of painting.

8.7.2 Coating systems for external renderings

8.7.2.1 Surface preparation

8.7.2.1.1 Cleaning

New surfaces normally should be brushed down with stiff (not wire) brushes to remove loose material. Efflorescence should be treated as described in 8.5.1.2. 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 11.5.8.

8.7.2.1.2 Treatment of stains

The recommendations given in 8.5.1.5 should be applied for the treatment of stains.

8.7.2.1.3 Stopping and filling

Minor cracks, holes and surface defects should be made good with exterior grade water-mixed cement-based filler or masonry cement before application of the primer or first coat of paint.

8.7.2.2 Priming

NOTE Recommendations for priming are given in Table 17.

When solvent-borne paint systems are to be applied, external renderings should be primed; it is not usually necessary with water-borne paints but see 8.5.1.4 and 8.5.1.5. This should be confirmed with the paint manufacturer.

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

8.7.2.3 Finishing

The selection of coating systems for external renderings should be in accordance with 8.5.3, and details of systems are incorporated in Table 17.

8.8 Concrete

8.8.1 General

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.

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. The surface finish of concrete can vary widely from smooth and dense (e.g. with pre-cast components) to rough and porous with large voids. 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.

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.

8.8.2 Coating systems for concrete

8.8.2.1 Surface preparation/cleaning

On new surfaces, deposits and loose material, including laitance, should be removed by scraping and brushing with stiff (not wire) brushes. On large areas, it might prove more effective to abrasive blast surfaces (using non-ferrous abrasives) to remove laitance and glaze on shuttered surface and expose.fine aggregate. On smooth, shuttered surfaces, paint adhesion might be enhanced when roughened by abrasive blasting. If efflorescence is evident, it should be treated as described in 8.5.1.2.

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

Old unpainted surfaces might require washing to remove accumulated dirt before painting; if this is necessary, time should be allowed for drying out before painting. Surfaces on which biological growths are present should be treated as described in 11.5.8.

8.8.2.2 Stopping and filling

Large voids and air-holes should be filled with masonry cement or epoxy resin mortars. Minor surface defects should be made good with interior or exterior grade water-mixed cement-based filler or with masonry cement. Application of cement paint or bagging with a cement:sand slurry can reduce surface roughness and fill minor imperfections.

8.8.2.3 Priming

NOTE Recommendations for priming are given in Table 16 and Table 17.

When solvent-borne systems are used on concrete a primer should be applied; it is not usually necessary with water-borne paints but see 8.5.1.4 and 8.5.1.5. This should be confirmed with the paint manufacturer.

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

8.8.2.4 Finishing

The selection of coating systems for concrete should be in accordance with 8.5.2 and 8.5.3, and details of systems are incorporated in Table 16 and Table 17.

Coatings which are applied to give additional protection should be of an impervious type, e.g. bituminous or other specialized coatings (7/8, 7/10, Table 10 and Table 11), to prevent ingress of water, corrosive salts and gases; and 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 coatings for the protection of concrete both new and repaired is given in BS EN 1062-1 and BS EN 1504-2.

8.9 Brick and stone

8.9.1 Characteristics

Brick and stone are durable materials, generally of attractive natural appearance and, when new, do not usually require painting.

NOTE 1 For information on the characteristics of brick an stone, see Annex K.

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.

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 8.5.1.4. Efflorescence can also occur on brickwork and stonework and should be treated in accordance with 8.5.1.2.

NOTE 2 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.

If moisture penetration occurs, paint coatings are likely to be disrupted; also, they can prevent or retard drying out of moisture and thereby increase the risk of the brick or stone being damaged by frost. It is recommended that, in these situations, brickwork and stonework should not be painted. Concrete blocks are strongly alkaline and an alkali-resisting system should be used preferably when the brickwork has substantially dried out.

The adhesion of conventional paints to the harder, non-porous stones, especially if the surface is smooth or polished, is likely to be poor and, if painting is essential, paints of the types recommended for glazed bricks (see 8.14.2) should be used. Where bricks contain high levels of ferrous oxide, a stain block primer should be used for sealing.

Note: Some bricks can contain high levels of ferrous oxide which can be present in the raw materials, in certain parts of the country. This can cause iron staining which will bleed through most water-borne coatings.

8.9.2 Coating systems for brick and stone

8.9.2.1 Surface preparation/cleaning

New surfaces, e.g. fair-faced brickwork, should be brushed down with stiff (not wire) brushes to remove loose material. Efflorescence should be treated as described in 8.5.1.2. 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. When washing has been carried out, time should be allowed for drying out before painting. Biological growths might be present on old external surfaces and should be treated as described in 11.5.8.

8.9.2.2 Stopping and filling

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 made good with ulterior or exterior grade water-mixed filler or with masonry cement.

8.9.2.3 Priming

Note: Recommendations for priming are given in Table 16 and Table 17.

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

Priming is not usually necessary with water-borne paints, but see 8.5.1.4, 8.5.1.5 and 8.9.1. This should be confirmed with the paint manufacturer.

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

8.9.2.4 Finishing

The selection of coating systems for brick and stone should be in accordance with 8.5.2 and 8.5.3, and details of coating systems are incorporated in Table 16 and Table 17.

Note: Further guidance on surface protection systems for concrete is given in BS EN 1504-2.

8.10 Precast concrete blocks

Note: For further information on concrete blocks, see Annex K.

8.10.1 Characteristics

8.10.1.1 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 drying out of the mortar joints before painting.

8.10.1.2 Alkalinity

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

8.10.1.3 Porosity

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.

8.10.1.4 Texture

Blockwork is often painted directly to save the cost of rendering or plastering, but it should be appreciated that 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 coatings (7/9 or 7/11) can usefully combine both protective and aesthetic functions. When appearance is important, blocks having an acceptable surface texture, e.g. of facing quality, should be used, paint being used to complement the texture rather than mask it.

8.10.2 Coating systems for precast concrete blocks

8.10.2.1 Surface preparation/cleaning

The surfaces of precast concrete blocks should be brushed down with stiff (not wire) brushes to remove loose material. Efflorescence, if present, should be treated as described in 8.5.1.2.

8.10.2.2 Stopping and filling

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

As indicated in 8.10.1.4, 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 (7/9 and 7/11).

8.10.2.3 Priming

NOTE Recommendations for priming are given in Table 16 and Table 17.

Priming is necessary with solvent-borne paint systems, and an alkali-resisting primer should be used. Priming is not usually required when water-borne paints are used, but see 8.5.1.4 and 8.5.1.5. This should be confirmed with the paint manufacturer.

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

8.10.2.4 Finishing

The selection of coating systems for concrete blockwork should be in accordance with 8.5.2 and 8.5.3, and details of coating systems are incorporated in Table 16 and Table 17.

NOTE Further guidance on surface protection systems for concrete is given in BS EN 1504-3.

8.11 Cement-based sheets, boards and components

WARNING Materials containing asbestos are subject to the legislation that requires precautions to be taken in handling them to ensure that they do not constitute a hazard to health (see Annex B). Cement-based insulating materials containing asbestos fibre, if found, should not be disturbed. Unknown cement-based insulating materials should be treated as containing asbestos fibre until properly identified. Specialist advice should be sought on the treatment of all asbestos containing materials and if necessary the correct method for its safe removal and disposal.

8.11.1 Coating systems for cement-based sheets, boards and components

8.11.1.1 Surface preparation/cleaning

New surfaces should be brushed down with stiff (not wire) brushes to remove loose material. With materials containing asbestos, precautions to prevent inhalation of dust are essential (see WARNING to 8.11 and Annex B).

Biological growths might be present on old, unpainted external cladding and roofing materials; if so, the surfaces should be treated as described in 11.5.8.

8.11.1.2 Stopping and filling

The necessity for filling does not normally arise with external cladding and roofing materials or with internal linings when patent fixing methods are used. When internal linings are fixed by nailing or screwing, a water-mixed filler (see 7.4.4) should be used for stopping.

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

8.11.1.3 Priming

NOTE Recommendations for priming are given in Table 16 and Table 17.

Alkali-resisting primers 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 in their use.

Alkali-resisting primers of conventional type, as normally used in solvent-borne paint systems, should not be used under chlorinated or acrylated rubber paints (see 8.11.1.5). The latter should be applied directly to the surface or over a chlorinated or acrylated rubber-based primer, as recommended by the paint manufacturer.

Asbestos-cement goods vary in porosity, and cement-based insulating boards can be highly porous. Primers or first coats should be thinned strictly in accordance with the manufacturer's instructions to accommodate variations in surface porosity and facilitate application.

8.11.1.4 Back-painting

Under certain circumstances, as indicated in K.3.2, fibre-cement sheets should be back-painted to prevent differential carbonation. For this purpose, impermeable paints of similar type to those used on the exposed surface should be used; alternatively, a cheaper material, e.g. bituminous paint, can be applied

8.11.1.5 Finishing

The types of coating system described in 8.5.2 and 8.5.3 and the systems shown in Table 16 and Table 17 are suitable for use on cement-based sheets, boards and components. If, however, a gloss or semi-gloss finish is required for asbestos-cement roofing and cladding sheets and components, chlorinated or acrylated rubber paint (which does not require an alkali-resisting primer) should be applied in preference to the system of alkali-resisting primer, undercoat and finish used with gloss finishes of conventional type.

8.12 Paper and wallcoverings including plasterboard

8.12.1 Characteristics

8.12.1.1 General

Problems can be experienced in respect of painting existing coloured wallcoverings.

NOTE For information on general characteristics of paper wallcoverings and plasterboard, see Annex J.

8.12.1.2 Wallpapers

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 papers to see if discoloration occurs; if it does, a solvent-borne primer or knotting should be applied to seal the surface of the paper (see 8.12.1.3) or the paper should be removed.

It should be appreciated that application of paint to wallpaper makes its removal more difficult, should this be necessary at a later date, especially if solvent-borne paints are used. Wallpaper should be painted only if it is firmly adhering and without blisters, creases or prominent joins.

8.12.1.3 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 could 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. The remaining sheet can be used as a sub surface for painting provided the surface adhesion is sound.

8.12.1.4 Non-woven papers or vinyl coated non-wovens

Non-wovens 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 8.12.1.2 or 8.12.1.3) should be resolved by removing the wallcovering.

8.12.2 Removal of paper and wallcoverings

In order to assess how much time is needed for the removal of the paper and wallcoverings, 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;

c) the number of layers to be removed.

CD/K/034:2009

8.12.3 Coating systems for paper, wallcoverings and plasterboard

8.12.3.1 Surface preparation

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 suspect, 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 as in 11.5.8.3.

If water-borne paints are to be used and there is a risk of discoloration (see 8.12.1.2), a test area should be coated with the paint it is proposed to use and should be inspected after 24 h. If discoloration occurs, it can be prevented by applying a coat of knotting (see 7.4.3) or solvent-borne primer (5/1 or 5/3) overall or to the areas responsible. Alternatively, the wallcovering should be removed.

8.12.3.2 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.

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. It is possible that if a standard decorative paint is used directly onto dry lining, 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 will also aid to even out the porosity of the substrate prior to painting.

NOTE Recommendations for internal plastering are given in BS 5492. Recommendations for dry lining and partitioning using gypsum plasterboard are given in BS 8212.

8.12.3.3 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.

8.12.3.4 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.

8.13 Plastics

8.13.1 General

Typical examples of plastics in buildings include unplasticized polyvinyl chloride (PVC-U) cladding, rainwater goods and window frames; glass reinforced polyester (GRP) cladding and mouldings; and a variety of plastics coatings for metal.

These materials generally have good durability, but the effects of weathering, soiling and mechanical damage over a number of years might suggest painting 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 plastics 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.

NOTE For more detailed information, see BRE Information Paper 11/79 [19].

If painting is considered as a method of restoring defective or deteriorated surfaces, specialist advice should be sought.

Other plastics surfaces that might need painting for decorative purposes are expanded polystyrene and vinyl wallcoverings.

8.13.2 PVC-U components

Painting new unplasticized polyvinyl chloride (PVC-U) with certain types of building paints can reduce the impact resistance. Specialist coatings have been developed and should be used to introduce new colour or rectify discoloration if it occurs. 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.

In addition to specialist coatings, PVC-U can be painted with some water-borne paints, which have been formulated to have good adhesion. Manufacturer's recommendations should be followed. 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.

Pahits 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. This might not be of significance where the areas are small and adjacent surfaces of traditional materials require maintenance painting at relatively short intervals. However, consideration should be given to the use of long-life coatings on large areas such as cladding. Long-life coatings are usually of specialist type, e.g. two-pack polyurethanes or epoxies, but specialist advice should be sought.

8.13.3 GRP components

Most paints can be used on glass reinforced polyester (GRP) components. 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.

As with PVC-U, consideration should be given to the maintenance aspects of painting GRP and the use of long-life coatings in certain circumstances. Although GRP is less sensitive to solar gain than PVC-U, the use of light-coloured finishes is recommended.

8.13.4 Plastics coated metal

8.13.4.1 General

A wide variety of organic coatings, classifiable as plastics, are used on metal cladding and other components. 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 coatings such as epoxy, polyurethane, polyester or silicone modified versions are also found.

It is essential that the pre-coating be identified to enable the application of a correctly adhering overcoating system, to be applied with or without a primer. Visual identification is not straightforward, but older PVC exhibits a characteristic ripple and polyester can be glossy, the others all appear smooth and generally matt. Fourier transform infrared (FTIR) spectroscopy should be used to identify samples from site. Manufacturers provide information on suitable primers and top coat(s) and this should include provision for painting any bare metal, e.g. edges or patches.

8.13.4.2 Identification

When identification is not possible, a site adhesion test should be undertaken with the range of primers available and also a direct application. The test should be done on cleaned areas and in accordance with the coatings and the manufacturer's instructions.

NOTE This might involve leaving the overcoating systems for up to 7 days to allow adhesion to develop via plasticizer linkage on PVC for example.

Adhesion should 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, the adhesion figure should be in excess of 1 N/mm2.

8.13.4.3 Surface preparation

Good surface preparation is vital and varies depending on the condition and type of the existing finish. a) All surfaces deemed to be in good condition should be powerwashed to remove all dirt, debris, growths and erosion by-products. Grease and oil should be removed with a suitable cleaner (soap or detergent) and all traces of cleaner need to be removed by rinsing.

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. Ensure all traces of chemical treatment are removed. Disbonding sections of PVC plastisol should be cut back to soundly adhered material.

c) Rusted areas should be prepared by removal of coating, oxidation products, dirt and debris, and abraded or blasted to, e.g. Sa2'/2, 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 growths should be identified and treated with a biocidal wash.

8.13.5 Expanded polystyrene

Expanded polystyrene is used in tile or sheet form as a ceiling or wall lining and for decorative applications to improve thermal insulation. Wall linings are generally employed as a base for wallcoverings, but ceiling tiles and cornices can be painted.

Paint solvents attack expanded polystyrene. Painting of expanded polystyrene wall and ceiling linings should be with water-borne paints.

WARNING! Paints containing solvents, especially gloss finishes, can create a fire hazard when used in conjunction with expanded polystyrene.

8.14 Glass and inorganic glazed surfaces

8.14.1 General

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 they provide little mechanical key, and this cannot usually be improved significantly by abrasion. Reliance has therefore to be placed on the inherent adhesive properties of the paint, and this can vary according to type and composition.

The painting of extensive or prominent areas should be undertaken only after consultation with the manufacturer, especially if the surfaces are exposed to weather or high humidity or are subject to abrasion; if possible, evidence of satisfactory performance hi similar conditions should be obtained.

8.14.2 Coating systems for glass and inorganic glazed surfaces

8.14.2.1 Surface preparation

Surfaces should be perfectly clean and dry at the tune of painting. It is recommended that surfaces are washed with detergent solution, followed by rinsing with clean water. Where external surfaces are greasy, solvent cleaning may be necessary (see 7.4.1). On vitreous enamel, abrasion with waterproof adhesive paper, while the surfaces are wet, can help to improve adhesion. Faulting should follow cleaning as soon as the surfaces are dry. If there is a delay, surfaces should be wiped with a clean cloth and methylated spirits immediately before painting.

8.14.2.2 Priming

Finishes are often applied directly to glass and glazed surfaces, but the paint manufacturer's recommendations in this respect should be followed. Some multi-colour finishes (7/14) are applied over a bonding primer. Where damage or deterioration of vitreous enamel has exposed O the metal substrate, the exposed metal substrate should be primed.

8.14.2.3 Finishing

In the interiors of buildings, glazed bricks and ceramic tiling are the surfaces of this type 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 and one-pack polyurethane finishes can also be used and should be applied directly to the surface. Chlorinated and acrylated rubber finishes should be considered, especially for conditions of high humidity or where condensation occurs. Some water-borne paints can be suitable in dry conditions and are used to provide temporary shading on glass, however specialist coatings are available for this purpose.

External surfaces should be treated as for internal surfaces but reference should be made to the manufacturer's instructions.

None of the conventional types of paints have the durability and resistance to wear of the original surfaces, and, where these properties are important, consideration should be given to the use of long- life specialist coatings 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.

8.15 Bituminous surfaces and materials

8.15.1 General

Surfaces and materials in this category include bituminous paints and coatings, some preservative treatments and asphalt surfaces.

These surfaces should not be painted with solvent-borne paints since there is a tendency for these surfaces to discolour them (bleeding) and sometimes to retard their drying. Cracking of applied paints might occur with some bituminous substrates.

8.15.2 Bituminious paints and coatings

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 (3/5). 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.

8.15.3 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 is has weathered for a year or more and is then primed with aluminium primer (3/4). 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.

8.15.4 Asphalt and bitumen

Light-coloured finishes for asphalt and bituminous roofing materials should be used to reduce heat absorption and improve appearance. Particular care in the selection of coatings is essential, as unsuitable types can crack, as described in 8.15.2, 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. Sand-rubbing of new asphalt is recommended 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 coatings are available for use on asphalt and bituminous roofing materials, and reference should be made to the manufacturer for specific recommendations, based on experience.

Quick-drying road marking paints, resistant to discoloration, should be used for marking asphalt roads, parking areas and factory-floors. Light-reflecting solid glass beads are incorporated in some types or can be applied to the surface while the paint is wet.

9 Application and practice

9.1 Conditions of application

9.1.1 General

The application and performance of coatings are affected by the conditions under which they are applied, e.g. of temperature, humidity and general exposure conditions. The influence of these and other factors is described hi 9.1.2 to 9.1.7.

9.1.2 Temperature and humidity

Temperature and humidity will have an effect on the drying behaviour of most coating types.

NOTE 1 See Annex L for information on temperature and humidity.

The manufacturer's recommendations in respect of temperature and its relation to curing tune and pot life should be observed, especially in the case of specialist coatings such as two-pack epoxy and polyurethane coatings.

In specifying the conditions under which coatings are to be applied, a general recommendation is that application should not start or should stop if the ambient temperature is below the manufacturer's recommendations (typically 8 °C or relative humidity exceeds 80%). In addition to the ambient temperature, a critical factor might be that of the surface to which the coating is applied. 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 In some circumstances, this general recommendation can be unduly restrictive and cause unnecessary delay or interruption of work. By agreement between the parties concerned, and having regard to the nature of the work and the types of materials involved, some relaxation of the recommendations in respect of temperature and relative humidity might be acceptable. Solvent-borne coatings, for example, can be less seriously affected than water-borne paints if applied in cold, damp conditions; application of primers and undercoats might be possible in conditions which preclude the application of finishes.

Any agreed relaxation of the specified conditions should, however, be subject to the provisos that:

A coatings are not be applied to surfaces on which condensation is present;

b) coatings are of types reasonably tolerant of the prevailing conditions of application;

c) records are kept of the occasions when relaxation is permitted.

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 (see 9.1.7).

9.1.3 Surface moisture

Adhesion, drying and other properties are nicely to be adversely affected if coatings are applied to wet surfaces. Application should not proceed when, as a result of adverse weather, high humidity or other cause, there is a visible film of moisture on the surface.

Condensation is often a problem in unheated buildings during the winter months. Temporary heating equipment can help, but it is important that heating be combined with adequate ventilation otherwise the problem can be aggravated. Portable gas and oil heaters produce water and should be used only if they are provided with means of exhausting combustion products to the outside of the building.

In some circumstances, e.g. when painting heavy metal sections, 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 it has not yet occurred.

When conditions improve, wet surfaces should be dried off, and tune should then be allowed for contained or trapped moisture to dry out. This is especially important with absorbent surfaces but it is also applicable to rough metal including metal-sprayed surfaces. Prepared iron and steel surfaces that have not received a priming coat should be prepared further if rusting has occurred.

9.1.4 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 coatings, and the manufacturer should be consulted.

The adhesion and drying of coatings might be impaired by the deposition of contaminants, including salt in marine situations. Where this occurs, surfaces should be cleaned thoroughly before application of each coat, and intervals between coats should be as short as possible.

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

9.1.5 Air movement and wind

Adequate movement of air assists drying and is essential to the removal of solvent vapours which can be unpleasant or potentially toxic or inflammable, especially when work is carried out in confined spaces; the manufacturer's recommendations in this respect should be strictly observed.

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

Precautions should be taken in the use of spray equipment externally in windy weather as paint droplets can be carried for considerable distances, causing damage or annoyance.

9.1.6 Lighting

Good lighting is essential to efficient working. Where natural daylight is lacking, an adequate level and type of artificial lighting should be provided.

The lighting whilst painting should simulate, as far as practicable, the final lighting scheme in intensity and direction of lighting.

NOTE Information concerning suitable illumination for differing purposes is given in the CIBS Code for interior lighting [20].

For most painting operations, 500 lux should be used. Higher levels, e.g. 750 lux, should be used for darker colours and inspection purposes. For colour matching, limited contrast between coats or areas, and fine detail work, 1 000 lux might be necessary.

Where the two higher lux levels are necessary and where colour perception in artificial light can be variable, illumination by lamps of colour groups 1A or IB of the CIBS Code for interior lighting [20], should be used; these include north light or artificial daylight types.

NOTE Examples of suitable bulbs and tubes are referred to in the CIBS Code for interior lighting [20].

9.1.7 Seasonal factors

If exterior painting is undertaken hi conditions when overnight frost or condensation is likely, the application of gloss finishes and water-borne coatings should be tuned to allow a reasonable period for drying before nightfall, otherwise their appearance or film properties might be unpaired. Surfaces, which are damp as a result of overnight conditions, should be dried before coatings are applied (see 9.1.3).

NOTE For further information on seasonal factors, see Annex L.

9.2 Craft procedures and practices

9.2.1 Condition of surfaces

Surfaces should be in a fit condition to allow work to proceed without detriment to the coatings to be applied. In some circumstances additional time is needed for drying out. Work by other trades that might affect painting should have been completed. If some tune 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 specifying authority.

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 (refer to the relevant substrate in Clause 8).

9.2.2 Protection and cleanliness

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.

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 might be used to finish off the cleaning.

Tools and equipment should be kept clean while in use and, where appropriate, cleaned immediately after use. Thorough cleaning after use is especially important with spraying equipment as residues of materials previously used can affect later applications or impair the efficiency of the equipment.

Debris and waste material should be disposed of promptly and not allowed to accumulate in the working area. Safety precautions should be observed in the disposal of waste materials (see B.1 and B.3).

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

9.2.3 Abrasion

Surfaces should be abraded (rubbed down) to reduce roughness, improve paint adhesion or assist cleaning. The types of abrasive materials in general use are as follows.

a) Glasspaper can be used either dry or with white spirit as a lubricant for the abrasion of wood, plaster and similar surfaces to improve adhesion of paint to non-ferrous metals (see 8.4.2.7). It can also be used to abrade painted surfaces, provided the paint is not lead-based, but wet- abrasion is more effective.

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 (see B.I.2).

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) Emery cloth or paper can be used either dry or with white spirit as a lubricant in preparing metals, especially non-ferrous metals (see 8.4.2.7) for painting.

e) Steel wire wool has general application for abrading and cleaning. If used in the preparation of aluminium for painting (see 8.4.2.3), 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.

f) Nylon fibre pads can be used instead of wire wool for some purposes (see 8.4.2.3).

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

Dust and debris resulting from abrasion should be carefully removed and disposed of. 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, tunes should be allowed for drying out before coatings are applied.

9.2.4 Stopping and filling

9.2.4.1 General

Stopping and filling should be carried out as early in the coating process as the type of material used and the nature of the substrate allow. 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 1 The materials in general use for stopping and filling are described in 7.4-4, and appropriate usage for substrates is indicated in Clause 8.

NOTE 2 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 overall smoothing and levelling of shallow depressions and rough, open-textured or coarse-grained surfaces.

9.2.4.2 Stopping

The materials used for stopping are usually fairly stiff in consistency and are generally applied with a putty knife or stopping knife. 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. 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 are used, surfaces should be primed and the primer allowed to dry before stopping. 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.

9.2.4.3 Filling

Depending upon 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 being 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. 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. With drying-oil/resin fillers, waterproof abrasive paper (see 9.2.3), with water as a lubricant, can be used. 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.

9.2.5 Preparation of materials

9.2.5.1 Stirring

Unless the manufacturer's instructions state otherwise, painting materials should be stirred before use and at intervals during use. 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 broad-bladed stirrer, long enough to reach the bottom of the container, should be used, and stirring should continue until no settlement remains. Mechanical equipment for stirring or shaking paint is available, and its use is advantageous when large quantities are involved.

Thixotropic coatings (see 7.2) should not normally be stirred before use, except possibly for roller or spray application; stirring or shaking temporarily impairs the thixotropic properties.

To avoid aeration and incorporation of any sediment, clear coatings are not usually stirred before use, but the manufacturer's instructions in this respect should be followed. Two-pack clear coatings should be stirred.

9.2.5.2 Thinning

Most of the coatings generally used in the painting of buildings, with the possible exception of some water-borne paints, are supplied ready for application by brush or roller. Water-borne paints could be supplied ready for use, but some need the addition of water. 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 coatings. To prohibit thinning absolutely, as some specifications require, can be unreasonable, but it should be carried out only under supervision and with the types of thinners and in the proportions recommended by the manufacturer.

9.2.5.3 Intermixing

Different brands or types of paints should not be intermixed without reference to the manufacturer.

9.2.5.4 Two-pack materials

Two-pack materials are supplied as two components, e.g. base and activator, hardener or curing agent, to be combined before use. 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 small quantity is required, it should be measured to ensure that the correct proportion of each component is used.

Some two-pack materials require an induction period (standing time) after mixing and before they are ready for use. Most have a limited pot-life (i.e. length of time during which they are usable), and this is temperature-dependent. The manufacturer's instructions in relation to induction period and pot-life should be observed.

9.2.6 Differing colours

The manufacturer's recommendations in respect of the colours of undercoats and first-coat colours should be observed. Wherever practicable, successive coats in paint systems should differ in colour. This assists application of continuous coats of uniform thickness, especially in conditions of poor lighting, and also facilitates inspection.

Batch to batch colour variations might occur and it is therefore recommended that paint be bought from the same batch to ensure good colour consistency. If this is not possible, batches should be combined or mixed in a single container.

9.2.7 Intervals between application of successive coats

Generally, each coat in the system should be dry throughout its thickness before the next coat is applied. As indicated in 9.1, atmospheric conditions can affect the rate of drying and, in consequence, the interval between coats; it should not, in any case, be less than the minimum recommended by the manufacturer. Some coatings might be suitable for wet-on-wet application, i.e. a second coat can follow immediately.

Except with coatings formulated for lengthy exposure without further coats, such as some primers for metal and wood (see appropriate substrate in Clause 8), intervals between coats should not normally exceed a few days, otherwise adhesion might be impaired. With some specialist coatings, the manufacturer might specify a maximum time to be allowed between coats.

9.2.8 Intercoat preparation

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

Except when the previous coating has become very hard, as a result of lengthy exposure, vigorous abrasion between coats is rarely necessary to assist intercoat adhesion. Light scuffing 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; if this occurs or the abrasive paper rapidly clogs, it is an indication that the surface is not sufficiently hard to permit abrasion.

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.

9.2.9 Defective materials

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

9.3 Application methods

9.3.1 General

The principal methods of applying coatings on site are by brush, roller, paint pad and paint glove and spray.

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 coatings for application by particular methods should be followed.

Whatever 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 and, where relevant, in the setting up and adjustment of equipment to obtain optimum results.

9.3.2 Brush application

9.3.2.1 Characteristics

Brushing can be used for the application of most coatings of conventional type, especially to small areas or where there is much cutting-in or frequent changes of colour. It is also generally recommended for the application of conventional types of primers to building surfaces, on the principle that the shearing action of brushing forces the coating into intimate contact with the surface, although suitable types of rollers can be equally effective in this respect.

With some exceptions, multi-colour finishes (7/15) cannot be applied by brush and should be sprayed. Difficulty might be experienced in the brush application of quick-drying coatings, especially to large areas. For these and for some specialist coatings, spray application is preferred.

Brush application to large, unbroken areas is slower than roller, paint pad or spray application and it is more difficult to obtain a uniform coating.

9.3.2.2 Types of brushes

The construction and dimensions of brushes should conform to BS 2992. For most purposes, brush fillings should be pure bristle, good quality mixed bristle or synthetic filaments. Synthetic filaments are harder wearing than natural or animal hair and should be used when working with caustic materials such as cement paints, but their material-holding properties might be slightly inferior.

NOTE Flat paint and varnish brushes, suitable for general use, range in width from 12 mm to 100 mm. Flat wall brushes, used mainly for application to broad surfaces such as walls and ceilings, are from 100 mm to 175 mm wide. Small fitches for narrow surfaces and decorative work are from 6 mm to 25 mm in width or diameter.

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. Apart from any constraints imposed by the extent or nature of the surface to be coated, generally smaller brushes should be used with more viscous materials, such as solvent-borne gloss finishes, rather than with those which offer little resistance to brushing, such as water-borne paints.

It is recommended that synthetic filament brushes are used for the application of water-borne coatings. They do not absorb water to the same extent as natural bristle brushes, and in consequence deliver a smooth, consistent application, improve the flow and wet-edge time of the coating material and hence reduce brush marks. Synthetic filament brushes are also much easier to clean.

9.3.2.3 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.

NOTE This technique might require modification according to the nature of the surface or the type of coating being applied.

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 coatings which should be applied as quickly as possible with the minimum of brushwork; roller or spray application of this type of coating is usually preferred, especially for large areas. In applying matt and mid-sheen coatings to ceilings and walls, the material should be applied and laid off using criss-cross strokes (switching) rather than hi one direction.

Over-heavy application of coatings 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 coatings, a surface skin can form which retards through drying. The opposite extreme of brushing out too far should also be avoided as this produces excessively thin films having poor appearance or lacking in protective properties.

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

Application, especially to large areas, should be so organized that wet edges are maintained, i.e. that each section of the work is joined up to the preceding section before its edge has set, thus preventing unsightly laps. 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.

9.3.3 Roller application

9.3.3.1 Characteristics

The types of coatings described in 9.3.2 as suitable for application by brush are also suitable for roller application; the limitations in respect of certain types of coatings also apply. The 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. A brush should be used to coat internal angles and corners, e.g. between ceilings and walls.

Although brush application of conventional types of primers to building surfaces is usually recommended, some types of rollers have a similar shearing action and can be equally suitable.

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

NOTE A degree of stipple or surface texture is characteristic of coatings applied by roller but, if the appropriate type of covering is used, this can hardly be discernible, especially with free-flowing materials such as gloss finishes.

9.3.3.2 Types of rollers

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

NOTE 1 Materials for roller coverings include various natural and synthetic fabrics and fibres. Coverings 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, the length of the fibres ranging from about 6 mm to 30 mm.

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 coatings 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 the application of coatings to corrugated sheeting, pipes and curved surfaces. Many rollers, including the special types, can be mounted on an extension pole to extend the operative's reach.

Rollers, other than the pressure feed types, 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 covering. Roller trays are designed for this purpose, but they hold only a small quantity of material, are easily overturned and are inconvenient for ladder work. Paint roller buckets should preferably be used, especially for large-scale work and when working from ladders; they are available in sizes holding 5 1 to 20 1 of material.

NOTE 3 Rollers are available in which material is supplied from a separate container' under pressure. They are claimed to show considerable savings in time compared with the normal type of roller by eliminating the need to recharge from a tray or bucket. In one type, material is supplied to the roller from an airless spray pump unit, via a flexible hose, the roller taking the place of the spray gun. Extension tubes giving a reach of up to about 2.5 m can befitted.

9.3.3.3 Basic techniques

Although it is probably easier to obtain a film of uniform thickness by roller than by brush, judgement in respect of the weight of coat applied is still essential. 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 9.3.2.3) although, in this respect, the greater speed of roller application is an advantage.

Where rollers cannot reach into corners and internal angles, brushes should be used for cutting-in and this should be done immediately ahead of rolling, the roller then being taken as closely 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.

9.3.4 Paint pads

Paint pads consist of a layer of paint-holding material similar to that used for short-pile roller coverings (see 9.3.3.2) fixed to a rigid or flexible backing. The pad is held in a metal or plastics plate and can be fixed or replaceable. The plate is provided with a fixed or adjustable handle. Various shapes and sizes are available; the largest sizes are about 150 mm x 100 mm and can be suitable for attachment to an extension pole. Application by paint pad is faster than by brush but slower than by roller.

In use, the pads should be charged by dipping the face of the covering into the paint and working it out on a corrugated or mesh surface as with a roller. A roller tray or roller bucket should be used for this purpose. The charged pad should then be placed against the surface and drawn along, using moderate pressure.

Where paint pads cannot reach into corners and internal angles, brushes should be used for cutting-in and this should be done immediately ahead of application by paint pad, the paint pad then being taken as closely to the angle as possible. They can, however, produce a finish free from brush marks or stipple.

Application by paint pad can be used for the following:

a) ship-lap cladding;

b) small areas that might not warrant putting a roller into use;

c) panelled and flush doors;

d) mouldings, picture rails and skirtings;

e) metal window frames;

f) wide lines and stripes.

It is essential that paint pads be of good quality and robust construction.

9.3.5 Paint gloves

Paint gloves or gauntlets have an outer surface of sheepskin or fabric similar to that used for roller coverings. In use, the gloved hand should be clipped into the material, which should then be transferred to the surface by wiping or dabbing. A sealed liner protects the hand, wrist and forearm against soiling with paint. They can be used to coat pipes, railings and surfaces which are inaccessible to other methods.

9.3.6 Spray application

9.3.6.1 General

There are several types of spray equipment, differing in method of operation and in the coatings 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 coating likely to be used for buildings and structures.

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 other methods of application. Spraying should not be used on small-scale work unless the coatings are of a type for which spray application is essential or preferred; brush or roller application can be more economic.

Spray application is essential for most multi-colour finishes (7/14) and is preferred for coatings based on solution binders (e.g. 11/5), especially for application to large areas. Zinc-rich epoxy primers (4/7) should be applied by spray, as should some specialist coatings. 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) The need for extensive masking or protection of surfaces not to be coated, although this is influenced by the type of equipment used.

b) Possible hazards to health or safety (see Annex B).

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

d) It is generally recommended that conventional primers for building surfaces not be applied by spray. Exceptions to this include zinc-rich epoxy primers and some specialist types which might be unsuitable for application by brush or roller.

Coatings and spray equipment manufacturer's recommendations on the selection and setting up of equipment and the preparation of materials should be followed and their guidance sought in cases of doubt.

9.3.6.2 Types of spray equipment

9.3.6.2.1 General

The following types of spray equipment are in general use for the site application of coatings:

a) air spray;

b) airless spray;

c) air-assisted airless 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.

9.3.6.2.2 Air spray

In air spray equipment, air under pressure is employed to atomize the coating and convey it to the surface. According to the design of the equipment, working air pressures range typically from about 0.20 MPa to 0.47 MPa (30 lbf/in2 to 70 lbf/in2) or more.

Lightweight units operating at pressures of 0.20 MPa to 0.27 MPa (30 lbf/in2 to 40 lbf/in2) should be used for decorative coatings. Larger units operating at higher pressures can be used for most types of coatings although airless spray application (see 9.3.6.2.3) might be preferred for some specialist types. Atomization is more effective with larger units than with lightweight units, enabling a higher standard of finish to be achieved. In addition, material throughput is higher, facilitating more rapid application.

As all forms of air spraying give rise to spray mist (although this is less pronounced with equipment operating at lower pressures) surfaces that are not to be painted should be masked and, for interior working, the provision of additional ventilation or means of extracting spray mist from the working area might be necessary.

If compressor units for air spray equipment are powered by a petrol or diesel engine, they should be located outside the building, if possible; if this is not practicable, exhaust fumes should be conveyed directly to the open air.

9.3.6.2.3 Airless spray

In airless spray equipment, a fluid pump forces the material at very high pressure, typically 14.3 Pa to 21.4 Pa (2 000 lbf/in2 to 3 000 lbf/in2), 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, including small units weighing less than 45 kg (100 Ib).

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, possible exceptions being those containing coarse aggregates or fibres, e.g. some masonry paints. Thicker films can be obtained than with air spray equipment, and should be used in particular for the application of high-build specialist coatings.

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 in respect of exhaust fumes as described hi 9.3.6.2.2 should be taken.

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

9.3.6.2.4 Air-assisted airless spray

Air-assisted airless spray equipment 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 lower pressure, usually in the range 6.7 MPa to 12.0 MPa (900 lbf/in2 to 1 700 lbf/in2). In addition, the spray gun is supplied with a small volume of air at low pressure. Air-assisted airless spray equipment allows the operator the same degree of control over application as does air spraying while having the freedom from spray mist and economy in the use of coating associated with airless spray

9.3.6.2.5 Hot spray

In hot spray equipment, the material is passed through a heater unit before delivery to the spray gun. Heating enables high viscosity, low solvent (or solvent-free) coatings to be applied by spray to give a thicker film. Coatings need to be specially formulated for hot spray application; water-borne coatings should not be used.

The hot spray method can be used in conjunction with either air spray or airless spray equipment.

9.3.6.2.6 Electrostatic spray

Electrostatic spray method involves imparting to the material an electrical charge of opposite potential to that of the surface to be coated, causing the charged particles to be attracted to the surface. This reduces wastage of material and also creates a wrap round effect so that components such as pipes and railings can be coated all round from one direction. Using a special unit to impart a charge to the material, the method can, in principle, be used in conjunction with air spray or air-assisted airless spray equipment for the application of coatings to structural surfaces. However, the electrical characteristics of the material and the surface to which it is applied are critical factors and, in practice, electrostatic spraying has little application for site work although it is used widely in industrial finishing. If its use is considered, equipment and coatings manufacturers should be consulted.

9.3.6.3 Basic techniques

All masking and protection of adjacent surfaces should be completed before spraying starts. Elaborate masking might be unnecessary when airless spray equipment is used; because of the virtual absence of spray mist or over spray, 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. It is advisable to cut along the edges of the tape with a sharp knife to prevent the coating film being pulled away with the tape.

WARNING 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.

Equipment should be checked to ensure that it is in good condition and working efficiently. Spray guns should be of appropriate type and set up in relation to the material to be applied; reference should be made to the equipment or coating manufacturer's literature for guidance in this respect.

Coatings should be prepared for use as described in 9.2.5. It should not be assumed that coatings 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 coating 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 of unsuitable type 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 150 mm to 200 mm; in airless spraying, the distance should be 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 arced. 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; usually, more overlap is required with air spraying than with airless spraying.

10 Inspection, sampling and testing

10.1 General

Most painting work is subject to final inspection on completion; on major projects, the work should be subject to inspection (see 10.2) at all stages. Sampling and testing of materials (see 10.3) might be required.

10.2 Inspection

10.2.1 General

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. It is often difficult to specify these in terms which preclude subjective judgement. 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 to be done.

The responsibility for inspection should be independent from that for application.

NOTE 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 staffer a clerk of works.

Inspectors should have a good knowledge of the materials, processes and techniques employed in the painting of buildings.

When work is to be subject to inspection, the intended procedure should be described in the specification. It is important to ensure that resources are available to implement the procedure described, especially when the work is to be subject to inspection and approval at each stage (see 10.2.2 regarding levels of inspection). If the inspector is empowered to suspend work (or take comparable action) or take samples, this should also be stated in the specification.

10.2.2 Levels of inspection

Typical levels of inspection are as follows.

a) Full. All operations are subject to inspection and approval before the next stage is started. This is the most effective level of inspection but is likely to require the services of one or more full-time inspectors and might be justified only on very large or complex projects.

b) Intermittent. Part of all operations is inspected and approved before the next stage is started. This level of inspection is less effective than full inspection but is less demanding in terms of cost and resources and therefore more appropriate for smaller projects or work of a straightforward nature.

c) Occasional. All operations are subject to inspection initially to establish standards of workmanship. Thereafter, inspection is carried out as judged necessary by the inspector. The effectiveness of this level of inspection depends largely upon the quality of supervision exercised by the contractor.

The following factors should be taken into account when selecting the level of inspection appropriate to a painting operation:

1) the nature of the work and the functions of the coating system: for example, normal maintenance redecoration work might not require full inspection, but this might be necessary for work involving the application of specialist coatings;

2) the cost of inspection in relation to the value of the contract;

3) the resources available for inspection, especially when several locations are involved;

4) the quality of supervision likely to be exercised by the contractor.

Ad hoc inspection of work in progress might be all that circumstances or resources permit. Although better than no inspection, it cannot be regarded as an effective method of ensuring compliance with the specification.

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.

10.2.3 Duties of the inspector

The inspector should assess whether compliance with the specification has been achieved in all respects. The inspector's duties are not described here in detail but should include some or all of the following:

a) ensuring that surfaces are in fit condition for the application of coatings: this might include checking the moisture content of substrates;

b) ensuring that preparatory work is carried out as specified and, where applicable, to agreed standards;

c) ensuring that work is carried out under suitable conditions, e.g. of weather, temperature, humidity, ventilation and illumination;

d) ensuring that materials are of the types and makes specified and are properly stored;

e) 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 film thickness;

f) 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 9.2.9);

g) taking samples for testing if this is a requirement of the specification or is necessary in order to investigate apparent defects;

h) 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;

i) maintaining work records and preparing progress reports;

j) where a separate painting schedule is provide, ensuring that all items are finished in the required colours and types of finish.

10.2.4 Final inspection

Whether or not work has been subject to stage inspection, it should be inspected on completion. In some circumstances, as noted in 10.2.2, 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. The main points on which the general quality of coating systems should be judged by visual inspection are as follows:

a) where applicable, satisfactory stopping and filling: it should be clearly specified if overall filling of surfaces to achieve a high standard of finish is required;

b) uniformity of gloss, sheen or 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, roller stipple or spray mottle;

e) freedom from tackiness;

f) accuracy of cutting-in;

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. 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 be highlighted by low angle illumination (see also 9.1.6).

10.3 Sampling and testing

The routine sampling and testing of materials should be carried out if required for one or both of the following reasons:

a) to ensure compliance by suppliers with specifications or stated requirements for materials;

b) as a safeguard against over-thinning, adulteration or similar undesirable 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 a third sample for submission to the manufacturer should this subsequently prove to be necessary.

Subsequent testing is generally the responsibility of the specifying authority, but the specification should define the contractor's responsibility for providing samples (including the frequency and quantity of material to be provided) and describe to which standard the tests should be carried out.

The coating should be tested in comparison to a test sample against an agreed standard. This might be the manufacturer's specification for the material or a physical sample supplied by the manufacturer or taken from a previously unopened container after thorough mixing. If they are available, the batch numbers of materials used as standards or submitted for testing should be recorded.

The paint should be tested in accordance with the relevant part of BS 3900. BS 3900 describes a comprehensive range of tests for paint under the following general headings:

Group A Tests on liquid paints (excluding chemical tests)

Group B Tests involving chemical examination of liquid paints and dried paint films

Group C Tests associated with paint film formation

Group D Optical tests on paint films

Group E Mechanical tests on paint films

Group F Durability tests on paint films

Group G Environmental tests on paint films (including tests for resistance to biological growth, corrosion and chemicals)

Group H Paint and varnish defects

Most of these tests require laboratory facilities and should be carried out by trained personnel.

Where the measurement of flow time is tested in accordance with BS 3900-A6, a minimum of 100 ml of material should be taken for testing. Where the thickness of applied paint films is to be measured, it should be in accordance with BS 3900-C5.

NOTE For further guidance on protective coatings on structural steel, see BS EN ISO 12944, and for concrete, see BS EN 1504-10.

11 Maintenance

11.1 General

The recommendations given in ISO 12944 and BS 5493 should be followed for the maintenance painting of steel structures and those in BS EN 1504-10 for concrete structures.

NOTE 1 Recommendations on the maintenance painting of buildings can be found in 5.10.

The general aim of maintenance in relation to coating systems should be to maintain or restore to a satisfactory standard the effectiveness of coating systems to their original functions (can include cleaning) at the lowest cost assessed on an annual basis.

NOTE 2 Attention is drawn to statutory requirements or terms of occupancy which require that maintenance is carried out.

Maintenance requirements should be considered at the design stage of new buildings.

NOTE 3 Application of the design principles referred to in Clause 4, including those relating to access, can make a considerable contribution to ease and economy of maintenance.

Initial treatment of new substrates, as described in Clause 8, should be considered in relation to subsequent maintenance requirements. Except possibly where the condition of substrates imposes restrictions on the selection of coating systems, as can be the case with wet substrates, the aim should be to use systems, which provide a sound base for further coats with the minimum of preparation.

NOTE 4 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.

A planned approach should be adopted in order to achieve the aims of maintenance. An essential factor is the establishment of a maintenance schedule, for areas requiring regular treatment at intervals that experience and observation have shown to be the most economic and 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. This facilitates proper assessment of future requirements and enables adjustments to be made to the maintenance schedule, if this is found to be necessary. Records should also be kept of the details, including costs, of all maintenance treatments carried out.

11.2 Factors affecting decisions on maintenance

11.2.1 Timing and frequency

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

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 be incurred as a result of deterioration of structural materials, loss of production or revenue decline in amenity value and other factors.

Buildings should be regularly inspected and the findings recorded to determine the optimum frequency of maintenance. Where experience or records are lacking, as they can be with new buildings, maintenance inspections should be carried out at relatively short intervals in the early stages.

NOTE 2 If this can be implemented, a film of substantial thickness can be built up fairly quickly, an important factor where the system has a protective function.

11.2.2 Condition of paintwork

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 (see 11.2.4). Its significance should be assessed in relation to the functional requirements.

NOTE For example, where the emphasis is on protection, forms of deterioration, which affect appearance alone, such as soiling, colour change or reduction in gloss, might have little significance. Conversely, most forms of deterioration affect appearance although they might not impair protective properties.

Causes of deterioration should be investigated, unless they are obvious, so that corrective action can be taken (see 11.3).

The more commonly encountered defects, typical causes and considerations in respect of remedial treatment can be found in Table 19 and Table 20, but where unusual or rapid deterioration is apparent, expert investigation and advice should be sought.

11.2.3 Variability of deterioration

Deterioration varies according to aspect, elevation, local exposure conditions, conditions of service and other factors and so specifications should be modified to allow for different forms of preparations or the application of additional coats. In some circumstances, patch-painting (see 11.2.7) should be considered.

11.2.4 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 and 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 (see 4.6.4.3);

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;

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 used, e.g. ceramic tiles or plastics sheets or components.

11.2.5 Atmospheric pollution

Painted surfaces subjected to heavy soiling and/or pollution from road traffic should be cleaned regularly (see 11.5.3) and might require more frequent painting.

11.2.6 Building function

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 systems used and the frequency of maintenance.

NOTE The function of a building might also affect its availability for maintenance treatment. For example, maintenance might be possible only outside normal working hours and then only for limited periods, and this can affect costs or impose constraints on the selection of coating systems. Similar considerations might apply when maintenance can be carried out only during shut-down periods.

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.

11.2.7 Patch-painting

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

NOTE 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.

Where the area to be treated is easily accessible, patch-painting should be carried out. However, 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 recoat the whole structure.

11.3 Selection of coating systems for maintenance

11.3.1 General

Where the coatings used previously have performed satisfactorily, materials of similar type should be used for maintenance.

Where performance has not been satisfactory, the reasons for this should be established which may include one or more of the following:

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) unskilled application;

f) use of poor quality materials;

g) use of materials of unsuitable type.

NOTE The type of coating 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 functions.

Where a) is the cause of unsatisfactory performance, 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 was used for initial treatment, functional requirements might indicate a change to a coating more resistant to washing or wear.

Where faulty performance is attributable to b), c), d), e) or f), corrective action should be taken in respect of procedures or quality of material rather than a change in the type of coating.

Where g) is the cause of unsatisfactory performance, the principles described in 4.6 should be followed in selecting alternative coating systems and reference should be made to 4.6.4 for coating systems with special conditions and requirements.

11.3.2 Compatability of coatings

Generally, no problems will be encountered in applying successive coatings of similar type. Difficulties might, however, be experienced with some combinations of existing and new coatings of dissimilar type. The manufacturer's advice should be sought if there are doubts as to compatibility of old and new coatings, but the following are typical of circumstances that might require consideration.

a) Application of water-borne coatings. Adhesion of these coatings, e.g. water-borne paints, over solvent-borne coatings might be poor, especially in conditions of high humidity and to glossy surfaces, which have to be abraded (see 11.5.4).

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 (5/3) might be required on highly pigmented or absorbent coatings.

c) Application of specialist coatings, 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. The manufacturer's advice should be sought in cases of doubt, and small-scale trials might be necessary.

d) Application of drying-oil/resin coatings over zinc-rich primers. Advice should be sought when drying-oil/resin coatings are to be used over zinc-rich primers.

e) Application of all types of coatings over bituminous coatings (see 8.15 and 11.5.9.2).

Difficulty can sometimes be experienced in identifying existing coatings Q by type especially in older buildings although in most cases this is not ^ significant in relation to the selection of coatings for maintenance.

Where identification is necessary, either simple site tests, e.g. the reaction of the coating to solvents of various types, or in other cases, laboratory examination should be undertaken to provide the information.

11.3.3 Components of maintenance coating systems

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, will usually provide a satisfactory result. Allowance should be made for bringing forward (see 11.5.7) 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 white or a light colour. Additional coats might also be necessary with some bright or strong colours; reference should be made to manufacturer's literature for guidance.

Exceptionally, e.g. on internal work in good condition and where the same or a similar colour is to be used, one coat of some types of finish might suffice, but manufacturer's recommendations hi this respect should be followed.

Surfaces from which the old coating has been removed completely should receive a full system as described for new substrates in Clause 8.

11.4 Organization of maintenance work

Reference should be made to Clause 5 for general guidance on organization and Clause 9 for general guidance on conditions of application and procedures. The following factors which have particular relevance to maintenance work should also be taken into account:

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 coatings 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 in order to create a satisfactory working environment, e.g. to exclude process fumes or dust from the working area during application of coatings.

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 coatings. Isolation of the working area, as in b), might be sufficient, but there might also be constraints on the types of coatings that can be used. Specific requirements should be established and the measures to be taken agreed between client and contractor.

Reference should be made in specifications to these and any other special requirements or conditions which might affect the organization of maintenance work.

11.5 Preparation of painted surfaces

11.5.1 General

The preparation of painted and similarly treated surfaces should involve one or more of the following processes:

a) removal of coatings (see 11.5.2);

b) cleaning (see 11.5.3);

c) abrasion (see 11.5.4);

d) priming (see 11.5.5);

e) stopping and filling (see 11.5.6);

f) bringing forward (see 11.5.7);

g) treatment of biological growths (see 11.5.8);

h) treatment of stains and discoloration (see 11.5.9).

NOTE On the assumption that preparatory work will be carried out by skilled and experienced operatives, techniques and methods are not described in detail.

For information on the preparation of old unpainted surfaces, e.g. exterior masonry and non-ferrous metal, reference should be made to the relevant substrate in Clause 8.

11.5.2 Removal of coatings

11.5.2.1 General

Whether or not a coating is to be removed will depend upon its condition and its compatibility with the coating to be applied.

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 to be applied is not compatible with the existing one, e.g. if a specialist coating 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 7.3.5, but the manufacturer's guidance should be sought in case of doubt.

Where the general condition of a coating is obviously poor, it should be removed.

NOTE Frequently, however, and especially in older buildings, 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.

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.

11.5.2.2 Removal by heating

WARNING Removal of paint by heating can result in the emission of toxic fumes and should not be used for the removal of paints containing lead pigment.

11.5.2.2.1 Burning off

Burning off with a blowtorch is usually the quickest and most economical for some types of coating, such as conventional oil or alkyd paints. It is not effective on all coatings and a test should be carried out on a small area before proceeding.

It should not be used to remove highly flammable coatings, e.g. cellulose types, or in proximity to flammable materials.

Burning off should not be used for removing coatings from woodwork that is to be recoated with a clear or semi-transparent coating system, because the wood might be scorched or discoloured. Burning off should not be used for carved or heavily moulded woodwork as it is generally impracticable.

Plaster, cement rendering, asbestos-cement and similar substrates should not be burned off unless the coating is of sufficient thickness to soften without transmitting excessive heat to the surface, otherwise cracking or disintegration, which might become explosive, can occur. Even then, only a low flame should be used.

Burning off should not be used for metal, as heat is conducted away too rapidly for burning off with the normal type of blowtorch to be effective. Flame cleaning (see 8.3.4.2.3) can be used to remove most paint coatings from steelwork, but this is not usually the essential reason for its use.

During burning off, all flammable materials, e.g. curtains and hangings, should be removed from the working area. Great care should be taken about burning off in situations where the flame might penetrate gaps and ignite accumulated rubbish such as old birds' nests. Means of extinguishing fire should be readily available. Burning off should be completed well before operatives leave the work area. Burned off surfaces and surroundings should be carefully inspected before leaving the work area to ensure that there are no signs of combustion (e.g. smouldering and high surface temperatures)

11.5.2.2.2 Hot air

Paint coatings can be softened by heat generated by passing a stream of air through an electrically operated heating element. Although the temperature of the air (up to 600 °C) is lower than that of a gas blowtorch (approximately 1 900 °C), it is sufficient to soften and permit the removal of oil-paint coatings. Although the absence of a flame decreases the fire hazard and the risk of damage to the surface, great care should still be taken.

11.5.2.3 Paint removers

Paint removers should be used to remove coatings when the nature of the substrate or other considerations precludes removal by heating as described in 11.5.2.2. There are two main types of paint remover: alkaline (or caustic) and organic solvent.

Alkaline paint removers, based on caustic soda, potash or similar material, are low in cost, non- flammable and water-rinsable. They readily saponify drying-oil/resin coatings but are usually ineffective with other types. They attack aluminium and zinc, and their residues are difficult to remove especially from porous surfaces.

Solvent-type paint removers can be based on flammable or non-flammable solvents. Solvent-type paint removers as specified in BS 3761 are based on dichloromethane and are non-flammable and water-rinsable and should be used for removing solvent-borne coatings. For other types of coatings including water-borne paints and two-pack coatings, solvent-type paint removers of similar type, but not necessarily conforming to BS 3761, may be used.

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. With alkaline types,
vinegar or acetic acid can be added to the rinsing water to neutralize residues.

In using paint removers, lungs should be protected with a respirator, skin contact should be avoided, and the eyes and hands should be protected. Solvent-borne types should be used in conditions of good ventilation (see also B.1.4, B.2 and B.3).

Particular care should be taken with industrial or phenolic paint removers.

11.5.2.4 Washing off

Non-washable size distemper, once widely used for ceilings, might be encountered in older buildings. It is essential to remove it before repainting, and this should be done by soaking the material with water until it has softened and can be sponged, scrubbed or scraped off.

Other water-borne coatings, including some water-borne paints, while not soluble in water might lose adhesion when thoroughly wetted to an extent that permits their removal (see also 11.5.2.7).

11.5.2.5 Scraping

Coatings having poor adhesion, locally or generally, can often be removed by scraping, without recourse to burning off 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 remainder is satisfactory and that the defective coating is removed back to a firm edge.

11.5.2.6 Abrasion

Abrasion includes hand or mechanical sanding, abrasive discs and pads and wire brushing and should be used for removing perished, heavily chalking or poorly adhering coatings. It might be the only practicable method of preparing external walls having 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 (5/3), after thorough preparation, might be necessary (see 11.5.5).

Precautions should be taken to prevent inhalation of dust and to protect eyes (see Annex B).

11.5.2.7 Steam stripping

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 water-borne paints from interior walls and ceilings. Steam stripping should be used for large areas, as it can be more effective than the washing-off method referred to in 11.5.2.4.

11.5.2.8 Abrasive blasting

Abrasive blasting (see 8.3.4.2.1) can be used for the removal of heavy accumulations of old coatings from external wall 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.

High-pressure water cleaning, referred to in 11.5.3, can also be an effective method of removing old coatings from external walls.

11.5.3 Cleaning

If 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, final rinsing with clean water before the solution has dried is essential. After rinsing, surfaces should be dried off and time be allowed for absorbed or trapped moisture to dry out before coatings are applied.

Washing might not be advisable for water-borne coatings, 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 advisability of wetting the surface, cleaning should be limited to dry abrasion and dusting off.

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.

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.

11.5.4 Abrasion (rubbing down)

NOTE Abrasive materials and methods are described in 9.2.3.

Gloss coatings should be abraded to provide adhesion for the new coating, care being taken not to cut through to the substrate. Abrading assists cleaning and can be combined with washing by using waterproof abrasive paper. Lead-based paint surfaces should be wet-abraded (see B.1.2)

Surfaces from which coatings have been removed by burning off or with paint remover, should then be abraded.

11.5.5 Priming

Surfaces from which coatings have been removed should be primed depending upon the nature of the substrate and the type of coating to be applied. Reference should be made to the appropriate substrate in Clause 8 for guidance.

As noted in 11.5.2.6, it can be difficult to remove perished, heavily chalking or poorly adhering coatings completely, especially from external walls. Preparation, usually by thorough scraping and brushing, should be followed by application of a primer-sealer (5/3) to bind any residual material and reduce the risk of subsequent flaking. It is emphasized that application of a primer-sealer is supplementary to thorough preparation; too much reliance should not be placed on the ability of these materials to penetrate multiple layers of old coatings. Penetration can be assisted by thinning, but the manufacturer's recommendations regarding this should be followed.

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 (see 11.5.9), a sealer should be applied, as necessary.

11.5.6 Stopping and filling

The materials and methods employed in filling should be selected in accordance with 7.4.4 and 9.2.4 respectively.

11.5.7 Bringing forward

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

11.5.8 Treatment of biological growth

11.5.8.1 General

The information in this subclause is based upon that given in BRE Digest 370 [6] to which reference should be made for a more comprehensive treatment.

11.5.8.2 External surfaces

Lichens and mosses are often found on roofs and external walls especially in rural areas. 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 districts 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 growths are present on surfaces that are to be painted, preparatory treatment should include application of a surface biocide.

NOTE Active chemicals used in surface biocides are subject to scrutiny for safety in use under the Control of Pesticides Regulations 1986 (as amended) [11] and require that only products with an HSE registration number be used. This regulation is being absorbed into the Biocidal Products Regulations 2001 [21], however it is an offence to use any pesticidal product without approval under the appropriate Regulations.

The efficiency of surface biocides will vary according to circumstances, for example sodium hypochlorite is readily available and is effective with a wide range of growths but has no residual activity.

When using surface biocides, the manufacturer's instructions should be followed regarding the use of protective clothing (e.g. goggles, gloves, overalls).

NOTE Professional operators will need to take into account procedures required under the Control of Substances Hazardous to Health Regulations 2002 (COSHH) [5] and see B.2.

Surface biocides take a few days to become effective and, in wet weather, can be washed out before they have had tune to act. They 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. The wash, repeated if necessary, kills the growth, but the dead organism takes some time to disappear. The dead matter should be removed by scraping and brushing, and this is often more effective when the growth is dry; however, it is important that asbestos-cement be not scraped or brushed except when wet. All dust and debris should be carefully collected, sealed in plastic bags and disposed of in a safe manner. After removal of the dead growth, a further application of surface biocide (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 abrasive blasting (see 11.5.2.8) or high-pressure water cleaning (see 11.5.3) when circumstances permit or warrant their use and should subsequently be treated with a surface biocide.

11.5.8.3 Internal surfaces

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 4.6.4.4. Preparatory treatment of painted or papered surfaces will depend upon the type of decoration and the extent to which it is affected.

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 surface biocide and kept under observation for a week or so, a further wash being applied if growth is renewed. When growth has ceased and the surface is dry, it can be redecorated.

Where infection is slight and the coating is of a type which will withstand application of a surface biocide, it might be sufficient to clean down without removing the coating and then to apply the wash, allow to dry and repaint.

11.5.9 Stains and discoloration

11.5.9.1 General

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 can require expert investigation but some typical examples are described in 11.5.9.2 to 11.5.9.6. Specialist stain resistant paints are available.

11.5.9.2 Bitumen staining (bleeding)

Where bitumen surfaces need to be overpainted, they should be treated in accordance with 8.15.

11.5.9.3 Knot staining

Discoloration of paint over knots and resinous areas can be indicative of incorrect or inadequate treatment during initial painting and might be transmitted to coatings applied during maintenance painting. If the existing coating is generally in good condition, i.e. does not need to be removed, further staining should be minimized by applying fresh knotting or specialist knot treatment.

11.5.9.4 Tobacco tar staining

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 might cause staining and retarded drying of subsequent coats. To remove the deposit, the coat should be scrubbed with a solution of household detergent or cleaning powder. However, to reduce the risk of the new coating being affected, a coat of aluminium primer (3/4), primer-sealer (5/3) or a proprietary stain blocker can be applied.

11.5.9.5 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 wallpaper should be removed (see 8.12.1.2).

11.5.9.6 Pattern staining

Pattern staining is a thermal effect, differing rates of heat flow through a composite structure causing variations in the amount of dust deposited upon a surface.

NOTE 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 produduce 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, e.g. gloss and mid-sheen types, should be used.

11.6 Application

The general considerations regarding application methods and techniques as described in Clause 9 should be followed. Spray equipment should not be used in occupied buildings in circumstances where spray mist would create a nuisance (see 9,3.6.1) and petrol or diesel engine compressors should not be used in situations where noise and exhaust fumes should be avoided.

Annex A
(informative)
Types of coatings

A.1 General

For the purposes of this code, paints and similar coatings are grouped in three categories as follows:

a) conventional coatings (see A.2);

b) specialist coatings (see A. 3);

c) factory-applied coatings (see A.4). Metallic coatings are referred to in 8.4.

A.2 Conventional coatings

Conventional coatings represent the greater proportion of the coatings 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 Tables 3 to 10, generally according to their functions within the coating system.

Conventional coatings based on binders of the types referred to in Tables 3 to 10 can be modified to impart specific properties, e.g. of mould-resistance or fire protection (see 4.6.4).

A.3 Specialist coatings

Specialist coatings have properties, e.g. of chemical resistance, hardness or other characteristics, not possessed by materials of conventional type (see 4.6.4). 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. For these reasons specialist coatings have limited usage in the painting of buildings.

Table 11 summarizes the characteristics of the principal types of specialist coating. Within the generic categories, there can be considerable variation in the formulation and, in consequence, the characteristics of individual materials.

Reference to manufacturer's recommendations is advised when there appears to be a requirement for the use of specialist coatings. BS EN ISO 12944 and BS 5493 give detailed recommendations regarding specialist coatings for the protection of iron and steel structures.

Table 11 lists specialist coatings that can give extra resistance and/or durability. These coatings can themselves be further modified to provide specific properties such as mould resistance or fire protection.

A.4 Factory-applied coatings

These range from stoving or air-drying paints, applied to wood and metal components by spraying or dipping, to coil coatings mechanically applied to coiled flat sheet for subsequent forming and fabrication. Coatings 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. These coatings can all be overpainted for aesthetic or maintenance purposes, by the correct choice of primer and top coat. The most common factory applied coating is PVC plastisol but more variation in coating types now exists (see 8.13.4).

For light gauge steel, BS 5493 gives guidance in choice of coatings, although there have been improvements in and additions to the types there described. Organic coatings for aluminium extrusions (e.g. windows) are defined in BS 4842, and the expected performance of a variety of coatings on metal and other claddings is tabulated in BS 5427-1. 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 no 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.

Annex B
(normative)

Health and safety

NOTE The list of health and safety hazards in Annex A does not purport to be exhaustive.

B.1 Hazards

B.1.1 General

The materials used for painting buildings are made from a wide range of chemical substances, some of which are toxic. However, if suitable precautions are taken, these materials can be used without risks to health.

NOTE The Control of Substances Hazardous to Health Regulations 2002 (COSHH) [9] require employers to assess the risks which might arise from hazardous substances at work and then to 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 [22].

The risk of exposure depends on the nature of the materials used, the conditions of use and the way in which preparation is implemented.

It might be possible to eliminate a hazardous substance either by changing the process or substituting a safe or 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. Personal protective equipment should only be used where other measures cannot adequately control exposure.

In addition to the manufacturer's recommendations, precautions to be taken by those engaged in the painting of buildings should include the following.

a) The least hazardous product and system of working should be used.

b) Overalls should be worn while working but should be removed before eating and before leaving work. They should be laundered at frequent intervals. Gloves, goggles and a suitable respiratory protection should also be worn when a hazard exists.

c) Reasonable measures should be taken to keep painters' materials off the skin, and hands should be washed before eating or drinking. Silicone-free barrier creams should also be used. Smoking while working should be discouraged since this can cause paint to be transferred to the mouth.

d) It is essential that paints, solvents and other painters' materials are not placed in containers normally used to hold food or drink, and they should be kept out of reach of children and animals. Residues should be disposed of safely.

e) If paint, solvent or other material is accidentally swallowed, medical attention should be sought immediately.

f) Adequate ventilation, either mechanical or natural, is essential.

B.1.2 Lead paints

The use of lead paints has declined in recent years but surfaces in older buildings might have been painted with lead paints. If this is the case, the dust created by dry abrasion is a hazard; and so wet abrasion (see 9.2.3) should be undertaken as it is safer and also more effective.

NOTE 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 [8]. For further information on lead and its exposure levels at work see HSE publications LI 32, Control of lead at work [23] and EHW/2005, Workplace exposure limits [24].

Lead paints should not be used on surfaces which might be licked or chewed by children or animals.

B.1.3 Fungicidal washes and coatings

Some coatings and preparatory washes might contain or be based on materials intended to inhibit moulds or other biological growths (see 11.5.8). While the use of inhibitors having atoxic effect on humans or animals is unlikely, the manufacturer's recommendations regarding their application and also their use on surfaces in contact with foodstuffs should be strictly observed.

B.1.4 Vapours, fumes and dusts

Inhalation of solvent vapours in high concentrations can cause narcosis and can affect the respiratory or digestive systems. Irritation of the eyes, nose and throat can also occur. These effects should be prevented by ensuring that there is sufficient ventilation of the compartment being painted to control solvent vapour concentrations.

NOTE 1 Attention is drawn to the Control of Substances Hazardous to Health Regulations 2002 [9]. Occupational exposure limits, which should be used for the purposes of these Regulations, are reproduced in HSE Guidance Note EHW/2005 [24].

If solvents, notably white spirit, are used for cleaning, 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 to evaporate before work proceeds.

Chlorinated solvents such as dichloromethane, that are used in some paint removers (see 11.5.2.3), are much more volatile than ordinary paint solvents, and the vapours, if allowed to accumulate, are powerful anaesthetizing agents. Also, if the vapours come into contact with flames or red-hot surfaces, they might decompose to form toxic substances. Accordingly, when using paint removers containing chlorinated solvents, it is essential that adequate ventilation is provided and that sources of ignition, including lighted cigarettes and pipes, are excluded from the working area.

Certain types of paint present particular toxic problems when applied by spraying. These include, for example, two-pack epoxy coatings, which can be potent skin and eye irritants, and two-pack polyurethane paints which contain isocyanates and present serious health hazards through inhalation of paint mists. Precautionary measures should be taken to prevent exposure to mist and vapour arising from their use, as both of these classes of paint can cause sensitization. When this is not reasonably practicable, a very high standard of control measures should be taken.

There should be sufficient flow of air through compartments being painted in order to control solvent vapour concentrations adequately. 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 reliable and might not always provide a sufficient flow of fresh air through the space or where natural ventilation is not possible (e.g. in underground and windowless compartments, pits, tank interiors, operating theatres etc.), a mechanical means of ventilation should be provided.

Factors such as the wind conditions outside the building, the volatility of the solvents involved, the rate of application of the paint and the surface area to be coated should be taken into account when deciding upon the method and extent of ventilation. In difficult or unusual circumstances, professional advice on ventilation should be sought.

Where vapours are created, for example in the spray application of two-pack polyurethane paints and epoxy surface coatings, or where surface preparation work creates dust and fumes, this should be regarded as potentially hazardous to health. Where it is not possible to control exposure to vapours, dust and fumes adequately by other means, then suitable respiratory protective equipment should be worn. It is also recommended that accumulations of dust on floors, ledges etc. should be removed with an industrial vacuum cleaner rather than by sweeping.

NOTE 2 Respiratory protective equipment can be regarded as suitable if it is a type-approved by the Health and Safety Executive (HSE) or conforms to a standard approved by the HSE. For further information on respiratory protective devices, see BS 4275 and HSE Guidance Note EH/16, Isocyanates: Health hazards and precautionary measures [25]. For further information on protection against dust, see HSE Guidance Note EH/44, Dust: General principles of protection [26].

Special precautions should be taken in work involving building materials containing asbestos.

NOTE 3 Attention is drawn to the Control of Asbestos at Work Regulations 2002 [27], which requires that any asbestos- containing material is assessed for the likelihood of release of asbestos fibres if disturbed, and that a safe working environment is maintained with respect to all asbestos materials identified. The supply and application of paints and varnishes containing asbestos are not permitted under the Asbestos (Prohibitions) Regulations 1992 [28] made under the Health and Safety at Work etc. Act 1974 [29], In case of doubt or for detailed guidance, reference can be made to the Health and Safety Executive and to HSE Guidance Notes HSG248, Asbestos: The analysts' guide for sampling, analysis and clearance procedures [30] and HSE Guidance Notes EH40/2005, Workplace exposure limits [24] (see also K.3.2 and K.3.3).

B.2 Injury to eyes and skin

Materials such as paint removers, alkaline cleaning solutions and some of the inhibitive washes referred to in 11.5.8 can cause serious injury if they enter the eyes. They might also have a harmful or irritant effect on the skin. When these and materials of a similar type are used, measures should be taken to prevent them from coming into contact with the skin. Where the circumstances or conditions of working are such that heavy contamination of the hands cannot be avoided, impervious industrial gloves should be worn.

Eye protection should be worn, especially when working overhead. 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 Personal Protective Equipment at Work Regulations 1992 [31], 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 Control of Substances Hazardous to Health Regulations 2002 [9].

Hands and exposed areas of skin should 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 might result in skin complaints or the absorption of materials through the skin. Over-vigorous scrubbing or the use of harsh cleaning powders or soaps should be avoided as it might also cause skin complaints.

Impervious industrial gloves should be used if heavy hand contamination is likely.

B.3 Fire and explosion

Many of the materials used by painters are flammable or will support combustion, so that suitable precautions should be taken in their storage, handling and use.

NOTE 1 Highly flammable liquids (paint solvents such as toluene or xylene) are the subject of legislation and there are statutory requirements with regard to their labelling, storage and use. Attention is drawn to the Highly Flammable Liquids and Liquefied Petroleum Gases Regulations 1972 [32] apply to the storage and use of certain flammable liquids.

Precautions should be taken to ensure that vapours of highly flammable solvents do not accumulate in a space or part of a space, which is being painted, as a potentially explosive mixture with air could eventually be reached. The vapour concentrations required to produce such a mixture (i.e. the lower explosive limit or LEL) are about 1% (v/v) in air and ventilation should be provided to ensure that 0.1% solvent vapour in air is not exceeded which gives a ten-fold safety margin.

NOTE 2 Attention is drawn to HSE Guidance Notes L101, Safe work in confined spaces [33] and HSG178, The spraying of flammable liquids [34].

It should be remembered, however, that there can be circumstances where breathing zone concentrations might be low but where pockets of high vapour concentrations nevertheless build up quickly due to poor art distribution, for example in pits and similar confined spaces. It is thus important to ensure that there is good air distribution throughout the whole space and to recognize that this might require the provision of additional means of mechanical ventilation or dispersion to deal with such areas in which there would otherwise be httle 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 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 placed in a metal bin with a close-fitting lid.

NOTE 3 For further information, reference can be made to the advice given in the HSE publication HSG168, Fire safety in construction work [13].

B.4 Noise

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 Information on noise levels and the corresponding maximum exposure times is given in the Noise at Work
Regulations 1989 [35]. Further information can be found in the HSE publication L108, Reducing noise at work [36] (see also BS
5228).

B.5 Spillages

Spillages of paint 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.
The area should be well ventilated to remove solvent fumes, and sources of ignition should be eliminated.

B.6 Waste disposal

Care should be exercised when disposing of waste, in particular if there could be heavy metal, e.g. lead, contamination of the waste.

NOTE Attention is drawn to Hazardous Waste (England and Wales} Regulations 2005 [37] which set out the regime for the control and tracking of the movement of hazardous waste for the purpose of implementing the Hazardous Waste Directive (91/689/EC) [38].

Annex C
(informative)

Wood

C.1 Design considerations

Timbers can be broadly divided into softwoods and hardwoods, and a range of species from both classes is employed 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, 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.

e) Weather protection. Wood surfaces exposed to the weather without surface protection are subject to discoloration,

f) defibration

g) and greying.

h) 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 any risk of decay. Nevertheless an intact paint film on all surfaces will prevent the wood becoming wet enough to support fungal growth, and will prevent the surface being colonized by moulds and other fungal spores. In this restricted sense paint contributes to the preservation of the wood surface.

i) Flame retardance. Coatings can be applied to wood and wood-based panel products to raise the resistance to spread of flame.

C.2 Characteristics

C.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 will occur in softwoods and hardwoods.

C.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.

C.2.3 Moisture content

Green timber contains both free water in the cell cavities and water absorbed by the cell walls. Reducing the moisture content to a mass fraction of about 25% to 30% of the oven-dry mass removes free water from the cell cavities, but the fibres remain saturated and the wood is fully swollen; it shrinks progressively as more moisture is removed. Shrinkage is greatest across the grain and is reversible; changes in moisture content through exposure to ram or fluctuations in relative humidity cause alternate swelling and shrinkage.

C.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.

C.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 they 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.

C.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.

C.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 are also employed.

C.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 will be more obvious on a light-coloured surface. An alternative is the use of an exterior wood stain (see 8.1.8.3).

The widespread adoption of water-borne paints has given rise to significant problems of staining over knots due to extraction of light-sensitive tannins contained in the knots into the coating (see C.2.5). 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.

C.2.9 Coating systems for interior use

C.2.9.1 Paint systems

C.2.9.1.1 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.

C.2.9.1.2 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, though there are moves to reduce solvent-content and for example to use 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 coatings with good resistance to mechanical damage or staining can be obtained. Water-borne varnishes have advanced considerably during recent years and in appearance and wear resistance properties are now almost equivalent to the established solvent-borne types.

C.2.10 Coating systems for exterior use

C.2.10.1 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 affects on coating adhesion.

Much dissatisfaction with the performance of exterior wood coatings over the years has been caused by the use of unsuitable general-purpose alkyd-based paints that lacked sufficient flexibility to cope with the demands of an unstable wood substrate. In order to aid the selection of suitable coatings, 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. DD ENV 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, BS7664. 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. It is advised that the standards of performance set in these standards are regarded as a minimum requirement for wood coatings.

C.2.10.2 Exterior wood stains

C.2.10.2.1 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 coatings lack the opaque protective pigments that are present in paints, and are in consequence less durable than opaque coatings 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.

C.2.10.2.2 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 um to 15 urn for a three-coat application, so the natural features of the wood are least obscured. Low-build stains weather by erosion rather than by flaking, and require a minimum of preparation prior to recoatmg. 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 enables 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 (am to 40 urn 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.

C.2.10.2.3 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.

C.3 Wood-based panels products

C.3.1 Characteristics

C.3.1.1 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 use 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.

C.3.1.2 Fibre building board, wood chipboard and plasterboard

Painting of fibre building board, wood chipboard and plasterboard 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 as follows.

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 manufacture 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 18).

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 coatings 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:

a) Pulp or ivory surface. A surface layer of finely-ground wood fibre is incorporated during manufacture 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.

b) 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.

c) Primed. The board is supplied primed with a pigmented primer ready for site coating. The treatment is available with standard hardboard and softboard.

d) Flame-retardant treatment. Chemical impregnation can render most boards flame retardant according to class 1 of BS 476-7:1997, 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 (see 8.2.2.3). The treatment is available with hardboard, mediumboard and softboard.

e) Perforated. Boards might be perforated during manufacture 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.

C.3.1.3 Wood chipboard

Wood chipboard is composed of chips or particles of wood, mainly softwood, in a synthetic resin binder. It is sometimes described as particle board. 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 coatings, 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 476-7:1997 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.

Annex D
(informative)

Fire

D.1 General

Three requirements for any fire to occur are:

a) a fuel;

b) an oxidizer (normally oxygen in the air);

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.

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, 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 Building Regulations 2000: Approved Document B - Fire safety [39] which specifies 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 the BS 476-7 (surface spread of flame) and BS 476-6 (fire propagation). With the advent of the European Construction Products Directive, a new range of European harmonized tests has been developed, together with a classification system. These European tests, which include BS EN13823, the single burning item test for measurement of heat release rate and surface spread of flame, can now be used as an alternative to the existing National Standard tests (e.g. BS 8202), and it is likely in the near future for Product Standards to be in place, allowing CE marking of construction products. 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 such parameters as substrate type, air gaps between substrate and backing, joint details, horizontal or vertical orientation have to be considered alongside the testing and classification result. Further, the production of burning droplets and smoke can form part of the final classification for a product.

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 being 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.

Annex E
(informative)

Anti-graffiti treatments

E.1 General

All substrates are vulnerable to disfigurement by graffiti and present different types of problem for 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 is also 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" coatings;

2) by selected graffiti resistant coatings.

E.2 Removal

The choice of materials and methods to remove graffiti will depend on many factors including the nature of the marker and the substrate.

The range of markers used by "graffitists" is potentially very wide and could in principle include the most durable coating types. Although some graffitists do go to some lengths to use markers that resist removal (e.g. leather dyes), the majority appear to use 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 will depend 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 such solvents as methylene chloride, methyl pyrrolidone, acetone, trichlorethene as well as acidic and alkaline solutions. They may be available in solution, paste, or bandage form. Within this range there is usually at least one that will be effective against commercial spray paints on smooth surfaces. However it is clear that this list includes many solvents that are under severe and increasing environmental constraints for VOC and other reasons. Their continued availability cannot be assumed.

The effectiveness of removal will depend 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 will also remove the surface leaving a clean patch, which would contrast strongly with adjacent un-cleaned areas. High-pressure spraying brings in additional health and safety, as well as operational factors. The use of abrasive methods may only achieve the desired restoration effect if the whole area is cleaned. Clearly economics and practicality will limit this.

In summary it may be observed that 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 impossible. The adage "prevention is better than cure" applies and in vulnerable areas, surfaces need to be treated to resist application and aid removal.

E.3 Prevention and damage limitation — anti-graffiti coatings

E.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 discouragement arises from the experience of the graffitist when their efforts are easily removed. Discrete signs that such treatment has been carried out may aid this. A more obvious lack of surface wetting would also be a discouragement, and this may 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 the main present purpose of anti-graffiti coatings is to aid removal.

E.3.2 Sacrificial coatings

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 may be removed by hot water jet. Some commercial systems have a special removal solvent. Systems bases on solubilized resins may be removed with mild alkali. Although these coatings are nominally colourless, they will darken the substrate to a degree, since surface penetration reduces light scattering.

Sacrificial coatings require re-coating after cleaning.

E.3.3 Semi-permanent coatings

These have a greater integrity than the sacrificial group and will contain typical acrylic resins as well as wax. The greater film integrity allows removal of the sacrificial coating with various removers, along with offending graffiti. The slightly higher build helps to physically block pores and prevent penetration by the graffiti marker.

E.3.4 Permanent coatings

Permanent coatings overlap with conventional masonry paints but are chosen to have greater resistance to abrasion and chemical cleaning methods. They will therefore include high performance fluoro-acrylics and two component polyurethanes and epoxies. Such coatings needs 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 will be difficult to remove, and continual overcoating would be impractical. On the other hand opaque permanent coatings (anti-graffiti paint), may be a viable option for obliterating graffiti without the need for removal. Conventional masonry paints can also be used for obliteration but will not be so readily cleaned if subject to further attack.

The use of multi-colour finishes (7/14) may help to disguise residual graffiti marking.

As an alternative to the high-build opaque treatment, some permanent low-build transparent systems are emerging which give long-term protection by lowering the surface energy.

E.3.5 Application of anti-graffiti coatings

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.

Annex F
(informative)

Constituents of Coatings

F.1 General

Most coatings consist of binder, solvent or thinner and, in paints and stains, pigment. The binder is the non-volatile film-forming constituent of the coating. 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.

Pigment provides colour and opacity and might have other functions in some types of coatings. 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.

F.2 Binders

F.2.1 General

The nature and proportion of binder present in a coating 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 F.2.2 to F.2.7.

F.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.

Coatings 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 with water-borne dispersions. The actual rate depends upon then* composition and the conditions of application, but typically they are dry to touch in 4 h to 8 h and re-coatable 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 coatings are traditionally organic solvent-thinned, usually with white spirit, although the manufacturer's recommendations in this respect needs to be observed (see F.3). However, it is also possible to solubilize or emulsify alkyds in water, thus moving them into the category of water-borne. Conversely, acrylic resins may be polymerized into aliphatic hydrocarbons by a process analogous to the "emulsion polymerization" referred to in F.2.3. These are described as "non-aqueous dispersions" or NADs, and may be blended with solvent-borne alkyds.

F.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". This type 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 above. Water-borne dispersions are also sometimes described as "latexes" by analogy with natural rubber latex.

Drying and hardening of water-borne dispersions proceed 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 re-coatable 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. Also, 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. Water-borne glosses have a lower gloss than alkyd paints, though their gloss retention is usually better.

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 embrittle more on ageing than do 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-coatings.

F.2.4 Chemically-curing binders

Coatings 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 coatings. 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 coatings of this type 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 and abrasion resistance characteristic of the two-pack types.

Two-pack chemically-curing binders are usually carried in solvent but some water-borne types are available.

F.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.

F.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 tune. 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 ISO 12944 and BS 5493) are based on silicates.

F.2.7 Bituminous binders

Bitumens and tars in solution or as emulsions are used in low-cost coatings, mainly for waterproofing. Suitable coal tar fractions are combined with epoxy resins in some specialist coatings (see Table 11).

Coatings 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 coatings applied over them (see 8.15).

F.3 Solvents and thinners

F.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).

Coatings are generally supplied ready for use, although further additions of the recommended thinner by the user might be permissible, e.g. to assist the penetration of priming coats on absorbent surfaces or for application of coatings by spray.

Over-thinning can seriously impair the opacity and other properties of coatings, but painting specifications need not preclude thinning; as indicated in the previous paragraph, thinning might be necessary in some circumstances. The specifications needs to state, however, that thinning is to be carried out under competent supervision and strictly in accordance with the manufacturer's recommendations as to type and proportion of thinner.

F.3.2 Hydrocarbon solvents

Hydrocarbon solvents are generally of the white spirit type, although aromatic hydrocarbons such as xylene or naphtha might be encountered occasionally. Conventional white spirit contains a mass fraction of about 20% of aromatic hydrocarbons, but low aromatic solvents such as de-aromatized white spirit or isoparaffins are increasingly used. As well as having low odour, these solvents are considered to be less harmful.

F.3.3 Oxygenated solvents

Oxygenated solvents are derived from organic chemicals and small quantities might be included for specific purposes, e.g. help film formation in some water-borne paints. They are a major constituent of cellulose-based paints and knotting solutions (see 7.4.3), and are also used in two-pack epoxy and polyurethane paints.

F.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.

F.4 Pigments

F.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 F.4.2 to F.4.6.

F.4.2 White pigments

Because of the preponderant use of white and light-coloured finishes, white pigments are of considerable importance in the manufacture of paint. Titanium dioxide is the most widely used white pigment; it is non-toxic, has colour and opacity and is resistant to discoloration.

NOTE The use of white lead is restricted to use by specialists for the maintenance of listed historic buildings.

F.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 dyestuff pigments are relatively low in opacity and, with strongly coloured coatings based on pigments of this type, additional coats might be required (see Annex G).

F.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; imparting bulk or structure to the liquid paint and helping to prevent settlement of the solid ingredients during storage; improving intercoat adhesion or imparting roughness or texture to the coating when this is required.

F.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 type, e.g. those based on chlorinated rubber or epoxy resin.

NOTE Red iron oxide (red oxide), although having no inhibitive properties, is often used in conjunction with inhibitive pigments as a colouring agent. Due to their toxicity, lead and chromate pigments have a restricted range of uses.

F.4.6 Laminar pigments

Laminar pigments have a flaky 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 coatings, are also used in heat-resisting paints.

Annex G
(informative)

Paint colours

The available pigments make possible a very wide range of colours 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 cards showing the standard colours 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 is a range of colours for building paints, derived from BS 5252, which establishes a framework within which a number (237) of colours 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 5378-2 give details of this application.

House colours are used by many large organizations to give corporate identity to buildings, equipment, vehicles, etc. Many standard colours of this nature used by official bodies are embodied in BS 381C.

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, 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.

Colours alter in drying: therefore, comparisons of colour in paint cannot be made until sample and 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 pah's 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 where ever possible different containers have the same batch numbers. Slight variations in colour could occur between different batches of paint which will be noticeable if the products are used in juxtaposition. If batching is not possible then different containers should either be intermixed in a larger vessel or individual batches used to complete whole separate elevations.

Coloured pigments vary considerably in opacity, and, with many strong colours, especially those employing dyestuff pigments, special undercoats or additional finishing coats might be needed in order to achieve satisfactory appearance. The manufacturer's recommendations in this respect need to be followed and, where necessary, the use of special undercoats or additional finishing needs to be covered in the painting specification.

Annex H
(informative)

Iron and steel

H.1 Characteristics

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.

H.2 Cast iron

The scale formed on cast iron is more adherent than the millscale 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.

H.3 Wrought iron

In respect of painting, this is similar in characteristics to mild steel although its corrosion rate might differ slightly according to its composition.

Annex I
(informative)

Plaster

I.1 General

BS 1191-1 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 hemi-hydrate 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, should 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.

I.2 Lightweight plasters

BS 1191-2 describes lightweight gypsum undercoat and finish plasters based on grade B plasters with lightweight aggregates. Their general characteristics, in relation to painting, are as described in 8.6.1.2. 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.

Annex J
(informative)

Paper and wallcoverings

J.1 General

Papers and other wallcoverings comprise, first, 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 that their appearance might be restored or that their colour might be changed. The mam 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:

i) wallpapers;

ii) paper-backed and sheet vinyls;

iii) coloured hessians;

iv) non-woven backed wallcoverings.

No problems arise with materials in the first category in respect of painting, but problems can be experienced with some of those in the second category, as indicated in 8.12.1.2 and 8.12.1.3.

J.2 Plasterboard

Plasterboard consists of a core of gypsum plaster with a thick paper liner on each side. Plasterboard can be skimmed with plaster after fixing, the surface then being painted as described for plaster in
8.6. It is also 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.

Annex K
(informative)

Bricks, stone and concrete blocks

K.1 Bricks and stone

K.1.1 Clay bricks

Most clay bricks contain soluble salts and these, in combination with water and the alkalis in cement mortars, can promote efflorescence (see 8.5.1.2). 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 Fletton common 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 surfaces can be affected. Sand-faced and rustic Flettons are not subject to paint adhesion failures to any great extent. BRE Information Paper 22/79, Difficulties in painting Fletton Bricks [40], recommends that external walls built with the intention of painting be 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 paints of conventional type 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 8.14.2) needs to be used.

K.1.2 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.

K.1.3 Concrete bricks

Concrete bricks are strongly alkaline.

K.1.4 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.

K.2 Concrete blocks

Precast concrete blocks are described in BS 6073-1 and BS EN 772-2. 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 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 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 internal and external 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 coatings can be used to prevent staining or soiling.

K.3 Cement-based sheets, boards and components

K.3.1 General

The sheets, boards and components to which this clause 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;

c) glass fibre reinforced cement (GRC) cladding.

K.3.2 Asbestos and fibre-cement goods

WARNING Materials containing asbestos are subject to the legislation that requires precautions to be taken in handling them to ensure that they do not constitute a hazard to health (see K.3.3 and Annex B).

Asbestos and 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), asbestos or other fibre and water, compressed to a fairly high density.

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.

Fibre-cement shares many of the properties associated with asbestos-cement.

Asbestos and fibre-cement is strongly alkaline when new and, if it is damp when painted or becomes so later, paints susceptible to alkaline attack (see 8.5.1.4) 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 (see 8.11.1.4).

K.3.3 Cement-based insulating boards, tiles and planks

Cement-based insulating boards, tiles and planks can be made from Portland cement (GEM 1) and asbestos fibre, glass and other fibres (superseding asbestos, which might still be found in older material). Calcium silicate can also replace Portland cement (CEM 1) in some types.

Cement-based insulating materials are less dense and more porous than asbestos and fibre-cement goods and are used principally as internal wall and ceiling linings. In the situations in which they are normally used, painting is essentially for appearance and to facilitate cleaning.

The materials, especially the types employing calcium silicate as a binder, are usually less alkaline than asbestos- and fibre-cement goods. Differential carbonation (see 8.11.1.44) is not a problem, and back-painting is not therefore necessary.

WARNING Cement-based insulating materials containing asbestos fibre constitute a serious hazard to health and if found, should not be disturbed. Unknown cement-based insulating materials should be treated as containing asbestos fibre until properly identified. Specialist advice should be sought on the treatment of all asbestos containing materials and if necessary the correct method for its safe removal and disposal.

K.3.4 Glass fibre reinforced concrete (GRC) components

Most GRC consists of Portland cement (CEM 1) 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.

Annex L
(informative)

Conditions Of application (temperature and humidity)

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 9.3.2.3).

Solvent-borne coatings, 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 through- harden slowly or develop surface defects such as sagging or rivelling (wrinkling). High temperatures cause solvent-borne coatings to become thinner, and this can result in the application of excessively thin films.

The drying of water-borne coatings depend 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 coatings, there is a secondary curing stage in which the full properties of the coating, e.g. of 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 coatings, 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 coatings, especially on external work. It is generally accepted that the optimum period for external painting in Great Britain 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 coatings. Confining external painting strictly to the period traditionally regarded as most suitable can often be unduly restrictive.