ENGINEERING STANDARD

FOR

PAINTS

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APPENDICES:

1. SCOPE AND FIELD OF APPLICATION

This Engineering Standard gives the minimum requirements mainly for initial construction and also maintenance painting of metal surfaces. The standard also gives minimum requirements for surface preparation and painting of piping, plant, equipment, storage tank, building etc. which will be exposed to different corrosive environments. Painting schedule, paint systems and paint color schedules are included in this respect.

The standard is intended for corrosion protection of steel structures of oil, gas and petrochemical industries mainly for refineries, chemical and petrochemical plants, gas plants, above ground facilities of gas transmission and distribution systems, marine structures and where applicable, in exploration, production and new ventures. This engineering standard is limited mainly to the liquidapplied paints (usually by brush or spray), metallic coating materials that are commonly used for corrosion protection in atmospheric or immersion service is also included. The rate of base metal corrosion where such coatings are used should not exceed approximately 1.3 mm/year (50 mils/year). For corrosion rate above this, both in atmospheric and immersion service, or where catastrophic failure is of concern, these coatings shall not be used, and corrosion-protective measures shall include the use of more corrosion-resistant alloys, cladding and special coatings and linings (see IPS-E-TP-270, IPS-E-TP-350 and IPS-E-TP-620) shall apply.

In addition, internal protection of pipes for water supply and external protection of underground structures are not covered.

It should be noted that eleven different paint groups including 59 paint systems are indicated for a number of applications in section 9 (paint schedule). The user shall therefore decided at the design stage or at the start of a project, which paint system is to be used.

Definitions, types of corrosion environments and standards of surface preparation are also specified here in this standard.

The basic principles of corrosion prevention by paints are discussed in Appendix A while Appendix B gives the characteristic of some paint systems. Appendices C, D, E and F introduce typical painting systems for storage tanks, refinery, fresh water vessels and ships respectively.

2. REFERENCE STANDARDS

Throughout this Standard the following standards and codes are referred to. The edition of these standards and codes that are in effect at the time of publication of this Standard shall, to the extent specified herein, form a part of this Standard . The applicability of changes in standards and codes that occur after the date of this Standard shall be mutually agreed upon by the Company and the Vendor:

SSPC (STEEL STRUCTURES PAINTING COUNCIL)

"Manual, Volume 1 and Volume 2"

BSI (BRITISH STANDARD INSTITUTION)

BS 349 "Specification for Identification of the Contents of Industrial Gas Containers"

BS 381C "Colors for Identification, Coding and Special Purposes"

BS 534 "Specification for Steel Pipes, Joints and Specials for Water, and Sewage"

BS 729 "Hot-Dip Galvanized Coatings on Iron and Steel Articles"

BS 1133 "Packaging Code"

BS 1319 "Specification for Medical Gas Cylinders, Valves and Yoke Connections"

BS 1706 "Electroplated Coatings of Cadmium and Zinc on Iron and Steel"

BS 2015 "Glossary of Paint Terms"

BS 2523 "Lead-Based Priming Paints"

BS 2569 "Sprayed Metal Coatings"

BS 3294 "The Use of High Strength Friction Grip Bolts in Structural Steel work"

BS 3382 "Electroplated Coatings on Threaded Components"

BS 3698 "Calcium Plumbate Priming Paints"

BS 4147 "Hot Applied Bitumen Based Coating for Ferrous Products"

BS 4164 "Coal Tar Based Hot Applied Coating Materials for Protecting Iron and Steel, Including Suitable Primers where Required"

BS 4232 "Surface Finish of Blast-Cleaned Steel for Painting"

BS 4604 "The use of High Strength Friction Grip Bolts in Structural Steel Work, Metric Series"

BS 4652 "Metallic Zinc-Rich Priming Paint (Organic Media)"

BS 4800 "Specification for Paint Colors for Building Purposes"

BS 4921 "Sherardized Coatings on Iron and Steel Articles"

BS 5493 "Code of Practice for Protective Coating of Iron and Steel Structures against Corrosion"

CP (CODES OF PRACTICE)

CP 110 "Structural use of Concrete"
CP 114 "Structural use of Reinforced Concrete in Buildings
CP 117 "Composite Construction in Structural Steel and Concrete"
CP 1021 "Cathodic Protection"

DIN (DEUTSCHES INSTITUTE FUR NORMUNG EV.)

DIN 18364 "Works for Protection against Corrosion of Steel and Aluminum"

AWWA (AMERICAN WATER WORKS ASSOCIATION)

NACE (NATIONAL ASSOCIATION OF CORROSION ENGINEERS)

RP-01-84 "Recommendation Practice, Repair of Lining Systems"

3. DEFINITIONS

3.1 Acid Pickling

Is a treatment for removal of rust and mill scale from steel by immersion in an acid solution containing an inhibitor. Pickling should be followed by thorough washing and drying before painting.

3.2 Blast Cleaning

Cleaning and roughening of a surface (particularly steel) by the use of metallic grit or nonmetallic grit (sand) or metal shot (usually steel), which is projected against a surface by compressed air, centrifugal force, or water.

3.3 Coating

Generic term for paints, lacquer, enamels, etc. A liquid, liquifiable or mastic composition that has been converted to a solid protective, decorative, or functional adherent film after application as thin layer.

3.4 Color

A phenomenon of light or visual perception that enables one to differeciate otherwise identical objects.

3.5 Corrosion Protection

Corrosion protection is the separation of the metallic material from the attacking medium by paint or coating.

3.6 Hand Cleaning

Surface preparation using hand tools such as wire brushes, scrapers, and chipping hammers.

3.7 Immersed

Is defined as permanent immersion such as submerged structures, offshore drilling rigs, etc.

3.8 Intermediate Coat (Undercoat)

The paint intended to be used between primer and top coat in a paint system.

3.9 Manual Cleaning

Includes hand cleaning and power tool cleaning.

3.10 Marine Atmosphere

Is defined by frequent and relatively high concentration of salt mist, but it does not imply direct contact with salt spray or splashing waves; it contains a high concentration of chloride in contrast to the high concentration of sulphur dioxide in the industrial environment.

3.11 Metallic Coating

A metallic coating means one or more layers of metal on a steel base (base material).

3.12 Non Saline Water

Is defined as potable and non-potable water applicable to river installations, sewage treatment tanks, water tanks, and domestic water systems.

3.13 Paint or Coating

Is defined one or more separate, coherent layers consisting of non-performed materials and a binder normally of organic nature on a steel base (base material).

3.14 Power Tool Cleaning

Use of pneumatic and electric portable power tools to prepare a substrate for painting.

3.15 Primer

Is a mixture of binder, inhibitive pigment and solvent. It is used as a first coat on a steel base (base material).

3.16 Sea Water

Is defined as sea and other saline waters and estuary water.

3.17 Shade

Means a color produced by a pigment or dye mixture having some black in it.

3.18 Splash Zone

Is defined as wind and water area of floating and tidal structures, such as wharfs, piers, sea walls, platforms, etc. or frequent salt spray.

3.19 Surface Preparation

Any method of treating a surface in preparation for painting. Swedish standards include photographic depictions of surface appearance of hand and power tool cleaning and various grades of blast cleaning over four initial mill scale and rust conditions of new steel.

3.20 Surface Profile

Surface profile is a measurement of the roughness of the surface which results from abrasive blast cleaning. The height of the profile produced on the surface is measured from the bottoms of the lowest valleys to the tops of the highest peaks.

3.21 Tint

Means a color slightly different from the one under consideration.

3.22 Top Coat (Finish)

The paint intended to be the last coat applied in a coating system; usually applied over a primer, or intermediate coat.

3.23 Tie Coat

Intermediate coat used to bond different types of paint coats. Coating used to improve the adhesion of succeeding coatings.

3.24 For glossary of paint terms see also BS 2015.

4. THE NEED FOR STANDARD

The potential life of a protective system is unlikely to be realized unless:

a) The correct choice of system is made;

b) the materials used in the system can be supplied when required and with the properties attributed to them when making the choice;

c) the materials are applied in conditions and with standards of workmanship described in the IPS-C-TP-102.

d) the handling, transportation and storage (over which the main contractor has minimal control) of all materials and coated components results in no damage to the integrity of the materials or coating that cannot be completely restored;

e) the erection procedures cause no damage to the coatings that can not be completely restored;

f) such restoration of damaged areas results in a protection at least as good as that of the undamaged areas.

There are many variable factors(both natural and otherwise) which can influence the fulfillment of all these conditions for success, and it follows that no two projects can be exactly similar, this is one reason why a "standard" specification shall always be included in a set of contract documents.

5. CORROSIVE ENVIRONMENTS

5.1 Rural Environment

An interior and exterior atmospheric exposure that is virtually un-polluted by smoke and sulphur gases, and which is sufficiently inland to be unaffected by salt contaminations or the high humidities of coastal areas.

5.2 Industrial Environment

Atmospheric exposures that include urban communities, manufacturing centers, and industrial plants (but would not include heavy industrial environments such as coke plants, which fall under chemical environments). The atmosphere contains a considerable amount of gas containing sulfur and industrial fumes that increase the rate of corrosion and adversely affect the paint life. This type of environment is categorized to three different zones as follows:

5.2.1 Mild industrial environment

Consists of normal indoor and outdoor weathering where light concentration of chemical fumes and light humidity conditions exist.

5.2.2 Moderate industrial environment

Consists of:

- industrial environment where moderately aggressive chemical, acid or caustic fumes exist;

- un-polluted coastal atmosphere;

- area where moderate humidity is found;

- area where there is condensation, splash, spray, spillage and frequent immersion of fresh water in intermediate temperatures up to 80°C.

5.2.3 Severe industrial environment

Consists of:

- coastal polluted atmosphere;

- severe industrial environment where manufacturing center and industrial plants exist (but not heavy industrial environments, which falls under chemical environments). And the atmosphere of which contains a considerable amount of gas containing sulfur and industrial fumes.

- area of high humidity;

- area where there is condensation, splash, spray, spillage and frequent immersion of salt water and mild corrosive products.

5.3 Water Immersion Environment (for protection of substrate see also IPS-E-TP-270)

5.3.1 Non saline water

Permanent immersion in fresh and potable water.

5.3.2 Sea water

Permanent immersion in sea water and other saline water and estuary water.

5.4 Chemical Environment (or Heavy Industrial Environment)

An exposure in which strong concentrations of highly corrosive gases, fumes, or chemicals either in solutions or as solids or liquids contact the surface. The severity may vary tremendously from mild concentrations in yard areas to immersion in chemical. So, this type of environment is categorized to three different zones as follows:

5.4.1 Mild chemical environment

Chemical exposure to acidic, neutral and alkaline environment. (PH. 2 to 12).

5.4.2 Moderate chemical environment

Chemical exposure to mild chemical solvents and intermittent contact with aliphatic hydrocarbons (mineral, spirits, lower alchohols, glycols, etc.).

5.4.3 Severe chemical environment

Severe chemical exposure to oxidizing chemicals, strong solvents, extreme PH., or contamination of these with high temperature.

Note:

Protection of substrate in contact with severe chemical environment needs special lining which is beyond the scope of this standard (see table B.1 and IPS-E-TP-270, IPS-E-TP-350, IPS-E-TP-620).

5.5 Marine Environment

Consists of three different corrosive environments:

5.5.1 Atmospheric zone

The zone of the platform which extends upward from the splash zone and is exposed to sun, wind, spray, and rain.

5.5.2 Splash zone

The zone of the fixed or floating offshore or onshore structure such as platforms, which is alternately in and out of the water because of the influence of tides, winds, and seas. Excluded from this zone are surfaces that are wetted only during major storms.

5.5.3 Submerged zone

The zone which extends downward from the splash zone and includes the position of the platform below the mudline (see water environment).

5.6 Underground Environment

All buried surfaces in direct contact with soil (inland, onshore, subsea) which is defined as earth, sand, rock, etc.

Note:

For protection of underground structures proper systems of coating shall be used which is beyond the scope of this standard (see Appendix B and IPS-E-TP-270).

6. ADHESION OF PAINT TO THE SUBSTRATE

The primer is the critical element in most coating systems because it is most responsible for preserving the metallic state of the substrate, and it must also anchor the total system to the steel. This it may do in one of two ways, depending upon the nature of the primer vehicle. Most coatings adhere to metal via purely physical attractions (e.g. hydrogen bonds) that develop when two surfaces are brought closely together.

Paint vehicles with polar groups(-OH,-COOH, etc.) have good wetting characteristics and show excellent physical adhesion characteristics (epoxies, oil paints, alkyds, etc.). Much stronger chemically bonded adhesion is possible when the primer can actually react with the metal, as in the case of wash primer pretreatment, or a phosphate conversion coating.

For adhesion to take place, the coating and substrate must not be separated from one another. Any contaminant on the steel will increase the separation and decrease paint film adhesion.

Moreover, reactive sites on steel at which adhesion can occur are masked not only by contamination, but also by chemically bound species which may themselves satisfy sites on the steel that would otherwise be available for reaction with the paint vehicle. Thorough surface preparation removes such contamination, and exposes many more reactive sites,there by dramatically increasing the amount of surface area where adhesion can occur.

7. FACILITIES FOR APPLICATION OF COATINGS

Surface preparation is normally done by the contractor applying the coating.

If blast cleaning is not available and it is necessary to use a surface preparation method that is inferior to blast cleaning, it is advisable to choose a paint which is compatible with that surface preparation; the advantages of some chemical resistant paints are lost if they are applied over inadequately prepared surfaces. When programming the work, factors to be considered include the following:

a) The sequence of operations (e.g. blast-cleaning before fabrication is normally cheaper than blast-cleaning after fabrication).

b) The application time (e.g. length of a drying or curing time for coating).

c) Methods of application (e.g. airless spray, or brush).

d) The possible advantage or disadvantage of applying the final coat(s) on site. Some coatings (e.g. galvanizing) cannot be applied on site.

8. REQUIREMENTS

8.1 General

8.1.1 The general technique of surface preparation shall be as recommended in IPS-C-TP-101 and the prepared surface before the application of the primer coat shall be in accordance with the applicable grade as specified in Table 1 (paint schedule).

Unless otherwise stated, the prepared surface shall be in accordance with the applicable grade as specified in Swedish Standard, SIS 055900 or SSPC, or BS 4232, or DIN 18364 Standards.

8.1.2 The painting system in general shall be specified in accordance with Table 1 (paint schedule).

8.1.3 Color schemes shall comply with the color schedule in current use at the particular center and/or tables 3, 4 and 5 (paint color schedule) in clause 11.

8.1.4 Paint systems are generally specified by dry film thickness of coat(s) and total dry film thickness of primer, intermediate and top coat rather than by the number of coats.

8.1.5 Unless otherwise stated in the schedule the total dry film thickness of paint systems shall be 150 microns minimum. All paints and paint materials used shall comply with the specification given in IPS Standards for Paint Materials and they shall be obtained from approved manufacturers only.

8.1.6 All materials shall be supplied in the manufacturer's original containers, durably and legibly marked with the description of the contents. This shall include the specification number, the color reference number, the method of application for which it is intended, the batch number, date of manufacture and the manufacturer's name, initials, or recognized trade mark. No intermixing of different brands or types of paints will be permitted. The storage and preparation of paints and other coating materials shall be in accordance with the manufacturer's instructions. For further information see IPS Standards for Paint Materials.

8.1.7 The products of only a single paint manufacturer shall be used for each complete paint system. The use of different paint manufacturers' products for successive coats on a single surface, or piece of equipment, is not permitted.

8.1.8 The characteristics of paint systems are described in Appendix B.

8.2 Surface Preparation

8.2.1 General

8.2.1.1 Paint life depends primarily on surface preparation. Surface preparation shall remove enough foreign bodies to allow the type of priming paint used to wet the surface thoroughly and develop adequate adhesion.

8.2.1.2 For surface preparation reference is made to IPS-C-TP-101, following are some general requirements for surfaces to be painted.

8.2.1.3 Steel surfaces shall be free from rust, mill scale, salts, oil, grease, moisture, etc. by the methods specified in IPS-C-TP-101.

8.2.1.4 The use of so-called rust converters, rust stabilizers and similar means for chemically converting the corrosion products of the iron into stable iron compounds, is not permissible for steel structures. This also applies to penetrating agents intended to inhibit rust.

8.2.1.5 After the surface preparation of the substrate, the grit, dust, etc. shall be removed and a layer of primer applied, before any detrimental corrosion or recontamination occurs.

8.2.1.6 The priming paint is a good "wetting" type such as blast primer and is normally applied by brush (see Appendix B table 2).

8.2.1.7 Fabrication should preferably be complete before surface preparation begins.

8.2.1.8 If hot-dip galvanized steel, stainless steel and non-ferrous metal surfaces are to be painted, a suitable pretreatment in the form of a light blast cleaning with a suitable abrasive such as aluminum oxide shall be given to ensure proper adhesion of the subsequently applied paint system (see Table 6).

8.2.1.9 Wood for woodwork should be treated with a shop-applied wood preservative, to prevent conditions under which organisms are likely to damage the wood.

This preservative treatment shall not have any adverse effect on the subsequent paintwork. Wood to be painted or varnished shall be made free from contamination. If necessary, a stopping putty (paste filler) shall be used for the stopping of holes for unevenness in the woodwork.

8.2.1.10 Concrete surfaces to be painted shall be clean, dry, structurally sound and be of adequate strength, free from laitance, and have some roughness to ensure proper paint adhesion. This surface preparation shall be obtained by blast cleaning, wire brushing with power tools, or etching with very dilute hydrochloric acid followed by rinsing with an excess of water. Mechanical cleaning is preferred to etching with hydrochloric acid and an excess of water, because concrete surfaces shall be dry to a humidity of not more than 4% wt. before paint is applied.

8.2.2 Selection of cleaning method (s) (see IPS-C-TP-101 subsection 4.2)

The cleaning method(s) shall be selected with reference to the following consideration. The choice between blast cleaning, acid-pickling, flame cleaning and manual cleaning is partly determined by the nature of the paint to be applied. It should be appreciated, however , that paint applied to a properly prepared (e.g. blast cleaned) surface always last longer than similar paint applied to flame cleaning or manual cleaned surfaces.

8.2.2.1 Initial condition of surface (rust grade)

8.2.2.2 New construction (uncoated surfaces)

8.2.2.3 Maintenance (coated surfaces)

8.2.3 Standards of surface preparation (see 4. 3. 2. 2 of IPS-C-TP-101)

8.2.3.1 Blast cleaning

The following grades of surface finish are defined in accordance with SIS 055900.

a) SA 3, blast cleaning to pure metal: Mill scale, rust and foreign matter shall be removed completely. Finally, the surface shall be cleaned with a vacuum cleaner, clean dry compressed air or a clean brush. It shall then have a uniform metallic color.

b) SA 2½, very thorough blast cleaning: Mill scale, rust and foreign matter shall be removed to the extent that the only traces remaining are slight stains in the form of spots or stripes. Finally, the surface shall be cleaned with a vacuum cleaner, clean dry compressed air or a clean brush.

c) SA 2, thorough blast cleaning: Almost all mill scale, rust and foreign matter shall be removed, finally, the surface shall be cleaned with vacuum cleaner, clean dry compressed air or a clean brush. It shall then be greyish in color.

d) SA 1, light blast cleaning: Loose mill scale, rust and foreign matter shall be removed.

The grade of surface finish compares as follows with some other internationally recognized standards:

STANDARD LEVEL OF CLEANLINESS IN DIFFERENT STANDARDS

TYPE OF SURFACE PREPARATION	SIS 055900 SWEDEN	SSPC & NACE USA	BS 4232 UK	DIN 18364 GERMANY	REMARKS
MANUAL CLEANING	St 2 THOROUGH SCRAPING, BRU-SHING, GRINDING ETC.	SP 2 — HANDTOOL CLEANING	—	—	ST2 OR SP2 AND HAND TOOL CLEANING IS RECOMMENDED ONLY FOR SPOT CLEANING
	St 3 VERY THOROUGH SCRAPING, BRU-SHING, GRINDING ETC.	SP 3 — POWER-TOOL CLEANING	—	—	
BLAST CLEANING	Sa 3 PURE METAL	SP 5 TMO1-70-NO1 WHITE METAL	FIRST QUALITY	—	
	Sa 2 1/2 VERY THOROUGH	SP 10 TMO1-70-NO2 NEAR WHITE	SECOND QUALITY	ENTROSTU-NGSGRAD 2	
	Sa 2 THOROUGH	SP 6 TMO1-70-NO3 COMMERCIAL	THIRD QUALITY	ENTROSTU-NGSGRAD 3	
	Sa 1 LIGHT	SP 7 TMO1-70-N04 BRUSH-OFF	—	—	
TYPE OF SURFACE PREPARATION	SIS 055900 SWEDEN	SSPC & NACE USA	BS 4232 UK	DIN 18364 GERMANY	REMARKS
CHEMICAL CLEANING	ACID PICKLING	SP 8 —	—	—	
		SP 1 SOLVENT CLEANING	BS 5493 CP 3012		

8.2.3.2 Manual cleaning

Manual cleaning using mechanical cleaning tools to remove mill scale and rust is the least satisfactory method of surface preparation and is used where blast cleaning is impractical or not economical. The surface produced shall be in accordance with IPS-C-TP-101 or SIS 055900 st3 or SSPC-SP 3.

The manual cleaning methods shall not be used for the preparation of steel where high quality long-life systems are to be used.

8.2.3.3 Chemical cleaning

a) Acid pickling: Pickling shall be carried out in the workshop.

The surface produced shall be in accordance with IPS-C-TP-101 Section 6. The process normally comprise:

- Immersion in a bath of warm dilute sulphuric acid or phosphoric acid both to remove mill scale and rust.

- Washing in a bath of warm water to remove all traces of sulphuric acid. This water wash may be omitted when phosphoric acid pickling is used.

- Immersion in a bath of hot dilute phosphoric acid to provide a passivated surface suitable for painting. The contents of the baths shall be discarded when the concentration is below that indicated specifically for the bath or if accumulation of sediment causes staining of the work.

b) Solvent cleaning: Solvent cleaning should be used prior to the application of paint and in conjunction with surface preparation methods specified above for the removal of rust, mill scale or paint, etc. Petroleum solvents such as kerosene, mineral spirits, or chlorinated solvents such as trichloroethylene or 1.1.1 trichloroethene can be used to dissolve and remove soil. Chlorinated solvents are also effective in removing heavy oils, greases and waxes (see IPS-C-TP-101 Section 5).

8.2.4 Surface preparation for maintenance

Initially all areas of loosened paint and scale and all points of rusting should be located and treated in a manner essentially similar to the preparation detailed in the previous section. If such areas are sufficiently numerous as to make exact location and definition a difficult proposition, then whole paintwork should be prepared overall by sand-blasting, chipping, scraping and power wire brushing to the standards detailed in the previous section.

All prepared areas shall then be degreased where necessary by solvent cleaning method. Surface preparation for maintenance shall be in accordance with IPS-C-TP-101 Section 13.

8.3 Paint Application

Paint application shall be in accordance with IPS-C-TP-102, here are some general requirements for painting.

8.3.1 General

All surfaces shall receive an appropriate paint system as specified in Table 1, with the following exceptions:

- any equipment furnished completely painted by the manufacturer unless it is specially required to match a color scheme or to repair damage to the paint film;

- hot-dip galvanized steel,weathering steel, stainless steel and non-ferrous metals, monel, brass, copper, aluminum jacketing unless it is specially required;

- nonmetallic surfaces;

- nameplates, code stampings and push-buttons;

- surfaces to be fireproofed;

- concrete, brickwork, tile, glass and plastics,unless specially required;

- machined surfaces;

- insulation weatherproofing material or sheeting;

- rubber hoses, belts flexible braided connectors, stainless steel tubing and fittings, gages, valve stems and motor shafts;

- and any surface particularly indicated as not to be painted.

The painting requirements often depend on the 'surface temperature' of the substrate involved. The surface temperature shall be taken to be the maximum operating temperature.

8.3.2 Paint application requirements

All paint shall be thoroughly stirred to give uniform consistency before use. The grade and quantity of thinners shall be agreed with the paint supplier, excessive thinning will be a cause for rejection of the work. Paint supplied as more than one component shall be thoroughly mixed in the proportions laid down by the supplier and applied within the specified time limit after mixing ('pot life').

Coatings containing heavy or metallic pigments that have a tendency to settle shall be kept in suspension by a mechanical agitator or stirrer.

No paint shall be used in which the vehicle has set hard and which can not readily be reincorporated by correct mixing. Similarly, no paint shall be used which has jellified or which has thickened to such an extent that too much thinner is required to brushing consistency.

No paint shall be used which has livered, gelled, or otherwise deteriorated during storage.

Paint shall not be applied under the following conditions:

- when the temperature of the surfaces is less than 3°C above the dew point of the surrounding air, and/or the relative humidity is higher than 80% ;

- when the temperature is below 4°C;

- when there is the likelihood of an unfavorable change in weather conditions within two hours after coating;

- when there is a deposition of moisture in the form of rain, condensation, frost, etc., on the surface*.

- when the surface temperature is more than 35°C.

Each layer of paint shall be allowed to dry for a period of time within the limits prescribed by the paint manufacturer, before the next layer is applied.

Subsequent layers of a paint system shall have a difference in tint or color.

Particular attention shall be paid to the painting of corners, edges, welds, etc. especially with respect to the specified minimum dry-film thickness.

During both application and drying, adequate ventilation and lighting shall be provided if the work area is enclosed.

All steel constructions or plates shall be provided with a priming or coating system to protect the steel surfaces during the transport, storage, construction and joining stages, e.g. welding of the project.

All surfaces inaccessible after assembly shall be fully painted before assembly.

*** This is likely to occur when the relative humidity is over 80% and the temperature is below 15°C**

8.3.3 Standard of paint application

In all methods of application the aim is to produce a uniform coating of the film thickness specified, free from pinholes, missed area, runs, sags or curtains, and wrinkling or other blemishes which may impair durability.

The following standard methods of paint application are applied as in IPS-C-TP-102:

8.3.3.1 Brushing

The film produced by brushing shall be free from brush marks, consistent with good practice for the type of paint used.

8.3.3.2 Spray application

Spray application shall give a full wet coating with a minimum of spray pattern (orange-peel effect, "see BS 5493"). Each successive pass shall overlap the previous pass to give a uniformly even film. This applies equally to air spray and airless spray.

8.3.3.3 Metallic coatings

Four methods for applying metallic coatings are in general use.

a) Hot-dip galvanizing

For structures, fittings and claddings;

b) Sherardizing

Mainly for fittings, fasteners and small items;

c) Electroplating

Mainly for fittings, fasteners and small items;

d) Metal-Spraying

For structures and fittings (including fasteners when done after fabrication). For more information see App. B.

8.4 Priming and Painting (see IPS-C-TP-102)

8.4.1 General

8.4.1.1 Prepared surfaces shall be primed generally within four hours or before visible re-rusting occurs.

Paints and other coating materials shall be applied in accordance with manufacturer's instructions and good industrial practice. The prepared surface shall be as specified in clause 8.2.3 and IPS-C-TP-101.

Unless otherwise stated, depending on the type of paint, the following surface preparation criteria shall apply:

PAINT TYPE	REQUIRED SURFACE PREPARATION IN ACCORDANCE WITH SIS 055900
ZINC SILICATE	GRADE SA 3
EPOXY	GRADE SA 2½
OIL-BASED (ALKYD)	GRADE SA 2½
RED LEAD	GRADE SA 2½
OTHERS	GRADE SA 2½

The degree of surface roughness or peak-to-valley height required after blast cleaning generally depends on the type of paint, but shall not exceed the following values:

- 80 microns for structural steelwork;
- 80 microns for tank lining;
- 50 microns for drum lining.

The minimum peak-to-Valley height shall be 30 microns.

8.4.1.2 Unless otherwise specified by the Company the priming coat or coats on steel shall have a total dry film thickness not less than 50 microns. When applied in two coats,a shade contrast between coats is recommended.

8.4.1.3 In order to minimize contamination between successive coats of paint, overcoating of the preceding coat shall be done as soon as is permitted by the particular specification, and not delayed beyond the period specified. When delays are unavoidable, the painted surface shall be thoroughly cleaned and dried to the satisfaction of the Engineer before overcoating may take place.

8.4.1.4 The total dry film thickness of paint systems (i.e. primer plus intermediate and topcoat) shall be in accordance with section 9, paint schedule, of this Standards.

8.4.1.5 When painting larger areas, full use should be made of paints formulated for high build and applied by airless spray, thus reducing the number of coats for the required minimum thickness.

8.4.1.6 Any defect or damage that may occur shall be repaired before the application of further coats; if necessary the particular surface(s) shall be made paint-free.

Areas which are to be overcoated shall be thoroughly cleaned, free from grease, oil and other foreign matter and shall be dry. The surfaces shall then be prepared to the standard as originally specified for each paint system (for large damaged areas), or prepared to the highest possible standard using mechanically operated tools (for small local damaged spots up to 1m).

Subsequently additional compatible coats shall be applied,until they meet the specification. These additional coats shall blend in with the final coating on adjoining areas.

8.4.2 Steel prepared by blast cleaning

Blast cleaned steel prepared to SIS Sa3 or Sa 2 1/2 will frequently be coated either in the shop or on site with a thin coat of a pre-fabrication primer. For this purpose a blast primer (see App. B) should be used.

For further priming over the above primer, or for direct application to blast cleaned steel, the priming paints shall be in accordance with Clause 9, Paint Schedule (Table 1).

It is essential that the total film thickness of the priming coats (blast primer plus second primer) shall meet the prescribed thickness of 75 microns minimum in all areas.

8.4.3 Steel prepared by acid pickling

8.4.3.1 Steelwork prepared by acid pickling should be treated with 2% phosphoric acid solution. This leaves a thin phosphate coating on a warm steel surface, to which the paint shall be applied immediately. This method is not generally used outside the pipe industry, but large plates for storage tanks have been pickled in this way. Generally, pickling is done by specialist firms.

8.4.3.2 Zinc-rich primers, both organic and inorganic, are not suit-able for application to phosphate pickled surfaces.

Zinc chromate primers are also not recommended for use on pickled surfaces and their use would generally be confined to aluminum surfaces.

8.4.3.3 Irrespective of the type of primer used on pickled steel it is essential that the total film thickness of the priming coats meet the prescribed film thickness of 50 microns minimum and this would normally be achieved by the site application of a further coat of priming in accordance with clause 9, Paint Schedule.

8.4.4 Steel prepared by wire brushing

Priming paints for steelwork prepared by wire brushing must have good wetting properties and must be applied by brush in order to ensure a high standard of adhesion to the prepared steel surface.

The red lead alkyd priming paint when applied as a two coat system to a minimum dry film thickness of 50 microns, is recommended for wire brushed surface.

8.4.5 Shop preparation, priming and painting

8.4.5.1 Full protection applied in the shop immediately after fabrication normally results in a longer life of the protective system. However, damage during transportation and erection may subsequently necessitate widespread repair or touch-up of coatings, so the structural steelwork, surface pipework, towers, vessels, heat-exchanger shells and similar containers which will not be lagged shall be treated in the shop as follows:

8.4.5.2 Mild industrial environment not more than three months

Blast clean, second quality, SIS 055900 Grade Sa 2½ .

Prefabrication primer, or blast primer, dry film thickness 20 microns minimum.

For moderate industrial environment the dry film thickness of primer should be 50 microns.

8.4.5.3 Mild industrial environment, more than three months

Blast clean, second quality, SIS 055900 Grade Sa 2½ .

prefabrication primer or blast primer overall, 20 microns dry film thickness, followed by full primer coat(s) 75 microns, and one intermediate coat overall but stopped back 100 mm from welding edges.

For moderate industrial environment the dry film thickness of shop primer should be 50 microns minimum.

8.4.5.4 Sever industrial environment, e. g. stored in sever corrosive environment deck cargo shipment

Blast clean, second quality, SIS 055900 Grade Sa 2½.

Full primer coats 75 microns min., overall, plus intermediate coat and topcoat to a total dry film thickness of 190 microns minimum.

8.4.6 Preparing of shop primed surfaces for overcoating

8.4.6.1 Any primed surface which has been exposed for more than a few days will have become contaminated and shall be cleaned down with fresh water and allowed to dry before overcoating.

8.4.6.2 Prefabrication primer or blast primer exposed longer than 6 months to the atmosphere shall be removed by blast cleaning before applying the specified paint system.

8.4.6.3 Prefabrication primer or blast primer less than 6 months old and still in a good condition shall be cleaned thoroughly with clean fresh water before applying the paint system and shall only be removed if they are not compatible with the subsequently specified paint system.

8.4.6.4 If it is necessary to protect austenitic stainless steel surfaces during transport and storage at site, a proofed material, e.g. plastic sheeting shall be used, unless the surfaces are provided with a prefabrication primer or blast primer (see Appendix B).

8.4.6.5 Shop-primed surfaces shall be cleaned thoroughly with clean fresh water before applying the subsequent layers.

8.4.6.6 The cleaning and patch painting of damaged spots and of weld areas shall be in addition to the complete specified paint system.

8.4.6.7 If previously painted pipework is to be cut and welded on site, all paint must first be removed from the area of welded joint.

8.4.6.8 Primed and painted surfaces which have been exposed to marine environments including shipment, will be contaminated with salt and should be lightly wire brushed, then washed with fresh water before overcoating.

8.4.6.9 Although zinc rich primers are very effective in preventing rusting. extended exposure develops a surface contaminated of zinc corrosion products which can impair the adhesion of subsequent coats. Zinc rich primers, both organic and inorganic, which have been exposed long enough to develop white surface staining, shall be prepared for overcoating by one of the following methods:

a) Light blast cleaning and dust removal;
b) Wirebrushing, followed by water washing;
c) Scrubbing with fresh water, using bristle brushes;

8.4.6.10 Damaged surfaces shall be repaired in accordance with Clause 9, Paint Schedule, with 10 cm. overlap.

8.4.7 Treatment of specific surfaces

8.4.7.1 Edges

It is imperative that all sharp edges be coated to the same film thickness as the adjacent steelwork to prevent premature break-down from this area. Corners, crevices, bolt heads and rivet heads require similar attention.

Where there is any doubt that these areas have received adequate film thickness the Engineer may direct that an additional strip coat of paint, be applied to ensure the full film thickness, without any additional cost to the Company.

8.4.7.2 Faying surfaces of friction-grip joints *

The faying surfaces of friction-grip bolted joints (see BS 3294 and BS 4604) require special attention. If left bare, all points where moisture could gain access shall be effectively sealed. The alternative is to protect the faying surfaces, but in this case the effect of the protective schemes on the slip factor has to be closely investigated, and their behavior under static, dynamic and sustained loading shall be considered. If adequate test results are not available they shall be obtained. Consideration shall also be given to possible losses of pre-tension arising from the behavior of protective coat-

ings on fasteners and in friction grip joints. Sprayed aluminum or zinc, hot-dip galvanizing paint of the zinc silicate type or special paint with abrasive addition shall be considered.

8.4.7.3 Fasteners

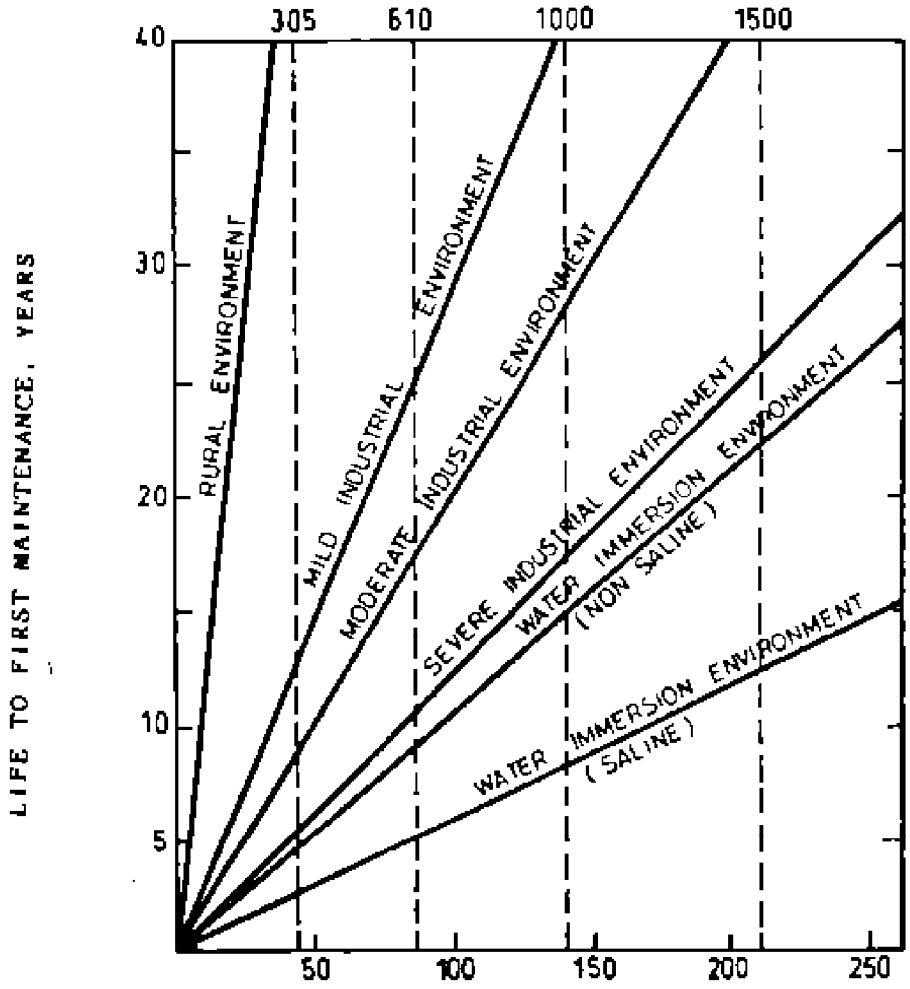
Fasteners which are exposed after assembly, such as steel pipe and cable-hangers, are zinc or aluminum coated, or blast-cleaned and primed before welding-on (if not blast-cleaned with the structure). Fixing nuts and bolts must be galvanized (see BS 729), Sherardized (see BS 4921), or electroplated (see BS 3382 and BS 5493 Table 4). An adequate thickness of zinc shall be applied, and when the zinc coating on fasteners (applied by galvanizing, electroplating or sherardizing) is too thin for the life requirement, further coatings shall be applied on surfaces exposed after assembly as follows:

a) Zinc-dust paints: to total thickness suggested by figure 1 for appropriate environment and life to first maintenance.

b) Other coatings: to thickness that will offer protection equivalent to that given to the main structure.

*** The term faying surfaces of a friction-grip joint means surfaces which, when in contact with another, transmit a load across the interface by friction.**

GALVANIZED COATING, SPECIFIED MINIMUM WEIGHT, G/M^2



SPECIFIED MINIMUM THICKNESS, MICRONS

TYPICAL LIVES OF ZINC COATINGS IN SELECTED ENVIRONMENTS
Fig. 1

8.4.7.4 Welds

As-rolled steel may be blast-cleaned and protected with blast-primer before fabrication and welding (see BS 5493 Table 4 A), this prevents the serious development of rust, which would be difficult to remove after fabrication. The use of steel that has rusted heavily during storage should be avoided for the same reason. When welding metal-coated or zinc-dust painted steel, it is necessary to remove the coating near the weld area, or mask-off the weld area before coating. Most painted steel can be cut and welded satisfactorily provided that the coating thickness is less than 25 microns, but welds that are likely to be heavily stressed shall be examined by the engineer for porosity. After welding, scale and heat-damaged coating shall be removed by local blast-cleaning and the area renovated by re-painting the original coating. Galvanized or metal -sprayed surfaces shall be made good by:

a) metal-spraying on site;
b) application of zinc-rich paints to reinstate the original dry film thickness; or,
c) application of low melting point zinc alloys heated by torch to pasty condition (these contain fluxes which shall be removed).

To avoid the need for early maintenance of site welds on painted structures they shall be blast-cleaned before protection.

8.4.8 Sprayed metal plus sealer system

A sealer (see BS 5493 Table 4C, Part 2) which fills the metal pores and smoothes the sprayed surface, improve the appearance and life of a sprayed-metal coating. It also simplifies maintenance, which then requires only the renewal of the sealer.

Sealers shall be applied immediately after spraying the metal coating. Pretreatment primer may be applied before sealing (see BS 5493 Table 4F, Part 4).

Metal-Spraying and sealing are done by specialist contractors who are equipped to apply the full protective system in shop or on site.

8.4.9 Metal plus paint system

8.4.9.1 General

Metal-Coated steel is painted only when:

a) the environment is very acidic or very alkaline (i.e. when PH Value is outside the range 5-12 for zinc or 4 to 9 for aluminum); or,

b) the metal is subject to direct attack by specific chemicals (see Note on page 33); or,

c) the required decorative finish can be obtained only by paint; or,

d) when additional abrasion resistance is required.

The thickness of the paint is related to the type of environment, generally one or two coat of paint (dry film thickness,100 micron) may be sufficient except in abnormally aggressive environments (like acid environment). Sealed sprayed metal is usually preferable to painted sprayed metal.

Appropriate paints usually have a longer life on metal coating than on bare steel, and rusting and pitting of the steel is reduced or prevented.

8.4.9.2 Zinc coatings plus paint

The paints used shall be compatible with the sprayed or galvanized surfaces. Most paints, other than those containing drying oils, are suitable for application to zinc-coated steel that has been pretreated as in IPS-C-TP-102 Subsection ....

New galvanizing will not normally be painted unless exposed to environments where progressive loss of zinc will ultimately cause corrosion of steel to occur within a 3-4 years period. In practice this would include galvanized steel subjected to industrial severe corrosive environment and marine atmospheres; also painting for appearance.

Where new galvanized steel is to be painted, it shall be thoroughly degreased by wiping down overall with white Spirits and primed with a brush applied coating of blast primer. Subsequent finishing with alkyd paints would then be permissible.

Where new galvanized steel is to be subjected to a particularly acid environment (moderate chemical) including contact with acids or close proximity to acid gases then, following thorough cleaning to remove grease and salts (washing with clean water may be necessary) the cleaned galvanized surface should initially be pretreated by the brush application of a two pack blast primer (see Table B.2) followed by at least two coats of epoxy paint in accordance with system 7D Table 2- Group 7 of this Standard.

Weathered galvanizing which has been subjected to a period of at least 12 months in its permanent location shall be thoroughly cleaned to remove all salts with clean water, dried and then primed with a brush applied coating of two pack blast-primer. Subsequent finishing with alkyd paints would then be permissible.

Certain fixings for galvanized sheeting, such as zinc coated strapping can normally only be obtained with a zinc coating even thinner than 75 microns. Such fixing should be prepared and primed after erection as above followed by intermediate coat and top coat.

Certain zinc coated steel surfaces including zinc metal spray, electroplated zinc and sherardizing, can also be treated as above.

Note:

For storage or transport of chemicals specialist advice shall be sought. The effect of the coating on the chemical shall be considered as well as the protection of the steel.

When subject to splashes of acid or alkaline chemicals, painting recommendations are similar to those given in groups 4, 5 and 7 of Table 2, except that oil-type paints (groups 1 and 2) shall not be used and zinc silicates are not recommended for acid conditions.

Metallic zinc is generally suitable for chemicals when the PH-value is in the range 5 to 12; metallic aluminum is generally suitable when the pH-value is in the range 4 to 9. Only specially formulated two-pack chemical-resistant paints and silicates are suitable for solvents and petroleum products. In splash conditions coal tar epoxy (7J for 10 to 20 years, 7I for 5 to 10 years, 7H for less than 5 years) or zinc silicate (5D for 10 to 20 years) may be suitable.

8.4.10 Stainless steel plus paint

Stainless steel is not normally required to be painted but where insulation is to be applied to stainless steel equipment or piping or such items that are to be stored in the open air for long periods or are to be shipped as deck cargo,protective coating should be specified by the company. Zinc containing paints are not allowed for this purpose.

For potential fire situations, where hot-dip galvanizing or zinc coating are present, austenitic stainless steel equipment shall be specially protected against the possibility of zinc embrittlement failure which may result in rapid fire escalation. Such equipment shall be located in a shielded position which will reduce the risk of molten zinc falling onto the steel. Any bare stainless steel parts, e.g. flanges, which are within reach of zinc shall be protected with a painted steel shield.

Where adequate shielding is impractical, hot-dip galvanized or zinc-coated components shall not be used in close proximity to and particularly above the stainless steel concerned. Stainless steel plates in store shall be stacked on edge.

8.4.11 High temperature surfaces

Resistance to heat is influenced mainly by the nature of the temperature cycle, the maximum service temperature and its duration. Furthermore the behavior of the coating will vary considerably according to whether or not the surface remains dry (even when cold). When warm, the presence of hot gases will have specific effects.

Only general recommendation is given in this Standard and the treatment for bare hot surfaces will be subject to a particular specification for each project which will be specified in the contract documents.

For temperatures up to 200°C, sealed sprayed aluminum or sealed sprayed zinc may be considered for long or even very long life to first maintenance, depending on the circumstances. A special silicone alkyd over a zinc silicate primer system may be considered for medium lives. Where silicones can not be tolerated, a silicone-free aluminum paint may be specified; advice should be sought from the paint suppliers. The maintenance periods is related to the operating temperature.

For temperatures up to about 550°C aluminum (175 microns nominal thickness) is suitable as sprayed. Arc-sprayed aluminum should preferably be specified where there may be cyclical temperature fluctuations. The sprayed aluminum may also be silicone-sealed and, for temperatures typically about 250°C, silicone-sealed sprayed aluminum can have a very long life (20 or more years).

The zinc silicate systems are also recommended, system 5B (see group 5 of Table 2) for example, may in moderate industrial environment, last for up to 10 years before maintenance is needed.

The zinc silicate/aluminum silicone treatment is to be preferred for severe industrial environment.

For temperatures up to 900°C aluminum (175 microns nominal thickness) applied by electric arc under controlled conditions may be considered for some uses, BS 2569: part 2, gives some alternatives.

For components to be used at service temperatures up to 1000°C the BS 2569: part 2 , specifies a nickel-chromium alloy; with sulphurous gases present, the nickel-chromium is followed by aluminum and in each case there is a subsequent heat treatment.

The life to first maintenance of coatings recommended for temperatures up to 550°C, up to 900°C, and up to 1000°C will depend on the exact combinations of conditions in service but will usually be less than 10 years, although the sprayed aluminum coating may last longer if maximum temperature and other conditions are not too severe.

Notes:

1) Oil-Based aluminum paint shall not be applied to surfaces above 100°C where flammable vapor or explosive dust may be present.

2) Heat-resisting silicone aluminum paint will become sufficiently hard to be handled at ambient temperatures, however in general, maximum performance is only obtained after the paint has been exposed for at least one hour to 200°C.

3) If for the detection of hot spots on the outside surface of cold wall reactors (i.e. reactors with an internal refractory lining)'temperature indicating paints are specified, the surface preparation and paint application shall be in accordance with the manufacturer's instructions. Only products from approved manufacturers shall be used.

8.4.12 Refrigerated surfaces (down to - 30°C)

The low temperature reduces the corrosion rates but facilitates condensation conditions. Where water is present an effective barrier layer is required on the steel.

The general recommendation for treatment of such surfaces is as follow:

a) Sealed or unsealed sprayed-metal coatings and bare galvanizing are generally suitable (e.g. systems 8A, 9B, 9D see groups 8 and 9 of Table 2).

b) Typical coating systems include zinc silicate (system 5B) or zinc-rich epoxy paint (system 4A) for 5 to 10 years and system 6C (chlorinated rubber paint system) for less than 5 years, epoxy paint (system 7B) for 5 to 10 years and system 7A for less than 5 years.

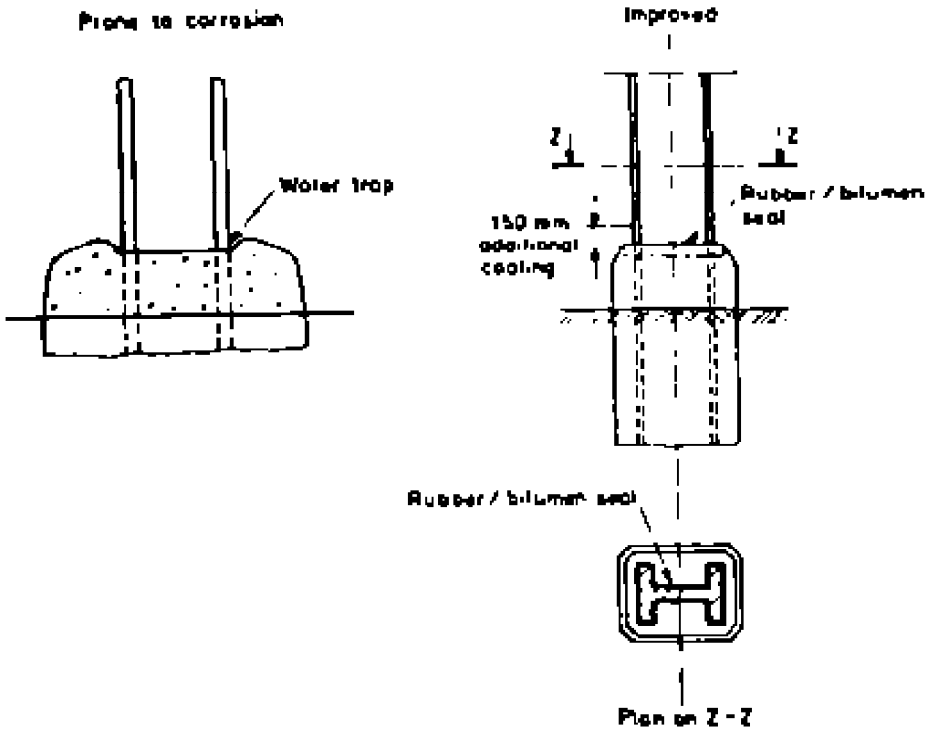
For temperature below -30°C specialist advice should be sought.

8.4.13 Concrete surfaces

If concrete surfaces are to be protected the first paint layer shall be applied by brush after having filled any surface imperfections with an appropriate putty.

8.4.14 Encasement in concrete

Steel require no protection when fully encased in alkaline (uncarbonated) concrete. Protection by sprayed-zinc, by galvanizing, or by zinc-rich coatings (see group 4 of Table 2), is beneficial in the zone which may become carbonated (see BS 5493" protection of steel by cement and allied products" and "concrete"). Where the coated steel enters the concrete, a bituminous coating may subsequently be applied usefully at any interface where water may tend to remain (see Fig. 2).



PROTECTION OF A STANCHION AT GROUND LEVEL
Fig. 2

8.4.15 Under insulation surfaces

Although a specific coating system cannot be recommended, the requirements that must be met by the coating can be specified.

In the insulation industry, a primer is sometimes used, particularly under spray-on foam insulation materials. It should be understood that the purpose of the primer is to present a clean surface for bonding of the insulation. The primer type paints are not intended to and will not prevent corrosion by hot water. The key to specifying a paint system is to remember that it will be exposed to hot water vapors, a very severe environment for paints.

The use of inorganic Zinc paint as a primer, coupled with the hot water, will not cause accelerated corrosion of the steel. Zinc and the silicate binder are both dissolved by hot water. Even if conditions favored the Zinc becoming cathodic to steel, the protective coating binder would dissolve and the coating would break down.

The advisability of using inorganic Zinc under other protective coatings is not as clear. Some tests seem to indicate good performance. Others show that inhibited primers with topcoats achieve maximum performance in hot-water systems. Therefore, the main criterion for a protecitve coating under insulation is that it resist hot water and water vapors. This severe service will also require high-quality surface preparation.

8.4.16 Marine structures

Structures exposed to marine conditions, including offshore equipment, Jetties, wharfs, dolphins, buoys, pipework, manifolds, hose handling gear, lifting equipment and machinery, deck, landing stages, separators for oil/water and oil/gas etc., require high grade of protection and shall be coated as specified in Table 1 (paint schedule) and where applicable as specified in IPS-E-TP-270, IPS-E-TP-350 and IPS-E-TP-620.

All immersed and partially immersed marine structures, including piling, submarine pipelines, harbor craft and buoys, oil/water separators and cooling water systems shall be provided with cathodic protection where necessary in addition to protective coatings (see IPS-E-TP-820 and IPS-E-TP-270).

8.4.17 Steel piping and valves

8.4.17.1 Painting of aboveground piping

Unless otherwise stated by the company only shop fabricated aboveground steel piping, with a diameter equal to or greater than 100 mm, shall be treated in the shop.

Steel piping of smaller diameter shall be painted at site all above ground valves shall be painted in the shop.

The paint systems used shall be in accordance with Table 1 (paint schedule).

8.4.17.2 Underground piping

Underground steel structures shall be coated in accordance with IPS-E-TP-270 and cathodically protected according to IPS-E-TP-820.

9. PAINT SCHEDULE

9.1 General

Table 1 indicates by system numbers, the painting schemes to be used for new steel structures, at site, which will be installed in different environments and also for maintenance working where applicable (see 8.2.4 for maintenance painting and also NACE Standard RP-01-84).

The systems classified by environment, where applicable, by typical life time to first maintenance, by surface temperature of the structure and by minimum dry film thickness, of the paint system indicate the options open to the specifier. Applicable paint systems for severe chemical environment are not included in Table 1 (see note under clause 5.4.3).

For some of the applications there are several systems that offer acceptable protection, so choice has to be guided by other characteristics. These include availability, convenience of application, ease of maintenance, and economy in use for the specific structures and situations involved. It may be necessary to assess life of each part of a structure separately. For each assessment (whether or not more than one is required) the following points should be taken into account:

a) Required life of structure;
b) Decorative aspects, the decorative life of a coating is not usually as long as the protective life;
c) Irreversible deterioration if scheduled maintenance is delayed;
d) Difficulty or ease of access for maintenance;
e) Technical and engineering problems in maintenance;
f) Minimum acceptable period between maintenances;
g) Total maintenance costs, including shut-down of plant, closure of roads, access costs, etc.

In aspect of the paint life (time to first maintenance) the paint systems are classified into three categories as follows:

Long typically 10-20 years
Medium typically 5-10 years
Short typically less than 5 years

Mechanical damage to coating during handling, transport and erection is not considered in Table 1, but is discussed under painting in IPS-C-TP-102.

The recommended treatments listed for longer lives will always protect for shorter period requirements and are frequently economical also for these shorter lives. The recommendations indicate minimum requirements to ensure protection.

Surface preparation, priming and coating shall be carried out before assembly/erection.

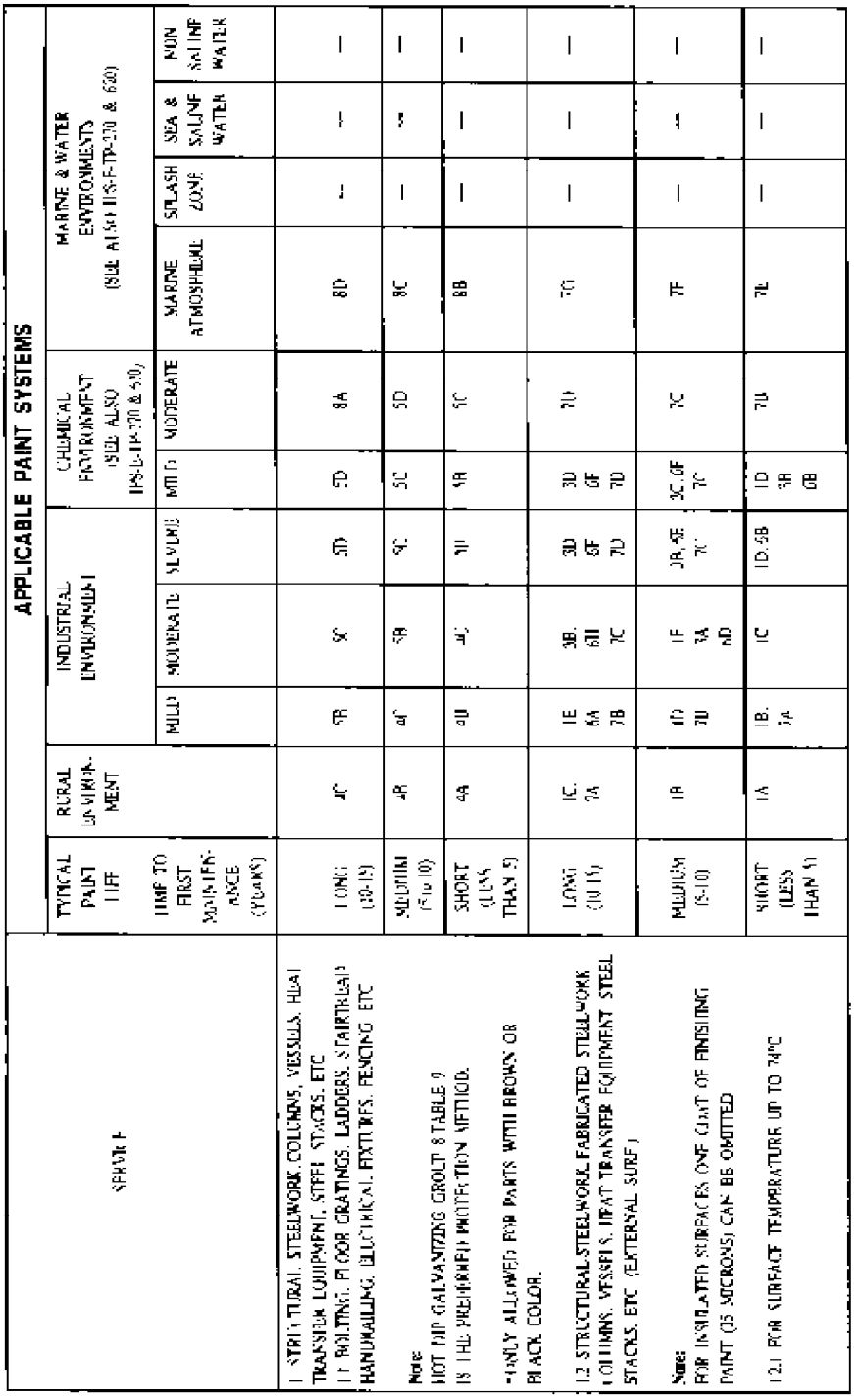
A prefabrication primer or blast-primer as a minimum shall be applied to carbon steel and intermediate alloy steel.

Shop primed surfaces shall be cleaned thoroughly with clean fresh water before applying the subsequent layers.

The cleaning and patch painting of damaged spots and of weld areas shall be done in addition to the application of complete specified paint systems.

All defects should wherever possible, be repaired with the paint systems as originally specified.

TABLE 1 - PAINT SCHEDULE



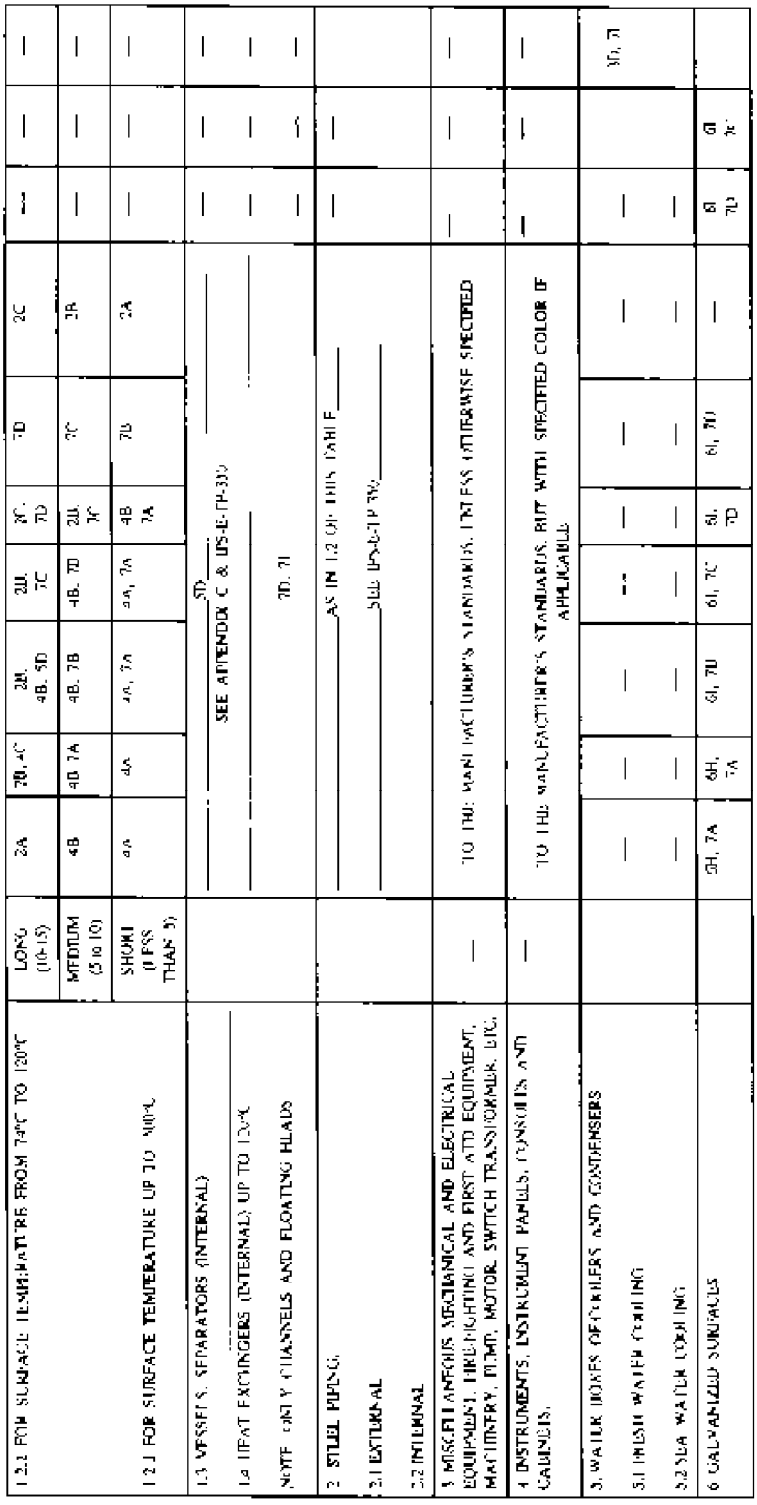
Notes:

1) For paint systems see table 2.

2) For protecting of marine structures see also IPS-E-TP-270, IPS-E-TP-350 and IPS-E-TP-620.

(to be continued)

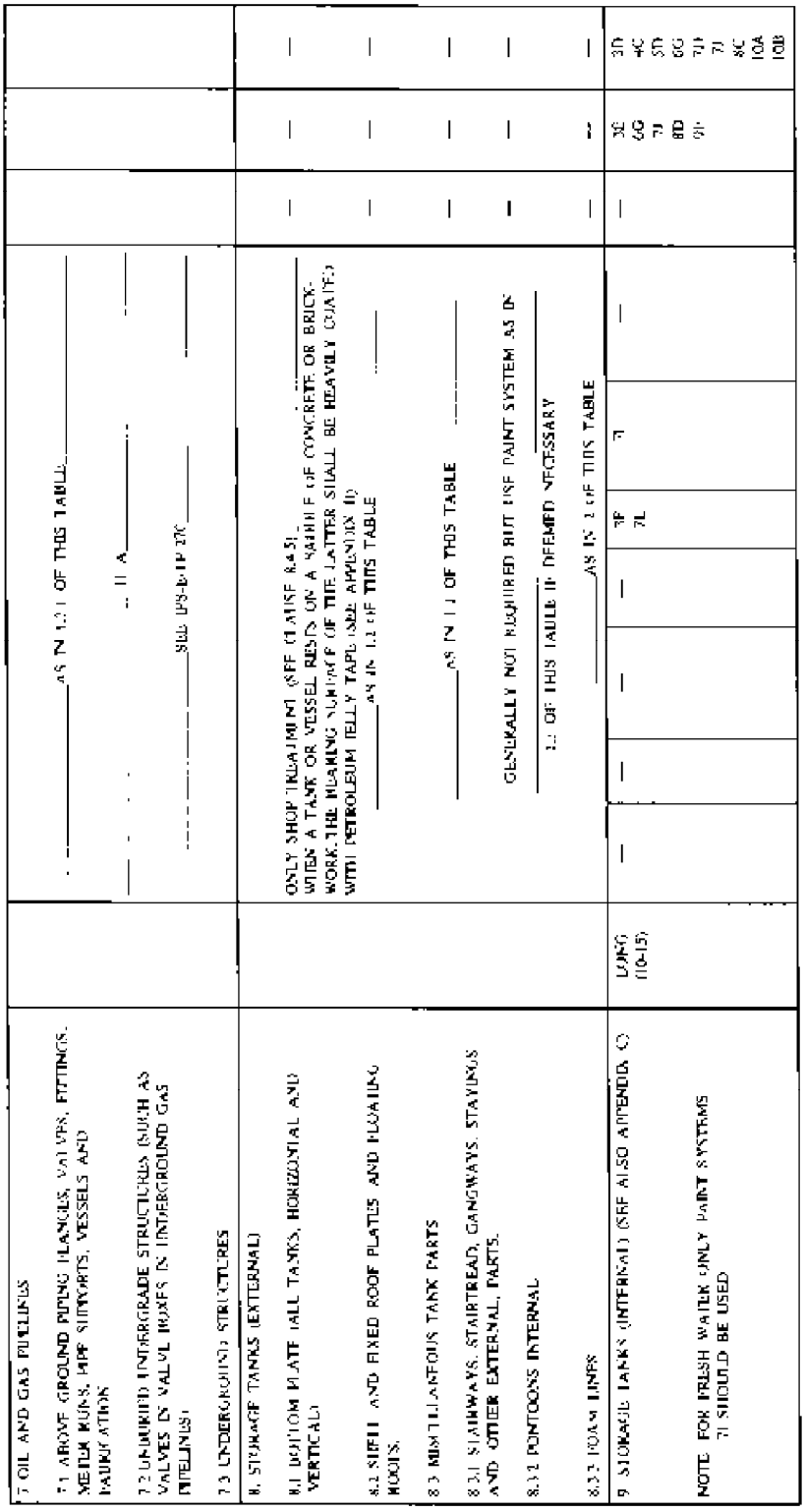
TABLE 1 - (continued)



1.2.2 FOR SUBSEA TEMPERATURE FROM 74°C TO 120°C	LONG (10-15)	2A	7B, 4C	2M, 4B, 5D	2M, 7C	4C, 7D	7D	2C	—	—	—
	MEDIUM (5 to 10)	4B	4B, 7A	4B, 7B	4B, 7D	2M, 4C	7C	2B	—	—	—
1.2.3 FOR SURFACE TEMPERATURE UP TO 400°C	SHORT (LESS THAN 5)	4A	4A	4A, 7A	4A, 7A	4B, 7A	7B	2A	—	—	—
1.3 VESSELS, SEPARATORS (INTERNAL)	SEE APPENDIX C & IPS-E-TP-320								—	—	—
1.4 HEAT EXCHANGERS (INTERNAL) UP TO 120°C									—	—	—
NOTE: ONLY CHANNELS AND FLOATING HEADS	7B, 7I								—	—	—
2 STEEL PIPING:	AS IN 1.2 OR THIS TABLE								—		
2.1 EXTERNAL	SEE IPS-E-TP-370										
2.2 INTERNAL											
3 MISCELLANEOUS MECHANICAL AND ELECTRICAL EQUIPMENT, FIRE FIGHTING AND FIRST AID EQUIPMENT, MACHINERY, PUMP, MOTOR, SWITCH TRANSFORMER, ETC.	—	TO THE MANUFACTURER'S STANDARDS, UNLESS OTHERWISE SPECIFIED							—	—	—
4 INSTRUMENTS, INSTRUMENT PANELS, CONSOLES AND CABINETS.	—	TO THE MANUFACTURER'S STANDARDS, PAINT WITH SPECIFIED COLOR IF APPLICABLE							—	—	—
5 WATER BOXES OF COOLERS AND CONDENSERS		—	—	—	—	—	—	—	—		7D, 7I
5.1 INLESH WATER COOLING		—	—	—	—	—	—	—	—		
5.2 SEA WATER COOLING		—	—	—	—	—	—	—	—		
6 GALVANIZED SURFACES		5H, 7A	6H, 7A	6H, 7B	6I, 7C	6I, 7D	6I, 7D	—	6I, 7D	6I, 7E	

(to be continued)

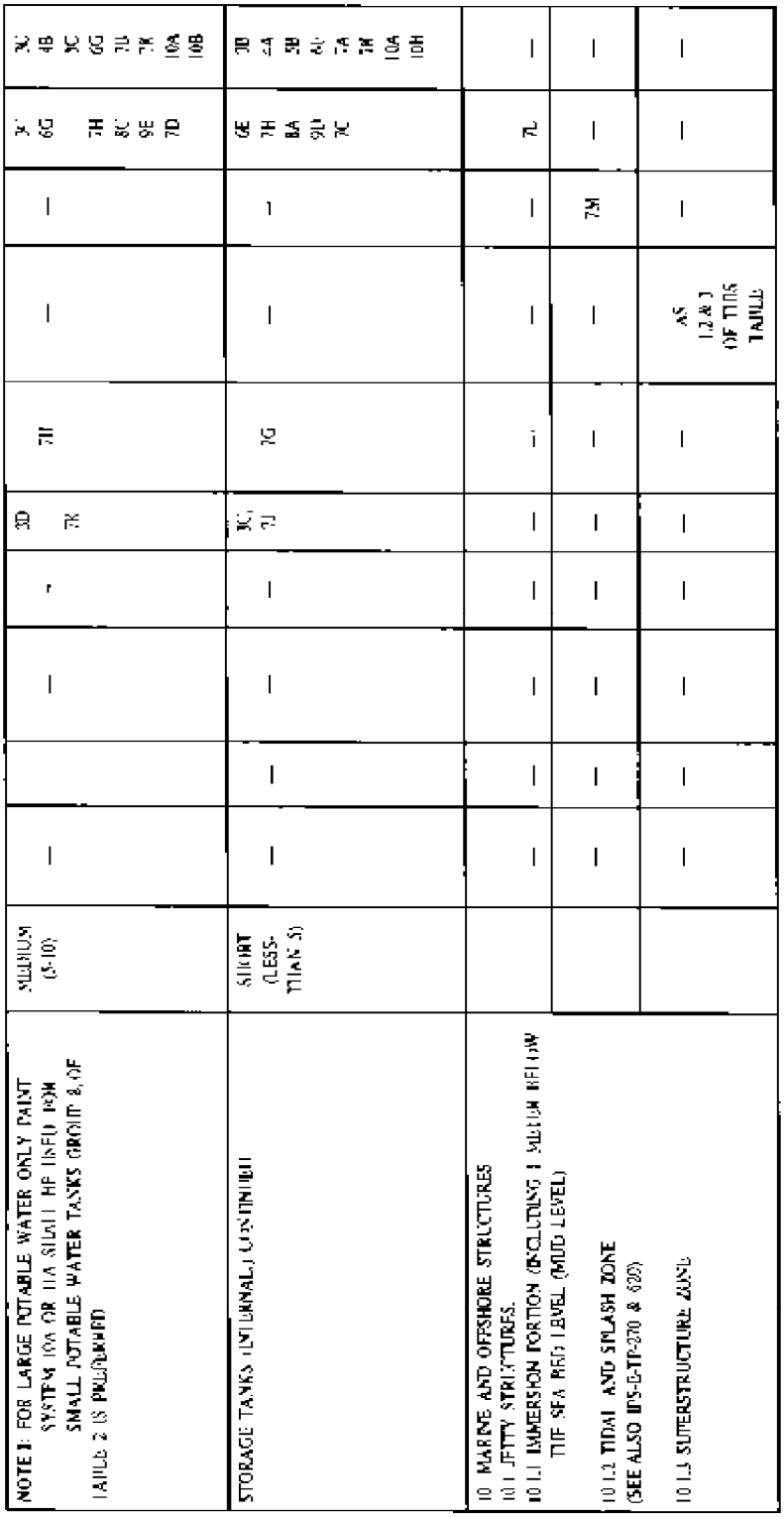
TABLE 1 - (continued)



7 OIL AND GAS PIPELINES										
7.1 ABOVE GROUND PIPING (FLANGES, VALVES, FITTINGS, METER RUNS, PIPE SUPPORTS, VESSELS AND MANUFACTURED										
7.2 UNBURIED ENTERGRADE STRUCTURES (SUCH AS VALVES IN VALVE BOXES IN UNDERGROUND GAS PIPELINES)										
7.3 UNDERGROUND STRUCTURES										
8 STORAGE TANKS (EXTERNAL)										
8.1 BOTTOM PLATE (ALL TANKS, HORIZONTAL AND VERTICAL)		ONLY SHOP REQUIREMENT (SEE CLAUSE 8.8.5) WHEN A TANK OR VESSEL RESTS ON A FOUNDATION OF CONCRETE OR BRICK-WORK, THE BEARING SURFACE OF THE LATTER SHALL BE HEAVILY COATED WITH PETROLEUM JELLY TAPE (SEE APPENDIX H)	—	—	—	—	—	—	—	—
8.2 SHELL AND FIXED ROOF PLATES AND FLOATING ROOFS.		AS IN 8.1 OF THIS TABLE	—	—	—	—	—	—	—	—
8.3 MISCELLANEOUS TANK PARTS		AS IN 8.1 OF THIS TABLE	—	—	—	—	—	—	—	—
8.3.1 STAIRWAYS, STAIRTREAD, GANGWAYS, STAYBOLTS AND OTHER EXTERNAL PARTS.		GENERALLY NOT REQUIRED BUT ONE PAINT SYSTEM AS IN 8.1 OF THIS TABLE IF DEEMED NECESSARY	—	—	—	—	—	—	—	—
8.3.2 PONTOONS INTERNAL										
8.3.3 FOAM LINES		AS IN 8.1 OF THIS TABLE	—	—	—	—	—	—	—	—
9 STORAGE TANKS (INTERNAL) (SEE ALSO APPENDIX C)	LONG (10-15)	—	—	—	7F 7L	7	—	—	3E 6G 7B 9B	3D 4C 5D 6G 7B 7J 8C 10A 10B
NOTE: FOR FRESH WATER ONLY PAINT SYSTEMS 7J SHOULD BE USED										

(to be continued)

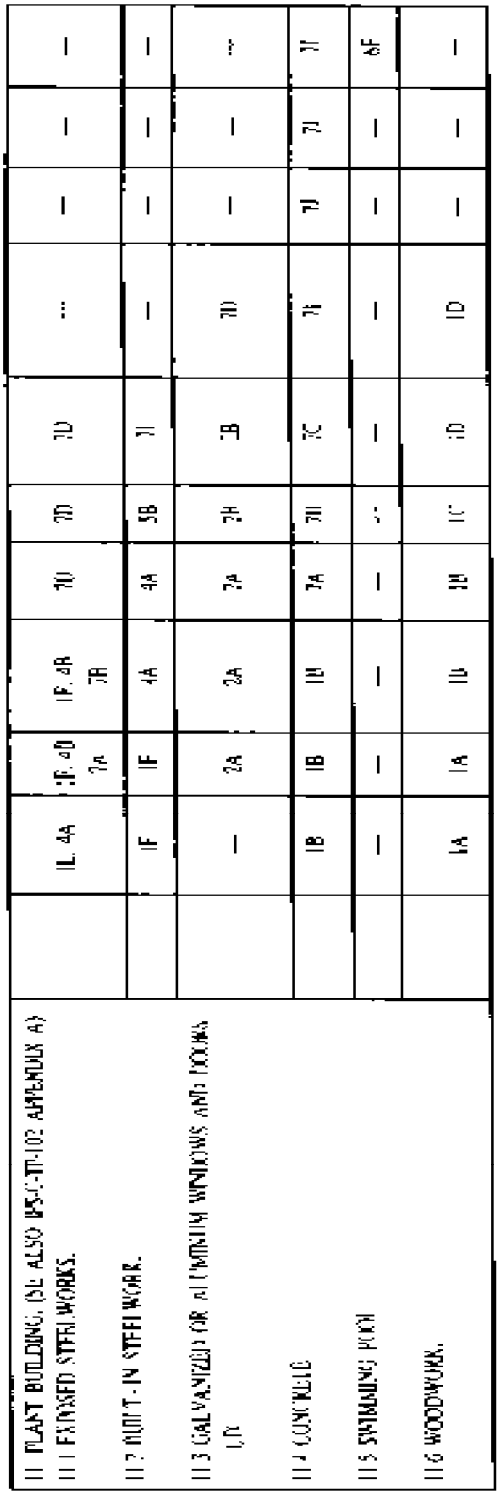
TABLE 1 - (continued)



NOTE 1: FOR LARGE POTABLE WATER ONLY PAINT SYSTEM 10A OR 11A SHALL BE USED FOR SMALL POTABLE WATER TANKS (REFER TO PARA 8.2 OF TABLE 2 IS PROVIDED	SOLARIUM (5-10)	—		—	—	3D 7R	7H	—	—	6G 7H 8C 9E 7D	3C 4B 5C 6G 7H 7K 10A 10B
STORAGE TANKS (INTERNAL) (CONTINUED)	SILICATE (LESS-THAN 5)	—	—	—	—	3C 7J	7G	—	—	6E 7H 8A 9B 7C	3B 4A 5B 6D 7A 7M 10A 10H
10 MARINE AND OFFSHORE STRUCTURES 10.1 JETTY STRUCTURES. 10.1.1 IMMERSION PORTION (EXCLUDING THE SPLASH ZONE) BELOW THE SEA BED LEVEL (MUD LEVEL)		—	—	—	—	—	—	—	—	7L	—
10.1.2 TIDAL AND SPLASH ZONE (SEE ALSO IPS-G-TP-370 & 620)		—	—	—	—	—	—	—	7M	—	—
10.1.3 SUPERSTRUCTURE ZONE		—	—	—	—	—	—	AS 12.1 & 3 OF THIS TABLE	—	—	—

(to be continued)

TABLE 1 - (continued)



Note:

For Paint Systems see tables 2 to 12.

10. PAINT SYSTEMS

This section specifies the paint systems for steel in different environments and conditions. The paint systems including metallic are coatings classified into 11 groups and each group consists of different paint systems which are presented in Tables 2 to 12.

All requirements shall be in accordance with the previous sections as far as practicable.

The specified dry-film thicknesses and surface preparation grades are minimum values.

TABLE 2 - PAINT SYSTEMS

GROUP 1 - OIL-BASE PAINT SYSTEMS FOR USE ON SURFACE TEMPERATURES UP TO 80°C

PAINT SYSTEM No.	SURFACE PREPARA-TION	PRIMER COAT PC	INTER-MEDIATE COAT IC	TOP COAT TC	MINIMUM DRY FILM THICKNESS (MICRONS)			
					PC	IC	TC	TOTAL
1A	ST 3	READ LEAD (IPS-M-TP-115)	ALKYD PAINT (IPS-M-TP-130)*	ALKYD PAINT (IPS-M-TP-130)*	70	40	40	150
1B	"	" "	" "	" "	70	50	50	170
1C	"	" "	" "	" "	70	60	60	190
1D	"	" "	" "	" "	70	70	70	210
1E	"	" "	" "	" "	70	80	80	230
1F	"	" "	" "	" "	70	90	90	250

*** (IPS-M-TP-125) for white**
(IPS-M-TP-165) for black
(IPS-M-TP-155) aluminum for intermediate
(IPS-M-TP-150) aluminum (leafing) for top coat
(IPS-M-TP-160) aluminum (high build) thixotropic for top coat

TABLE 2 - (continued)

GROUP 2 - SILICON ALKYD PAINT SYSTEMS FOR USE ON DRY SURFACES UP TO TEMPERATURE 200°C (SEE 8.4.15)

PAINT SYSTEM No.	SURFACE PREPARA-TION	PRIMER COAT PC	INTER-MEDIATE COAT IC	TOP COAT TC	MINIMUM DRY FILM THICKNESS (MICRONS)			
					PC	IC	TC	TOTAL
2A	SA2 ½	ZINC SILICATE (IPS-M-TP-210)	EPOXY POLYAMIDE (IPS-M-TP-220)	SILICON ALKYD (IPS-M-TP-175)	70	125	50	245
2B	" "	"	"	"	70	220	50	345
2C	" "	"	"	ACRILIC (IPS-M-TP-168)	75	25	25	125

(to be continued)

TABLE 2 - (continued)

GROUP 3 - VINYL PAINT SYSTEMS
FOR USE ON SURFACE TEMPERATURES UP TO 80°C

PAINT SYSTEM No.	SURFACE PREPARA-TION	PRIMER COAT		INTER-MEDIATE COAT	TOP COAT	MINIMUM DRY FILM THICKNESS (MICRONS)				
		PC		IC	TC	W.PC	PC	IC	TC	TOTAL
3A	SA2 ½	WASH PRIMER IPS-M-TP-180	VINYL READ-LEAD IPS-M-TP-185	VINYL PAINT (IPS-M-TP-200)*	VINYL PAINT (IPS-M-TP-200)*	10	40	25	25	100
3B	" "	"	"	"	"	10	60	25	25	120
3C	" "	"	"	"	"	10	70	25	50	155
3D	" "	"	"	"	"	10	80	25	50	165
3E	" "	"	"	"	"	10	100	50	50	210

*** (IPS-M-TP-170) for black**

TABLE 2 - (continued)

GROUP 4 - ORGANIC ZINC-RICH PAINT SYSTEMS
FOR USE ON DRY SURFACES UP TO TEMPERATURE 120°C* (SEE 8.4.15)

PAINT SYSTEM No.	SURFACE PREPARATION	COATING	MINIMUM DRY FILM THICKNESS (MICRONS)
4A	SA 3	ZINC-RICH EPOXY PAINT (IPS-M-TP-205)	75
4B	"	"	100
4C	"	"	150

TABLE 2 - (continued)

GROUP 5 - INORGANIC ZINC-RICH PAINT SYSTEMS
FOR USE ON DRY SURFACES UP TO TEMPERATURE 400°C* (SEE 8.4.15)

PAINT SYSTEM No.	SURFACE PREPARATION	COATING	MINIMUM DRY FILM THICKNESS (MICRONS)
5A	SA 3	ZINC-SILICATE PAINT (IPS-M-TP-210)	50
5B	"	"	75
5C	"	"	100
5D	"	"	150

*** The appearance of zinc-rich coatings are improved by the application of a suitable sealer coat, guidance on type of top coat to be used should be obtained from the supplier of the zinc-rich coatings.**

(to be continued)

TABLE 2 - (continued)

GROUP 6 - CHLORINATED RUBBER PAINT SYSTEMS FOR USE ON SURFACE TEMPERATURES UP TO 65°C

PAINT SYSTEM No.	SURFACE PREPARA-TION	PRIMER COAT PC	INTER-MEDIATE COAT IC	TOP COAT TC	MINIMUM DRY FILM THICKNESS (MICRONS)			
					PC	IC	TC	TOTAL
6A	ST 3	CHLORINATED RUBBER INHIBITIVE (IPS-M-TP-145)	CHLORINATED RUBBER INTERMEDIATE (IPS-M-TP-140)	CHLORINATED RUBBER TOP COAT (IPS-M-TP-135)	35	100	30	165
6B	"	"	"	"	70	100	60	230
6C	SA 2 ½	"	"	"	35	60	60	155
6D	"	"	"	"	70	100	30	200
6E	"	"	"	"	70	100	60	230
6F	"	"	"	"	70	100	100	270
6G	"	"	"	"	100	100	100	300
6H	"	ZINC SILICATE (IPS-M-TP-210)	"	"	75	100	100	275
6I	"	"	"	"	75	200	200	475

(to be continued)

TABLE 2 - (continued)

GROUP 7 - EPOXY PAINT SYSTEMS FOR USE ON SURFACE TEMPERATURES UP TO 120°C

PAINT SYSTEM No.	SURFACE PREPARA-TION	PRIMER COAT	INTER-MEDIATE COAT	TOP COAT	MINIMUM DRY FILM THICKNESS (MICRONS)			
		PC	IC	TC	PC	IC	TC	TOTAL
7A	SA 2½	EPOXY POLYAMIDE (IPS-M-TP-215)	EPOXY POLYAMIDE (IPS-M-TP-220)	EPOXY POLYAMIDE (IPS-M-TP-225)	35	100	45	180
7B	"	"	"	"	70	100	70	240
7C	"	"	"	"	70	100	100	270
7D	"	"	"	"	70	150	100	320
7E	"	ZINC RICH EPOXY (IPS-M-TP-205)	"	"	75	80	125	280
7F	"	ZINC SILICATE (IPS-M-TP-210)	"	"	65	80	80	225
7G	"	"	"	"	75	80	125	280
7H	"	"	EPOXY POLYAMINE (IPS-M-TP-226)		100	100	100	300
7I	"	EPOXY POLYAMINE (IPS-M-TP-226)	"	"	125	125	125	375
7J	"	—	—	COAL TAR EPOXY (IPS-M-TP-190)	—	—	150	150
7K	"	—	COAL TAR EPOXY (IPS-M-TP-190)	"	—	150	150	300
7L	"	COAL TAR EPOXY (IPS-M-TP-190)	"	"	150	150	150	450
7M*		EPOXY CLAD	—	—	—	—	—	3MM*

*** See IPS-E-TP-270**

Note:

1) Two-Pack polyurethane paint (IPS-E-TP-235) can also be used as top coat in epoxy paint systems 7A to 7F instead of epoxy polyamide top coat.

2) Aliphatic urethane topcoats are recommended where the highest degree of gloss and color retention, along with chemical resistance and recoatability, are desired.

TABLE 2 - (continued)

GROUP 8 - ZINC COATINGS OTHER THAN SPRAYED SYSTEMS

PAINT SYSTEM No.	SURFACE PREPARATION	COATING	MINIMUM DRY FILM THICKNESS (MICRONS)
8A	ACCORDING TO (IPS-C-TP-101)	GALVANIZED	85
8B	"	"	100
8C	"	"	140
8D	"	"	210

TABLE 2 - (continued)

GROUP 9 - SPRAYED-METAL COATING SYSTEMS

R. No.	SURFACE PREPARATION	COATING	MINIMUM DRY FILM THICKNESS (MICRONS)
9A	ACCORDING TO (IPS-C-TP-101)	ALUMINUM	100
9B	"	"	250
9C	"	"	250
9D	"	ZINC	100
9E	"	"	150
9F	"	"	250

Note:

Arc-Sprayed aluminum for use on surface temperature up to 550°C

TABLE 2 - (continued)

GROUP 10 - COLD APPLIED BITUMEN PAINT SYSTEMS

PAINT SYSTEM No.	SURFACE PREPARA-TION	PRIMER COAT PC	INTER-MEDIATE COAT IC	TOP COAT TC	MINIMUM DRY FILM THICKNESS (MICRONS)			
					PC	IC	TC	TOTAL
11A	SA 2½	ASPHALT MASTIC (IPS-M-TP-105)	ASPHALT MASTIC (IPS-M-TP-105)	ASPHALT MASTIC (IPS-M-TP-105)	800	800	800	2400
11B	SA 2½	COAL TAR PRIMER (IPS-M-TP-280)	COAL TAR MASTIC (IPS-M-TP-230)	COAL TAR MASTIC (IPS-M-TP-230)	400	800	800	2000

(to be continued)

Notes On groups 10:

1) All materials should be applied in accordance with the manufacturer's instructions. Care should be exercised to ensure there is no mixing of material from different sources or of different types. In particular, it should be recognized that the chemical and physical characteristics of bitumen-based coatings differ from those of coal-tar-based coatings and that the two kinds of coating should not be blended in protective coatings. It is also essential to clear out plant thoroughly when the use of coal-tar coating materials follows that of bitumen coating materials or vice versa.

2) For application by flooding or other means, the temperature of the coating material should be such that the Viscosity is controlled to give the thickness of coating required, and not so high as to cause excessive fuming. No grade of material shall be heated above the maximum application temperature given by the manufacturer or above 250°C.

11. PAINT COLOR SCHEDULE

11.1 General

Included in Table 3 are colors for appearance and identification of buildings, steelworks, pipeworks, instruments, tanks, plant equipment, machineries safety and fire equipment etc., and also safety colors and safety signs to be adopted by the oil, gas and petrochemical industries. This specification is basically selected from the British Standard 381 C and specifies surface(opaque)colors for painting.

Tables 4 and 5 specify the standard colors for painting gas cylinders in use at all plants and medical centers throughout the oil,gas and petrochemical industries with reference to BS 1319, BS 349 and BS 381C.

TABLE 3 - PAINT COLOR SCHEDULE

FOR BUILDINGS, STRUCTURES, PIPEWORKS, TANKS AND SAFETY AND FIRE EQUIPMENT ETC.

ITEM	COLOR
1. BUILDING	
a) EXTERNAL	AS SPECIFIED ON DRAWINGS
b) INTERNAL	"
c) DOORS AND WINDOWS	"
2. STEEL WORK	
a) STRUCTURAL STEELWORK	AS PRIMED OR SPECIFIED ON DRAWINGS OR BLACK
b) STAIRWAYS INCLUDING STAIR TREADS	AS PRIMED
c) PLATFORMS:	LIGHT ORANGE, TO BS 381C. No. 557 BLACK
UPPER LADDER	
d) HAND RAILS:	LIGHT ORANGE, TO BS 381C. No. 557
MID - RAIL	
KICK PLATES	
e) FIRE ESCAPES AND LADDERS INCL. SAFETY LOOPS	SIGNAL RED,TO BS 381C. No. 537
f) PIPES, COLUMNS, SUPPORTS IN WALK WAYS	DIAGONAL WHITE AND CANARY YELLOW (BS 381C. No. 309) BANDS OF 15 cm
3. PIPEWORK	
3.1 INSIDE PLANT BOUNDARIES	
a) PRODUCT LINES	WHITE
b) STEAM LINES	ALUMINUM
c) WATER LINES	ALUMINUM
d) FIRE MAINS	SIGNAL RED, TO BS 381C. No. 537
e) FOAM LINES	SIGNAL RED, TO BS 381C. No. 537
f) DANGEROUS, POISONOUS CHEMICALS AND GASES	CANARY YELLOW, TO BS 381C. No. 309
g) NATURAL GAS LINES	" " " " " " "
h) SOUR GAS LINES	DARK YELLOW MIDDLE
i) CRUDE OIL LINES	MIDDLE BROWN, TO BS 381C. No. 411
j) GLYCOL LINES	BLACK
k) VALVES, FLANGE TO FLANGE ON GAS-LINES	WHITE AND CANARY YELLOW, TO BS 381C No. 309 BANDS
ON OIL-LINES	WHITE AND CANARY YELLOW, TO BS 381C No. 309 BANDS
l) AIR SUPPLIES	ARCTIC BLUE, TO BS 381C. No. 112
m) ALL PUMPS AND VALVES: SMALLER THAN 7 cm (3")	CANARY YELLOW, TO BS 381C. No. 309
LARGER THAN 7 cm (3")	CANARY YELLOW BANDS
n) LINE CONTENTS:	TO BE WRITTEN IN BLACK ON ALUMINUM BACKGROUND WITH ARROW FOR FLOW DIRECTION.
o) IDENTIFICATION:	TO BE BANDS 10 cm. (4") WIDE AT VALVES AND FLANGES ON ALUMINUM BACKGROUND

(to be continued)

TABLE 3 - (continued)

4. INSTRUMENTS	
a) PANELS, CONTROL CONSOLES AND INSTRUMENTS	BRILLIANT GREEN, TO BS 381C. No. 221
5. TANKS	
a) AVGAS, MOGAS, NAPHTHA, PENTANE	WHITE
b) KEROSENE	LIGHT GREY, TO BS 381C. No. 631
c) GAS OIL	LIGHT STRAW, TO BS 381C. No. 384
d) DIESEL	SEA GREEN, TO BS 381C. No. 217
e) FUEL OIL	BLACK
f) CRUDE OIL	MIDDLE BROWN, TO BS 381C. No. 411
g) WATER TANKS	ALUMINUM
h) 1- IDENTIFICATION NUMBERS ON TANKS OTHER THAN BLACK	BLACK
2- ON BLACK TANKS	WHITE
6. HEATERS AND HEAT EXCHANGER	
a) HEATER CASING AND STACK	BLACK
b) HEAT EXCHANGERS	WHITE
7. MOBILE PLANT	
a) BACK AND FRONT SHIELDS	CANARY YELLOW AND BLACK DIAGONAL BANDS
b) FORKS OF FORK LIFTS SLING HOOKS	CANARY YELLOW, TO BS 381C. No. 309
c) GUARDS, SAFETY PARTS ON ROTATING MACHINERY-BELTS, COUPLING, PUMPS AND MOTORS	CANARY YELLOW, TO BS 381C. No. 309
8. MACHINERY	
a) PUMPS	LIGHT GREY (BATTLESHIP), TO BS 381C. No. 631
b) BASE PLATES	LIGHT GREY (BATTLESHIP), TO BS 381C. No. 631
c) OUTDOOR AND INDOOR ELEC. MOTORS	WHITE HIGH GLOSS
d) MOVING PARTS INCLUDING COUPLINGS, FLANGES, AREAS COVERED BY GUARDS	LIGHT ORANGE, TO BS 381C. No. 557
e) CABLE BOXES	ARCTIC BLUE, TO BS 381C. No. 112
f) MACHINE TOOLS	BRILLIANT GREEN, TO BS 381C. No. 221
g) ALL OTHER ELECTRICAL ITEMS AS FUSE BOXES, JUNCTION BOXES, LIGHTING TOWERS, LIGHTING FITTINGS ETC.	INDOOR: MANUFACTURERS STANDARD OUTDOOR: GALVANIZED OR ZINC SPRAY FINISH OR ALUMINUM
h) MAJOR SWITCH GEAR, TRANSFORMERS AND CONTROL PANELS	LIGHT GRAY, TO BS 381C. No. 631

(to be continued)

TABLE 3 - (continued)

9. MISCELLANEOUS	
a) COOLING WATER SUMP	ALL SUMPS CONTAINING COOLING WATER AND OR EFFLUENT VALVES TO HAVE ENAMELED DIAGRAM PLATES ATTACHED TO GUARDRAIL. PLATES TO HAVE WHITE BACKGROUND WITH LETTERING IN BLACK
b) IDENTIFICATION OF EQUIPMENT W. I. N. = WORKS IDENTIFICATION NUMBER	ALL ITEMS OF EQUIPMENT AND PLANT TO HAVE IDENTIFICATION NAME AND W. I. N. PAINTED ON IN WHITE LETTER OVER BLACK BACKGROUND.
10. SAFETY COLOR SCHEME	
a) FIRE FIGHTING EQUIPMENT INCLUDING FIRE PUMPS, HOSE-STATIONS, FIRE MONITORS, SUPPORTING TOWERS AND FIRE HYDRANTS CO_2 BOTTLES IN SUBSTATIONS.	SIGNAL RED, TO BS 381C. No. 537
b) SAFETY SHOWERS AND OTHER SAFETY INSTALLATIONS	BRILLIANT GREEN, TO BS 381C. No. 221
c) DANGEROUS OBSTRUCTIONS	ALTERNATIVE BANDS OF BLACK AND CANARY YELLOW
d) RELIEF AND SAFETY VALVES	CANARY YELLOW, TO BS 381C. No. 309
e) DANGEROUS OR EXPOSED PART OF MACHINERY	CANARY YELLOW, TO BS 381C. No. 309
f) DANGER POINTS OF ELECTRICAL INSTALLATION	ARCTIC BLUE, TO BS 381C. No. 112
g) FIRST AID EQUIPMENT	WHITE LETTERING BRILLIANT GREEN, TO BS 381C. No. 221
h) BREATHING APPARATUS MASKS AND OTHER SAFETY EQUIPMENT	BRILLIANT GREEN, TO BS 381C. No. 221
11. NOTICES ON SIGNBOARDS	
a) PLANTS USING CAUSTIC SODA OR ACIDS	BLACK LETTERS ON YELLOW BACKGROUND
b) PLANTS WITH HIGH CONCENTRATION OF HYDROGEN SULPHIDE	RED LETTERS ON YELLOW BACKGROUND
12. STENCILING	
a) CONTRACTORS SHALL PUT STENCIL MARKING ON TANKS, VESSELS, EQUIPMENT NUMBERS IN ENGLISH / FARSI	
b) STORAGE TANKS SHALL HAVE DIGITS STENCILED IN BLACK MINIMUM OF 1.5 m. HIGH AT LEAST ON TWO SIDES	

TABLE 4 - PAINT COLOR SCHEDULE

FOR SOME INDUSTRIAL GAS CONTAINERS

NAME OF GAS	CHEMICAL FORMULA	BODY & BAND COLOR	COLOR NUMBER TO BS 381C.
ACETYLENE	C_2H_2	MAROON	541
AIR	—	LIGHT GREY	631
AMMONIA	NH_3	BLACK	—
		SIGNAL RED BAND NEAR VALVE FITTINGS, CANARY YELLOW BAND BETWEEN RED BAND AND GROUND COLOR	537 AND 309
ARGON	Ar	PEACOCK BLUE	103
CARBON DIOXIDE	CO_2	BLACK	—
CARBON MONOXIDE	CO	SIGNAL RED CANARY YELLOW BAND NEAR VALVE FITTINGS	537 309
CHLORINE	Cl_2	CANARY YELLOW	309
COAL GAS	—	SIGNAL RED	537
ETHYL CHLORIDE	$C_2H_5C_L$	LIGHT GREY SIGNAL RED BAND NEAR VALVE FITTINGS	631 537
ETHYLENE	C_2H_4	DARK VIOLET SIGNAL RED BAND NEAR VALVE FITTINGS	796 537
ETHYLENE OXIDE	C_2H_4O	DARK VIOLET SIGNAL RED BAND NEAR VALVE FITTING CANARY YELLOW BAND BETWEEN RED BAND AND GROUND COLOR	796 537 309
HELIUM	He	MIDDLE BROWN	411
HYDROGEN	H_2	SIGNAL RED	537

(to be continued)

TABLE 4 - (continued)

HYDROGEN CYANIDE	HCN	PEACOCK BLUE CANARY YELLOW BAND NEAR VALVE FITTING	103 309
METHANE	CH_4	SIGNAL RED	537
METHYL BROMIDE	CH_3Br	PEACOCK BLUE BLACK BAND NEAR VALVE FITTINGS	103 —
METHYL CHLORIDE	CH_3Cl	LIGHT BROWN, WITH GREEN, SIGNAL RED, BAND NEAR VALVE FITTING	225 537
NEON	Ne	MIDDLE BROWN BLACK BAND NEAR VALVE FITTING	411 —
NITROGEN	N_2	LIGHT GREY BLACK BAND NEAR VALVE FITTINGS	631
OXYGEN	O_2	BLACK	—
PHOSGENE	$COCL_2$	BLACK PEACOCK BLUE BAND NEAR VALVE FITTINGS. CANARY YELLOW BAND BETWEEN PEACOCK BLUE BAND AND GROUND COLOR	— 103
PROPANE (COMMERCIAL)	—	SIGNAL RED	537
SULPHUR DIOXIDE	SO_2	LIGHT BROWN WITH GREEN. CANARY YELLOW BAND NEAR VALVE FITTINGS	225 309

Note:

Cylinders with valve protecting extension:

Color of band near valve fitting shall be painted on protecting extension.

TABLE 5 - PAINT COLOR SCHEDULE

FOR MEDICAL GAS CYLINDERS

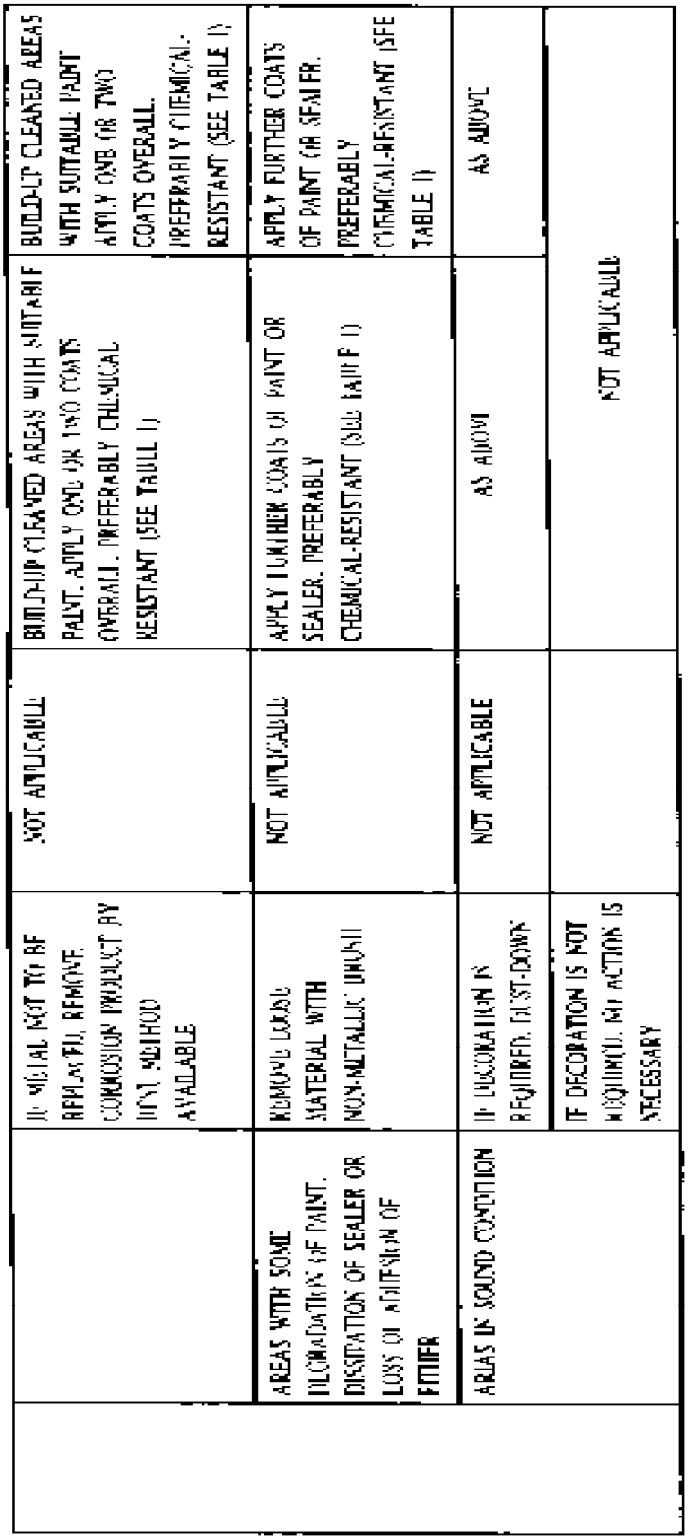
NAME OF GAS	SYMBOL	VALVE END COLOR	BODY COLOR
OXYGEN	O_2	WHITE	BLACK
NITROUS OXIDE	N_2O	ARCTIC BLUE	ARCTIC BLUE
CYCLOPROPANE	C_3H_6	LIGHT ORANGE	LIGHT ORANGE
CARBON DIOXIDE	CO_2	LIGHT GREY	LIGHT GREY
ETHYLENE	C_2H_4	VIOLET	VIOLET
HELIUM	He	LIGHT BROWN	LIGHT BROWN
NITROGEN	N_2	BLACK	LIGHT GREY
OXYGEN AND HELIUM MIXTURES	O_2+He	WHITE AND MIDDLE BROWN	BLACK
AIR (MEDICAL)	AIR	WHITE AND BLACK	GREY
OXYGEN AND NITROUS OXIDE MIXTURE	O_2+N_2O	WHITE AND ARCTIC BLUE	ARCTIC BLUE

TABLE 6 - SITE TREATMENT OF PREVIOUSLY METAL-COATED STEELWORK

INITIAL CONDITION	PRESENT CONDITION	SURFACE PREPARATION (IPS-C-TP-101)	REPLACEMENT OF METAL WHERE REQUIRED	PAINT TREATMENT OVER	
				SPRAYED METAL	GALVANIZING
BARE METAL COATING	AREA OF CORROSION AND/OR SOUND RUSTING OF SUBSTRATE*	IF METAL IS TO BE REPLACED, BLAST CLEAN	SPRAY METAL TO REQUIRED SPECIFICATION	NOT NORMALLY NECESSARY, IF OVER COATING IS REQUIRED SEE TABLE 1 AND CLAUSE 8.4.9	
		IF METAL NOT TO BE REPLACED, CLEAN CORRODED AREAS BY BEST MEANS AVAILABLE	NOT APPLICABLE	BUILD UP CLEANED AREAS WITH SUITABLE PAINT SYSTEM AND PREFERABLY, APPLY CHEMICAL-RESISTANT FINISH OVERALL (SEE TABLE 1)	BUILD UP CLEANED AREAS WITH SUITABLE PAINT SYSTEM AND PREFERABLY, APPLY CHEMICAL-RESISTANT FINISH OVERALL (SEE TABLE 1)
	AREA WITH SOME WHITE CORROSION PRODUCTS	IF ENCRUSTATION REQUIRED WASH TO REMOVE SALTS, USING STIFF BRUSH IF NECESSARY, REMOVE LOOSE MATERIAL WITH NON-METALLIC BRUSH		APPLY SEALING COAT AND CHEMICAL-RESISTANT FINISH FOR MAXIMUM LIFE (SEE TABLE 1)	APPLY SUITABLE SURFACE PRETREATMENT FOLLOWED BY PREFERABLY, CHEMICAL-RESISTANT FINISH (SEE TABLE 1)
		IF DECORATION NOT REQUIRED, NO ACTION IS NECESSARY	NOT APPLICABLE		
	AREAS IN SOUND CONDITION	IF DECORATION IS REQUIRED, WASH TO REMOVE SALTS USING A NON-METALLIC BRUSH	NOT APPLICABLE	APPLY SUITABLE PAINT WHICH SHOULD BE CHEMICAL-RESISTANT FOR MAXIMUM LIFE (SEE TABLE 1)	APPLY SUITABLE SURFACE PRETREATMENT (SEE IPS-C-TP-102) FOLLOWED BY SUITABLE PAINT WHICH SHOULD BE CHEMICAL-RESISTANT (SEE TABLE 1)
		IF DECORATION NOT REQUIRED, NO ACTION IS NECESSARY		NOT APPLICABLE	
SEALED OR PAINTED METAL COATING	AREA OF CORROSION OR SOME RUSTING OF SUBSTRATE*	IF METAL IS TO BE REPLACED, BLAST CLEAN	SPRAY METAL TO REQUIRED SPECIFICATION	SEE TABLE 1 AND CLAUSE 8.4.9 CONSIDER ONE OR TWO COATS OVERALL PREFERABLY CHEMICAL-RESISTANT	SEE TABLE 1 AND CLAUSE 8.4.9 CONSIDER ONE OR TWO COATS OVERALL PREFERABLY CHEMICAL-RESISTANT

(to be continued)

TABLE 6 - (continued)



*** It shall be confirmed that the apparent rusting emanates from the substrate.**

APPENDIX A
BASIC PRINCIPLES

A.1 CORROSION PREVENTION BY PAINT COATINGS

Carefully formulated and selected paint systems can and do prevent corrosion. Normally paint coatings are applied in two or three coats and, apart from a single coat of an inorganic zinc silicate, a one-coat paint system is rarely used and would require excessive care to ensure freedom from pinholes and minor discontinuities and to obtain an even thickness. The sequence of coats is called;Primer, Intermediate coat (under coat) and top coat (finish).

The "primer" is of the utmost importance to the paint system, as it is the tie-coat between the metal and subsequent coats. Primers should be:

a) well adhering to the steel;
b) anticorrosive, and;
c) a suitable base for intermediate coat.

The adhesion to the steel is primarily a function of the resin binder in the primer. The Anti-Corrosive nature is largely contributed by the pigments. Whereas the formation of a good base for the topcoats is partly a function of the binder,but also the ratio between the quantities of pigment and binder play an important part.

The choice of the type of binder for the primer is also governed by the choice of topcoats, which in turn is determined by the requirement for resistance to the environment. An all-purpose primer that can be overcoated with all types of top coats would simplify the Painting task, but this ideal is not yet available.

For a paint coating to stop corrosion from starting, it is evident from the previous reactions that this can be achieved by one of the three methods, either alone or in combination:

d) barriers to restrict the access of moisture, oxygen and salts;
e) electrical method;
f) chemical inhibition.

A.2 BARRIER CHARACTERISTICS

As all coatings are permeable to both water and oxygen to some extent, it is therefore impossible to completely exclude them from reaching the steel surface. However, some coatings are more impermeable than others, and catalyzed epoxies, coal-tar epoxies, solution vinyl and chlorinated rubber paint systems are used in water immersed environments. These are typical "self-primer" materials which means that the intermediate coat or topcoat is used as first coat on the steel and an "anti-corrosive " primer is not required, that is, they prevent corrosion by a barrier effect only.

These highly impermeable coatings relay on excellent adhesion to the surface and the maintenance of film integrity as water diffuses through the coating. For this reason it is essential that such coatings do not contain any water-soluble components, otherwise blistering with eventual rupturing and exposure of bare steel will occur due to osmosis, which is the passage of water through a semi-permeable membrane (the paintfilm) when different concentrations of salts exist each side of the paint coating.

Equally damaging is the presence of salt from sea air or sea water osmosis. It is essential that steel be fresh water washed to remove them or other soluble salts before any surface painting or preparation (including blast cleaning), as they can be blasted into the steel surface and become trapped beneath the paint coating.

A.3 ELECTRICAL METHODS

Electrical method of preventing corrosion involves minimizing the flow of corrosion current so that, if negligible current flows, negligible corrosion results. Thus, in a corrosion:

$$I = \frac{E}{R}$$

Where I is the corrosion current, E is the polarized potential difference between local anodes and cathodes, and R is the total electrolyte resistance,which must be much greater than the metal conductor resistance.

Thus the higher the value of R, the less will be the value of I, so that by making the electrolytic path of the current of high resistance, the movement of ions is impeded. Paint resins with the highest electrical resistance are catalyzed epoxies, phenolics, vinyls and chlorinated rubbers each with values in the order of 10 ohm/square centimeter.

The addition of coal tar further adds to the resistance, and the addition of extended pigments in the first coat such as talc, china clay, mica and iron oxide also assist in increasing the resistance.

As mentioned above, the removal of soluble on the surface is necessary because their presence will short-circuit the resistance of the paint film so that the value of I increases, possibly to the stage where rusting will occur.

Film thickness is variable and, as the diffusion of water through a paint film varies inversely with the film thickness, it is clear that it will take longer for moisture to diffuse through a thick than a thin film. Similarly the thicker the coating the higher will be the electrical resistance and, for immersed or buried surfaces, the dry film thickness of paints would need to be between 250 and 500 microns.

An alternative method of electrically preventing corrosion of iron is to imply a metal more anodic (that is less noble) than iron, such as zinc. Thus zinc-rich paint coatings will protect the steel, as the iron is no longer the anode of the electrical circuit, the zinc metal becomes the anode and the iron will not corrode.

A.4 CHEMICAL INHIBITION

Chemical inhibition refers to the use of special pigments which are employed in the primer coat. These anti-corrosive pigments function in varying ways, but broadly by:

a) blanketing either the anode or cathode areas;

b) interfering with either the anode or cathode reaction preventing the formation of ferrous hydroxide;

c) in the case of zinc chromate, by oxidizing the ferrous corrosion product to ferric oxide which plugs the anodic areas and increases the electrical resistance.

APPENDIX B

B.1 CHARACTERISTIC OF PROTECTIVE SYSTEMS

B.1.1 General

Paint systems usually consist of primer, intermediate coat(s) or undercoat(s) and top coat or finish. Each Component normally Contains pigment (solid particles) suspended in solution of binder (resin solution). Choice of pigment and ratio of pigment to binder depends on the function of the paint, e.g. more binder will be used in a penetrating primer for sprayed metal and more pigment in a high-build intermediate coat.

B.1.1.1 Binders

The binder more clearly defines the essential characteristics of the coating (Appendix B of BS 5493). Drying oil type paints (like alkyd paints) dry in the presence of atmospheric oxygen; the action is catalytically promoted by metallic soaps. One-Pack Chemical-resistant Coating (such as chlorinated rubber and vinyle paints) usually dry by evaporation of solvent but the moisture cured-polyurethanes are also in this group. Two - Pack chemical-resistant coatings (epoxy paints) form by chemical reaction; The two components have to be mixed just before use.

B.1.1.2 Pigments

The pigments may inhibit corrosion, reinforce the dry film, provide color, and/or absorb or reflect ultra - violet radiation, thus improving the durability and stability of the coating.

B.1.1.3 High-build coating

High-build formulations permit much greater film thicknesses per coat. They are usually applied by airless spray but can be applied by roller or brush.

B.1.1.4 Compatibility

All paints within a system should have compatibility between coats and with the metal substrate (i.e. there should be adequate adhesion to the substrate and between coats over the operating temperature range and there should be no undersoftening to cause lifting, wrinkling or bleeding through of stains). For this and other reasons it is generally advisable to obtain all the components of a paint system from the same source; otherwise, assurance of such compatibility should be obtained. If cathodic protection is applied to the structure, the paint system shall be compatible with it (see B.3.5).

B.1.1.5 Solvents

Solvent modification of paint composition is frequently necessary to allow for the characteristics of different matters of application.

B.1.1.6 Handling, stacking and repair

Two-pack chemical-resistant paint withstand reasonable handling and can be readily stacked when fully cured, but most other paints are relatively easily removed down to primer. One-pack chemical-resistant paints tend to stick on stacking, but drying-oil containing paints can be stacked, with care. Touching-up on site is easy for most paints but initial abrasion may be needed to provide adequate adhesion of touching-up treatments over two-pack chemical-resistant paints.

B.1.2 Primers

Primers usually consist of binders, inhibitive pigments and solvents.

The primers commonly used are as follows (some typical formulas are given in tables B.1 and B.2):

a) prefabrication primer which is used for steel before fabrication (table B.1)
b) blast primers which are used for steel either before or after fabrication (table B.2);
c) drying oil primers (see IPS-M-TP-115);
d) one - pack chemical - resistant primers (see IPS-M-TP-145);
e) two - pack chemical - resistant primers (see IPS-M-TP-215);
f) wash primer (see IPS-M-TP-180).

B.1.3 Zinc-Rich Paints *

Metallic zinc-rich paints may be organic (group 5 of table 2) or inorganic. With 90% or more of zinc - dust (which may contain up to 4% zinc oxide) in the dry film the coating will afford cathodic protection but will be slightly permeable. The formation of zinc salts gradually render the coating impermeable and it will then be a barrier coating. If damage to the coating exposes the steel the zinc will again become cathodically sacrificial to prevent rust spreading. Suitable sealer coats improve the appearance of zinc-rich paint coatings. The advice of the coating supplier shall be sought regarding the type of sealer to be used, especially if the surface is exposed between applications. The various uses of zinc-rich paints, as blast primer, fabrication-primer or main coating, are recommended. Members and assemblies coated with zinc-rich paints may be handled or stacked as soon as the coating is dry, but exposure of freshly applied zinc silicate paints to moisture within a stack can result in deleterious changes.

*** Commonly called zinc-rich coatings.**

B.1.4 Drying oil Type Paints

Drying oil type paints cover a wide range of material, ranging from largely obsolescent simple oil paints, which were slow-drying but tolerant of less than perfect surface preparation, to phenolic varnishes and epoxy ester paints, which dry well even at low temperatures. Recoating usually presents no problem but chemical resistance is poor to moderate and weather resistance is moderate to good.

Silicone alkyds, are more expensive than other drying oil type paints, but keep cleaner and retain color and gloss better than most other coatings.

B.1.5 One-Pack Chemical Resistant Paints

One-pack chemical resistant paints, dry under any ventilated conditions but, where coatings are built up thickly retained solvent may keep films soft and prone to damage for days or even weeks. Recoating is easy, unless the surface has become heavily contaminated, because the films remain soluble in suitable hydrocarbon solvents. Where the highest chemical resistance is not required a system of anticorrosive drying oil type primer, carefully selected for compatibility with a chemical resistant finishing system, allows some relaxation of the steel preparation standards.

B.1.6 Two-Pack Chemical Resistant Paints

Two-pack chemical resistant paints, are resistant to acids, alkalis, oils and solvents, but shall not be used unless the highest quality of surface preparation and application can be assured. Cured films are hard and solvent resistant so that intercoat adhesion may be doubtful, particularly where surface contamination may occur. Coal tar epoxy and urethane/tar coatings are rather cheaper and may be easier to apply, but are restricted to darker colors and have lower solvent resistance.

Hot-applied, solvent free epoxies have a particular usefulness for tank linings where flammable solvents could be a hazard.

Where the greater part of a two-pack chemical resistant system is to be applied in the shop and where travel or erection damage may have to be touched up on site it may be advantageous to use a system, incorporating a chlorinated rubber travel coat (1), which will readily accept a further chlorinated-rubber coat after erection.

1) Two-pack primer and intermediate coat overcoated with one-pack chemical resistant finish[or travel coat (tie coat)] and site finish. Travel coat (tie coat) is a paint with the binder of chlorinated rubber modified with alkyd in the ratio 2 (min.) to 1 (CR to alkyd), see 3.23 for definition)

B.1.7 Bituminous Coatings (see also IPS-E-TP-270 and IPS-E-TP-350)

B.1.7.1 General

Bituminous coatings are low - cost coatings whose protective properties depend on film thickness. There is a wide range of materials based on either mineral bitumen or coal tar fractions applied as unheated solutions,hot solutions, or hot melts; bituminous emulsions are little used for the protection of steel. Specially developed materials, based on powdered coal dispersed in pitch (IPS-M-TP-290), are widely used for the protection of underground pipes. Blast-cleaning before coating gives the best performance.

Bituminous coatings [see Standards IPS-M-(TP-285, TP-295, TP-230)] have good resistance to dilute acids and alkalis, salt solutions and water, but are not resistant to vegetable oils, hydrocarbons and other solvents. They may become brittle in cold weather and soften in hot weather. Bitumen-coated articles shall not be stacked.

Bitumen solutions and emulsions are readily applied by brush or spray and are often used as priming coats for the heavy -duty materials which can be applied hot or cold at the works or on site.

The specifier should consider inhibitive oleo-resin-based primers for heavy-duty bitumen provided that sufficient drying time (several weeks) can be allowed to pass before overcoating.

B.1.7.2 Coal tar enamels

Coal tar enamels have high resistance to moisture and good adhesion to steel, so they are very suitable for structures that are immersed in water (especially foul water) or buried in the ground. The appropriate water supply authority should be consulted before coal-tar-based material is used in conjunction with potable water. Coal tar enamels are less readily softened by hydrocarbon oils.

Prolonged exposure to weather and sunlight causes surface chalking because of oxidation and loss of plasticizing components, so coal-tar enamels and bitumens shall never be specified for such conditions (unless they are overcoated with asphaltic material in solution or emulsion form), nor shall they be used in very hot conditions (such as may arise in a pipeline downstream of a compressor).

The coatings may be reinforced with glass fiber or asbestos wrapping, especially for the protection of pipelines. Wrappings made from vegetable fibers such as cotton or hessian are liable to micro-biological attack.

B.1.7.3 Asphaltic coatings

Asphaltic coatings have much better resistance than coal tar enamels to sunlight, weather and exposure to the direct heat of the sun. Resistance to breakdown under sunlight can be improved with flake aluminum. Asphaltic coatings are recommended for buried or submerged conditions and they are best used with inhibitive primers.

B.1.7.4 Application of coal tar and asphalt enamels

The materials are heated as needed in boilers near the application site. For vertical surfaces the material is daubed on with a stiff brush, covering small rectangular areas with short strokes and overlapping to form a continuous coating. In weld areas the brush strokes shall be in the direction of the weld; a second coat shall then be applied in the opposite direction. For horizontal surfaces the material can be poured on and then trowelled out and if unevenness occurs where a smooth surface is required, it may be permissible to play a blow-lamp onto the surface and finish by troweling. Considerable skill is required in all these operations.

B.1.7.5 Overcoating

In general, only bituminous material should be used for overcoating bituminous material. It is, however, possible to overcoat with some emulsion paints or cement paints and these may be desirable to reduce surface heating under sunlight.

B.2 CHARACTERISTICS OF METALLIC COATINGS

B.2.1 Zinc Coatings (Other Than Zinc-Rich Paints)

B.2.1.1 General

Four methods for applying metallic coatings are in general use.

a) Hot-dip galvanizing: for structures, fittings and claddings.
b) Sherardizing: mainly for fittings, fasteners and small items.
c) Electroplating: mainly for fittings, fasteners and small items.
d) Metal-spraying: for structures and fittings(including fasteners when done after fabrication).

The desirable weight or thickness of bare zinc for use in different environments can be derived from figure 1. The metal corrodes at a predictable and uniform rate, which increases as sulphur dioxide pollution of the environment increases.

Areas of discontinuity or insufficient thickness of a metallic zinc coating, however caused, may be rectified at any stage by the application of sprayed zinc, special zinc-alloy solder sticks or zinc-rich paints.

B.2.1.2 Galvanizing

Cleaned steel is immersed in a bath of molten zinc; a partial alloying action result in a metallurgically bonded coating. As soon as the steel is cool (after withdrawal from the bath) it may be stacked and transported or it can be primed for overcoating.

The size of structural assembly that can be galvanized is limited by the size of the largest bath in each galvanizer's works.

The Standard does not refer to the galvanizing of steel thinner than 5 mm. Thinner components have thinner galvanized coatings (see BS 729) coatings on continuously galvanized sheet are specified in BS 2989 (with further reference in DD 24). The coating weight specified for sheet is the total weight on both sides of the metal; for components the rate of coating on one side only is specified.

For sections not less than 5 mm thick reference should be made to BS 729, where a minimum specified weight of zinc, 610 g/m^2 is equivalent to a thickness of 86 microns (shown as '85 microns minimum' in the tables) on each face. The thickness of coating varies with the thickness of steel, surface preparation and conditions of immersion. It may be increased to 140 microns (1000 g/m^2) if either the steel is grit-blasted before coating or the steel contains silicon (typically more than 0.3%). The coating thickness may be increased to 210 microns (1500 g/m^2) by using silicon (typically more

than 0.3%) or silicon-killed steels and consultation with the steel supplier and galvanizer is essential if these thick coatings are required. Brown staining may occur early in the life of steel containing silicon. This is a surface phenomenon and does not affect the protective value of the coating. By reference to figure 1, the different lives of some galvanized coatings can be estimated and the appropriate life requirement to first maintenance may be assessed.

B.2.1.3 Sherardizing

This process is used mainly for small parts and fasteners, particularly for threaded work where only small change of dimension is acceptable. After suitable surface preparation, the items are tumbled in hot zinc dust. The thickness of the coating varies with the processing conditions; two grades (15 microns and 30 microns are specified in BS 4921, and the lives of those thicknesses are compared in figure 1).

B.2.1.4 Electroplating

Zinc-plating of small parts by the electrolytic deposition of zinc from zinc-salt solutions is done only by specialist firms. It is rarely economic to electroplate thicker than 25 microns. Cadmium plating is an alternative used for special purposes. BS 1706 specifies coating techniques for threaded parts.

B.2.2 Sprayed-Metal Coatings

The metals commonly used for spraying structural steel are zinc and aluminum. The technique of spraying metals is applicable to structures and fittings either in the shop or on site. An atomized stream of molten metal is projected from a special gun(fed by either wire or powder) onto a surface prepared in accordance with BS 2569. There is no size limit and the process is especially economical when the area/weight ratio is low.

All grades of steel can be sprayed. The steel surface remains cool and there is no distortion, nor is there any effect on the metallurgical properties of the steel.

Coating thicknesses less than 100 microns are not usually specified unless the sprayed metal is to be sealed or painted immediately.

For most atmospheric environments, there is no advantage in spraying aluminum to a thickness greater than 150 microns(nominal).

B.3 CHARACTERISTICS OF SOME OTHER PROTECTIVE SYSTEMS

(see also IPS-E-TP-270 and IPS-E-TP-350)

B.3.1 Powder Coatings

Coatings formed from pigmented resins, applied as dry powders and fused by heat, have been developed for protection of lightweight steel components. Some types of powder coatings also find applications on pipes and hollow sections, e.g. lighting columns, where simple shapes facilitate coating and heat curing. They are unlikely to be economical for use on heavy sections because of the high temperatures required for fusing or curing.

Powder coatings are of two main types:

a) thermoplastic powders, based on e.g. polyethylene, poly-propylene, vinyl copolymers, or nylon-II, which fuse to form films without any chemical change;

b) thermosetting powders, based on e.g. epoxy, polyester, acrylic or polyurethane resins, which cure to chemically cross-linked films after being fused by heating.

Thermoplastic powders are frequently applied by a fluidized-bed technique in components that have been preheated so that the powder will stick readily. Coatings can be built up to a thickness of 200 microns to 300 microns one operation and are highly protective where a complete wrap-round can be achieved.

Thermosetting powders are usually applied by electrostatic spraying to a film thickness usually between 50 microns 100 microns. Epoxy powders are easily applied and form tough coatings. Polyester and polyurethane powders give better resistance to weather. Selected polyurethane and nylon powders are particularly useful where impact and abrasion resistance is important, as on certain types of fastener. Unless anticorrosive pretreatments or solventborne primers are first used, powder coatings often have indifferent adhesion so that protection may fail rapidly once the coating has been broken.

B.3.2 Grease Paints

Coatings based on greases have two uses:

a) as permanent non-curing coatings for application to the inside of box sections, and;
b) as temporary protective (see BS 1133: section six, 1966) for components in store or for machined surfaces before assembly.

Thick grease films form effective barriers to moisture but inhibitors are added to increase the effectiveness. Greasebased coatings shall be used in conjunction with tapes or other wrappings on components that are to be stacked or are liable to rough handling.

B.3.3 Wrapping Tapes and Sleeves (see also IPS-E-TP-270)

Wrapping with adhesive tape protects ferrous metals, particularly pipelines, joints, valves, and other fittings by excluding the environment from the substrate.

For further protection against accidental damage and to promote adhesion of the wrapping tape it is good practice to clean thoroughly from the substrate any rust products and to prime with an inhibitive primer before taping.

Buried pipelines are often supplied wrapped at works with bitumen or coal tar reinforced by glass fiber and only the joints require wrapping at site.

When applying wrapping tape an overlap of at least half the width of the tape is recommended and for coating pipes of up to 300 mm diameter it is good practice to use tape of width matching approximately the diameter of the pipe. Application by hand is satisfactory for small jobs but for large installations, such as long pipelines, fully automatic or semi-automatic methods are used. The skills lie in obtaining a consistent tension throughout the operation, uniform bonding and the avoidance of air pockets. Three types of wrapping are commonly available.

B.3.3.1 Petroleum-jelly tapes

These consist of fabric of natural or synthetic fiber or glass cloth impregnated with a mixture of petroleum jelly and neutral mineral filler. They shall be used in conjunction with a petroleum-jelly primer. The coating is permanently plastic; it is suitable for application to irregular profiles and shall be smoothed by hand, taking care to avoid any air pockets. When used above ground, these tapes should be protected by a bituminous-tape overwrap in situations where they may be subject to damage by abrasion. They are also suitable as insulation to avoid bimetallic contacts.

B.3.3.2 Synthetic resin or plastic tapes

The most readily available synthetic tapes are polyvinyl chloride (PVC) and polyethylene tapes. These polymer strips, usually 125 microns to 250 microns thick with a fabric core, are coated on one side with a compact adhesive, normally of synthetic rubber base.

They are usually available in a range of colors if pipe identification is required.

Synthetic resin or plastic tapes are suitable as insulation to avoid bimetallic contacts, particularly in damp or dirty conditions. Best protection is obtained if the steel is first cleaned and coated with a conventional rust inhibitive primer. For exterior exposure black polyethylene tape is preferred to polyvinyl chloride because its surface degrades much less on exposure to sunlight and weather.

B.3.3.3 Coal tar and bitumen tapes

These tapes are used mainly for buried pipelines. They have a high resistance to moisture and good adhesion to steel. The fabric reinforcement is usually made from glass fiber. The steel shall first be cleaned and give a coating of coal tar or bitumen primer.

According to the temperature expected in service so can the low properties of the tape be varied. For some high temperatures and especially for high-duty requirements, the grade of coal tar or bitumen used is such that it is necessary to heat the tape to soften it sufficiently for good application and bonding, and to heat the overlap when applied, to obtain the best seal.

B.3.3.4 Two-pack taping

In this method of high-duty protection a woven tape is impregnated, after wrapping, with a two-pack solventless composition, normally a polyester or two-pack epoxy. The technique used is similar to that used in the preparation of glass fiber moulding, except that the resin-impregnated glass cloth is intended to adhere to the metal substrate. This method is used especially for shafting exposed to marine conditions and for surfaces which may be subject to cavitation corrosion.

The surface to be protected shall first be thoroughly cleaned to bright metal, then primed with a two - pack epoxy(or similar). It shall then be wrapped with glass cloth in sheet or tape form and the cloth impregnated with a two-pack polyester or two-pack epoxy composition. It is good practice to apply a thin coating of the impregnating resin before applying the reinforcing substrate; then several layers are built up and the final surface is troweled smooth. The coating will then set to a hard glass-like tough protective coating which is impermeable to water.

B.3.3.5 Plastic sleeves

Polythene and similar plastic may be used as protective sleeves on pipe and are sometimes shrunk on to the metal. For spun iron pipes and castings the application of a non-adherent but snug-fitting polythene sleeve gives good protection. The sleeving is applied at the time of laying the pipe and joints are taped with adhesive strip.

B.3.4 Protection of Steel by Cement and Allied Products

Cement-mortar linings are widely used for internal protection of water mains. Special formulations and coating procedures are used. They have limited impact resistance but may be repaired on site by fresh applications. Conversely, steel structures (and steel reinforcement) may be in contact with, or embedded in, concrete. the BS Codes of practice CP 110 and CP 114 to CP 117, relating to concrete and steel/concrete structures, contain relevant information.

Exposed steel may be covered with gypsum plaster and magnesium oxychloride cements, but it should first have been coated with a suitable bitumen coating that is resistant to water penetration while the plaster or cement is curing.

B.3.5 Cathodic Protection

The degree of protection afforded by a cathodic system may be enhanced by paint coatings, but not all paint systems are compatible with cathodic protection systems and specialist advice should be sought.

(to be continued)

APPENDIX B (continued)

TABLE B.1 - TYPICAL ORGANIC ZINC-RICH PAINTS (PREFABRICATION PRIMER)

NUMBER	BINDER	MAIN PIGMENT	VOLUME SOLIDS (NOMINAL%)	MAIN PIGMENT IN TOTAL PIGMENT (WEIGHT % MIN.)	DRY-FILM THICKNESS (MICRONS PER COAT MINIMUM ADVISED)	ADDITIONAL INFORMATION
1	TWO-PACK-EPOXY	ZINC DUST	35	95	50	QUALITY COVERED BY IPS-M-TP-205 MAXIMUM OF 75 MICRON RECOMMENDED BY SPRAY FOR EACH LAYER. AN INITIAL PREFABRICATION PRIMER MAY BE ONLY 25 MICRONS

TABLE B.2 - TYPICAL BLAST PRIMERS

NUMBER	BINDER	MAIN PIGMENT	VOLUME SOLIDS (NOMINAL%)	MAIN PIGMENT IN TOTAL PIGMENT (WEIGHT % MIN.)	DRY-FILM THICKNESS (MICRONS PER COAT MINIMUM ADVISED)	ADDITIONAL INFORMATION
1	TWO PACK EPOXY	ZINC PHOSPHATE	25	40	20	SEE BS 4652 ESSENTIAL TO AVOID SETTLEMENT OF PIGMENT ALSO HAS USES OTHER THAN AS A BLAST PRIMER
2		ZINC DUST	30	95	40	
3	TWO-PACK POLYVINYL BUTYRAL	ZINC TETROXY-CHROMATE	10	85	15	

(to be continued)

APPENDIX B (continued)

TABLE B.2

4	TWO-PACK POLYVINYL BUTYRAL/-PHENOLIC	ZINC TETROXY-CHROMATE	10	85	15	SUSPECT WITH CATHODIC PROTECTION IF THERE IS ANY DISCONTINUITY COVERING SYSTEM
5	ONE-PACK POLYVINYL BUTYRAL/-PHENOLIC	ZINC PHOSPHATE	22	20	20	
6		ZINC CHROMATE	22	20	20	

TABLE B.3 - TYPICAL DRYING OIL PRIMERS

NUMBER	BINDER	MAIN PIGMENT	VOLUME SOLIDS (NOMINAL%)	MAIN PIGMENT IN TOTAL PIGMENT (WEIGHT % MIN.)	DRY-FILM THICKNESS (MICRONS PER COAT MINIMUM ADVISED)	ADDITIONAL INFORMATION
1	BLEND OF RAW AND PROCESS DRYING OILS	RED LEAD	75	98	40	BRUSH APPLICATION RECOMMENDED SLOW DRYING (SEE IPS-M-TP-115)

(to be continued)

APPENDIX B (continued)

TABLE B.4 - TYPICAL RESISTANCE CHART FOR SOME PAINTS

GENERIC TYPE	CURE MECHANISM	ACID	OXID-IZING ACID	ALKALI	SALT	SOL-VENT	WEA-THER	MAX. TEMP. DRY HEAT
CHLORINATED RUBBER	SOLVENT EVAP.	VG	VG	G	VG	P	G	66°C
EPOXY (POLYAMIDE)	CHEM. CROSSLINKING	E	G	E	E	VG	G	121°C
SILICONE (ALUM.)	SOLVENT/HEAT	P	P	F	G	F	G	538°C
VINYL	SOLVENT EVAP	E	E	VG	E	P	VG	121°C
ZINC-RICH (INORGANIC)	HYDROLYSIS	E*	E*	E*	E	E	E	400°C*
ZINC-RICH (ORGANIC)	CHEM. CROSSLINKING	VG*	VG*	VG*	VG	VG	VG	149°C**

Rating Scale:

(E) Excellent-no effect, best selection where performance and appearance retention are desired.

(VG) Very good-no effect on performance, very little appearance degradation.

(G) Good-little effect on performance, some appearance degradation.

(F) Fair-performance and appearance affected by exposure.

(P) Poor-not suitable, coating attacked.

*** Results indicate zinc rich coating performance when topcoated. Use of these coatings untopcoated in chemical environments is not recommended.**

**** Limited by topcoat in the system.**

APPENDIX C
INTERNAL PAINTING OF ABOVE GROUND STEEL TANKS, LPG SPHERES AND VESSELS

C.1. GENERAL

Tables C.1 to C.12 indicate the painting schemes to be used on vertical tanks at site.

Horizontal tanks are dealt within section C.2 below.

Spheres and vessels for pressurized petroleum gases are dealt within section C.3 and vertical tanks in section C.4, which is further divided in respect to product(s) to be stored.

For the treatment of tanks storing specific products not included in any of the tables, the painting system shall be specified in each case.

C.2 HORIZONTAL TANKS / VESSELS

When a tank or vessel rests on a saddle of concrete or brickwork, the bearing surface of the latter shall be heavily coated with petroleum jelly tape (see Appendix B).

Shop treatment shall be given to both sides of the plates of horizontal tanks/vessels which are to be used for storage of specific products.

If treatment is not applied in the shop, the surfaces shall be blast cleaned at site to grade Sa 2½.

The outer surface shall then be painted as indicated in paint schedule (table 1 clause 8 storage tanks, external) and the inner surface treated as indicated below.

a) Petroleum products, except as in (b)

The shop coat on horizontal tanks/vessels for petroleum products need not be made good and further painting is not necessary;

b) Food grade hydrocarbons

Painting is not required if a prefabrication or shop primer has been applied, it shall be removed by blast cleaning;

c) Benzene, toluene and xylene tanks for products containing more than 60% aromatics;

Painting is not required, if an oil-based red lead shop primer has been used, this shall be removed by blast cleaning;

d) Chemical and solvents such as alcohols, ketones and ethers;.

Horizontal tanks are used for storing a wide range of chemicals, particularly processing chemicals, at manufacturing plants.

Special tank lining materials are often required which are outside the scope of this standard.

e) Teepol

As for the shell of vertical tanks as indicated in clause 8.2 of table 1.

C.3 SPHERES AND CYLINDRICAL VESSELS FOR LIQUEFIED PETROLEUM GASES UNDER PRESSURE

Shop treatment shall be given to both sides of the plates of spheres and cylindrical vessels for liquified petroleum gas (LPG). Under pressure. No further painting is required on the inside but the outside shall be painted as indicated in paint schedule (table 1 clause 8 storage tanks, external).

C.4 VERTICAL TANKS

For external painting see paint schedule (table 1 clause 8 storage tanks,external) and for internal see tables C.1 to C.12 here after.

(to be continued)

APPENDIX C (continued)

TABLE C.1 - INTERNAL PAINTING CRUDE OIL TANKS

TANK PARTS AND CONDITIONS		PAINT SYSTEMS
BOTTOM PLATES	BELOW 60°C AND NOT SEVERELY CORROSIVE	SHOP PRIMED ONLY (NO TREATMENT AT SITE)
	BELOW 60°C WHEN SEVERELY CORROSIVE	7L
	ABOVE 60°C	7L
	BOTTOM COURSE	AS FOR BOTTOM PLATES
	TOP COURSE 1500 mm FIXED ROOF TANKS: a) GENERALLY, EXCEPT B	AS FOR REST OF SHELL
	FIXED ROOF TANKS: b) SOUR CRUDE	7L
	FLOATING ROOF TANKS	1C
	REST OF SHELL	SHOP PRIMED ONLY NO TREATMENT AT SITE
ROOFS	FIXED ROOF SHEETS-/TRUSSES: a) GENERALLY, EXCEPT b	1C
	FIXED ROOF SHEETS-/TRUSSES: b) SOUR CRUDE	7L
	UNDERSIDE FLOATING ROOF	AS FOR REST OF SHELL

APPENDIX C (continued)

TABLE C.2 - INTERNAL PAINTING:

MOTOR GASOLINE TANKS AVIATION GASOLINE GRADES AND THEIR COMPONENT TANKS, NAPHTHA TANKS

TANK PARTS		PAINT SYSTEMS
BOTTOM PLATES		7B
	BOTTOM COURSE	AS FOR BOTTOM PLATE
SHELL PLATES	TOP COURSE (1500 mm)	" " " "
	REST OF SHELL	" " " "
ROOFS	UNDERSIDE FLOATING ROOFS	" " " "

(to be continued)

APPENDIX C (continued)

TABLE C.3 - INTERNAL PAINTING:
HYDRO-TREATED (DRY) KEROSENE AND KEROSENE TYPE JET FUEL TANKS, WHITE SPIRITS, SBP'S AND THEIR COMPONENT TANKS PETROLEUM PRODUCT, E. G. LUB OIL BASE, OILS, CAT. CRACKER FEED STOCK TANKS, RESIDUAL FUEL OIL TANKS

TANK PARTS		PAINT SYSTEMS
BOTTOM PLATES		7B
SHELL PLATES	BOTTOM COURSE	LOWER HALF AS FOR BOTTOM PLATES
		UPPER HALF AS FOR REST OF SHELL
	REST OF SHELL	SHOP PRIMED ONLY (NO TREATMENT AT SITE)
ROOFS	SHEETS / TRUSSES	1A

TABLE C.4 - INTERNAL PAINTING:
WET TREATED (MEROX) KEROSENES AND KEROSENE TYPE JET FUEL TANKS

TANK PARTS		PAINT SYSTEMS
BOTTOM PLATES		7B
SHELL PLATES	BOTTOM COURSE	AS FOR BOTTOM PLATES
	REST OF SHELL	"
ROOFS	SHEETS / TRUSSES	"

TABLE C.5 - INTERNAL PAINTING:
GAS OIL AND DISTILLATE DIESELS AND THEIR COMPONENTS

TANK PARTS		PAINT SYSTEMS
BOTTOM PLATES		7A
SHELL PLATES	BOTTOM COURSE	"
	REST OF SHELL	"
ROOFS	SHEETS / TRUSSES	"

(to be continued)

APPENDIX C (continued)

TABLE C.6 - INTERNAL PAINTING:

TANKS FOR FOOD GRADE HYDROCARBONS

TANK PARTS		PAINT SYSTEMS
BOTTOM PLATES		BLAST CLEAN TO SA 2 (NO PAINTING)
SHELL PLATES	BOTTOM COURSE	"
	REST OF SHELL	"
ROOFS	SHEETS / TRUSSES	1A

TABLE C.7 - INTERNAL PAINTING: BENZENE, TOLUENE AND XYLENE TANKS AND TANKS FOR CONTAINING MORE THAN 60 % AROMATICS

TANK PARTS		PAINT SYSTEMS
BOTTOM PLATES		BLAST CLEAN TO SA 2
SHELL PLATES	BOTTOM COURSE	"
	REST OF SHELL	"
ROOFS	SHEETS / TRUSSES	1A

TABLE C.8 - INTERNAL PAINTING "TEEPOL" TANKS

TANK PARTS		PAINT SYSTEMS
BOTTOM PLATES		7B
SHELL PLATES	BOTTOM COURSE	AS FOR BOTTOM PLATES
	REST OF SHELL	AS FOR BOTTOM PLATES
ROOFS	SHEETS / TRUSSES	AS FOR BOTTOM PLATES

TABLE C.9 - INTERNAL PAINTING: INDUSTRIAL WATER TANKS

TANK PARTS		PAINT SYSTEMS
BOTTOM PLATES		10A OR 10B OR 7K
SHELL PLATES	BOTTOM COURSE	AS FOR BOTTOM PLATES
	REST OF SHELL	"
ROOFS	SHEETS / TRUSSES	10A 10B

(to be continued)

APPENDIX C (continued)

TABLE C.10 - INTERNAL PAINTING: BALLAST WATER, SLOP-AND DEMINERALIZED WATER (BELOW 60°C) TANKS

TANK PARTS		PAINT SYSTEMS
BOTTOM PLATES		7K
SHELL PLATES	BOTTOM COURSE	AS FOR BOTTOM PLATES
	REST OF SHELL	"
ROOFS	SHEETS / TRUSSES	10A OR 10B OR 7K

TABLE C.11 - INTERNAL PAINTING: DRINKING WATER TANKS

TANK PARTS		PAINT SYSTEMS
BOTTOM PLATES		7I (8C FOR SMALL TANKS)
SHELL PLATES	BOTTOM COURSE	AS FOR BOTTOM PLATES
	REST OF SHELL	"
ROOFS	SHEETS / TRUSSES	"

TABLE C.12 - INTERNAL PAINTING: REFRIGERATED STORAGE TANKS

TANK PARTS	PAINT SYSTEMS
OUTER SHELL PLATE ROOF PLATES SUSPENDED DECK STEEL LINING SHELL AND BOTTOM (BOTH SIDES) TANK INTERNAL PUMP SHAFTS INNER TANK SHELL AND BOTTOMS BOTH SIDES FINE GRAINED C, MN STEEL	4C
9 % N1 STEEL	NO PAINTING

APPENDIX D

TYPICAL REFINERY PAINTING SYSTEMS SCHEDULE FOR STEEL SURFACES RECOMMENDED SCHEME

SURFACE	PAINT SYSTEM	COMMENTS
BURIED PIPING	SYSTEM 10 B + 1 GLASS & 1 FELT WRAP & FINISH COAT OF WHITE WASH (SEE IPS- E-TP-270 OR AWWA SPEC. C-203)	
BURIED STRUCTURES OTHER THAN PIPING	7L	
DOCKS (ABOVE WATER) & MOORING BUOYS	7C	IF BLACK COATING IS ACCEPTABLE THE ALTERNATE IS LOWER COST AND IS LOWER COST AND JUST AS EFFECTIVE
DOCKS (BELOW WATER) & SHEET PILING, BEFORE DRIVING	7L	IN ADDITION TO THE COATING, CATHODIC PROTECTION SHOULD BE CONSIDERED FOR MAXIMUM PROTECTION
FENCE FABRIC, CHAIN LINK	8C	
(UNINSULATED) EXCHA-NGERS, VESSELS, HEATERS STACKS, ABOVE GROUND PIPING, ETC. TO 93°C IN MILD AND MODERATE INDUSTRIAL ENVIRONMENT	5C	
IN SEACOAST AND SEVER INDUSTRIAL ENVIRONMENT	5D	(1) WITH SOME ITEMS GALVANIZING MAY BE CONSIDERED INSTEAD OF COATING. (2) COMPATIBILITY OF TOPCOAT WITH ZINC-RICH PRIMER MUST BE DETERMINED BEFORE APPLICATION.
93-260°C	5D	(1) THESE ARE NOT PERFECT MATERIALS BUT ARE PROBABLY THE BEST AVAILABLE RECOMMENDATIONS FOR HOT SURFACES.
204-371°C	5D	(2) THE ZINC-RICH INORGANICS DO A GOOD JOB OF CORROSION PROTECTION BUT SOME COATING SUPPLIERS MAY BE ABLE TO FURNISH A SUITABLE SILICONE TOPCOAT, WHERE COLOR IS IMPORTANT.
INSULATED SURFACES UNDER INSULATION IF METAL SURFACE OPERATING TEMPERATURE WILL BE UNDER 180°C	7K	

(to be continued)

APPENDIX D (continued)

PREPAINTED ITEMS (COMPRESSORS, PUMPS MOTORS, ETC.)	NONE NORMALLY REQUIRED	NUMBER OF COATS DEPENDING ON HIDING REQUIRED.
STRUCTURAL STEEL IN MILD AND MODERATE INDUSTRIAL ENVIRONMENT	8A	
IN SEACOAST AND SEVERE INDUSTRIAL ENVIRONMENT	8D	IF GALVANIZED OR SHOP-COATED WITH ZINC-RICH INORGANIC, CLEAN AND BLAST WELDS AND TOUCH-UP WITH COMPATIBLE ZINC-RICH COATING AFTER ERECTION IN FIELD.
WALKWAYS, HANDAILS, LADDERS, LINE SUPPORTS NUTS, BOLTS, AND MISCELLANEOUS HARDWARE	8D	IT IS RECOMMENDED THAT MICARTA BLOCKS (OR SIMILARLY EFFECTIVE MATERIALS) CEMENTED AND SEALED UNDER PIPELINE WHERE THEY REST ON SUPPORTS.
TANKS INTERIOR CLEAN PETROLEUM PRODUCTS (FINISHED PRODUCTS)	SEE APPENDIX C	EVEN IF TANK IS NOT TO BE COATED, IT IS RECOMMENDED THAT STEEL BE SANDBLASTED OR PICKLED TO REMOVE MILLSCALE. THIS IS A GOOD PROTECTION AGAINST PITTING.
BRINE OR WASTE WATER	7L	
CLEAN WATER, OR CONDENSATE	7D	IF POTABLE WATER, COATING SHOULD BE NONTAXIC
CRUDE BOTTOM & UP TO 45 cm ON SHELL	7L	
CRUDE, LOWER & MIDDLE SHELL PLATES, AND ROOF	NO COATING	
CRUDE, TOP RING (FLOATING ROOF ONLY)	7B	USE ALTERNATE ONLY IF CRUDE NOT SOUR
TANKS, EXTERIOR ABOVE GRADE, SHELL & CONE ROOF IN MILD AND MODERATE INDUSTRIAL ENVIRONMENT	1D	FOR LIGHT PRODUCTS, A CHALKING WHITE FINISH IS PREFERRED TO MINIMIZE EVAPORATION LOSSES.
IN SEACOAST AND SEVERE INDUSTRIAL ENVIRONMENT	7F	WHERE PICKUP OF DIRT IN THE ATMOS PHERE IS A PROBLEM ON LIGHT-COLORED FINISH, OVERCOATING WITH A SOIL RETARDANT SOLUTION SHOULD BE CONSIDERED.
FLOATING ROOF	5D	FOR ALTERNATE, IF POST-CURED ZINC-RICH INORGANIC IS USED, MAKE CERTAIN CURING AGENT IS REMOVED BEFORE TOPCOATING.
BELOW GRADE SHELL	7L	IN ADDITION TO COATING, CATHODIC PROTECTION SHOULD ALSO BE CONSIDERED FOR MAXIMUM PROTECTION.
BOTTOM	APPLY CATHODIC PROTECTION	SET TANKS ON SAND, PULVERIZED LIMESTONE, OR CONCRETE PAD SLIGHTLY ABOVE GRADE WHERE POSSIBLE.

(to be continued)

APPENDIX D (continued)

TYPICAL REFINERY PAINTING SYSTEMS SCHEDULE FOR STEEL SURFACES OTHER THAN RECOMMENDED SCHEME

SURFACE	SURFACE PREPARATION (SEE IPS-C-TP-101)	PAINT SYSTEM	FINISH	COMMENTS
ALUMINUM	NONE NORMALLY REQUIRED			DO NOT USE LEAD BASE PRIMER ON ALUMINUM
CONCRETE INTERIOR WALLS	CLEAN	1 OR 2 COATS WHITE LATEX BLOCK FILLER (UNTIL VOIDS ARE FILLED)	1 OR 2 C OATS 2 - PACKAGE POLYESTER, OR CATALYST-CURED EPOXY (AN ALKYD, VINYL LATEX, OR ACRYLIC LATEX MAY BE SUBSTITUTED WHERE WASHA BILITY IS NOT IMPORTANT	NUMBER OF COATS DEPENDS ON HIDING REQUIRED. FOR PREVIOUSLY PAINTED WALLS, CHECK WITH BLOCK FILLER MANUFACTUREER ON POSSIBILITY OF ADHESION PROBLEMS
EXTERIOR WALLS	CLEAN	1 OR 2 COATS WHITE LATEX BLOCK FILLER (UNTIL VOIDS ARE FILLED)	1 OR 2 COATS 2 - PACKAGE POLYESTER (AN ALKYD, EXT. VINYL LATEX, OR EXT. ACRYLIC LATEX MAY BE SUBSTITUTED)	
FLOORS	MURIATIC ACID ETCH, DETERGENT WASH & ALLOW TO DRY	1 COAT CATA-LYST-CURED URETHANE	2 COATS CATALYST-CURED URETHANE	(1) PREFERRED SYSTEM CAN NOT BE APPLIED OVER CONVENTIONAL ALKYD OR OLEORESINOUS PAINTS. (2) CONSIDERATION SHOULD ALSO BE GIVEN TO TILE, OTHER FLOORING MATERIALS AND TO TINTED CONCRETE.
TANKS, BRINE & WASTE WATER	CLEAN & DRY	COAL TAREPO-XY (400 MICRONS)*		SANDBLASTING OR ACID-ETCHING MAY BE REQUIRED
COPPER	NONE NORMALLY REQUIRED			
GALVA-NIZED	No COATING NORMALLY REQUIRED FOR SEVERAL YEARS			

(to be continued)

APPENDIX D (continued)

PLASTERED WALLS OFFICES, HALLS, ETC.	CLEAN	2 OR 3 COATS LATEX (ACRY-LIC OR VINYL		
WASH-ROOMS. ETC.	CLEAN	1 COAT EMULSION-TYPE PRIME-SEALER	2 COATS, 2 - PACKAGE POLYESTER OR CATALYST CURED EPOXY	(1) WITH CATALYSTCURED EPOXY, WALL SEALER MAY OR MAY NOT BE REQUIRED DEPENDING ON MANUFACTURER. (2) TOPCOAT SHOULD BE MILDEW-RESISTANT FOR HUMID AREAS.
WOOD GENERAL	CLEAN & DRY	1 COAT WOOD PRIMER	2 COATS ALKYD OR OLEORESINOUS	TOPCOATS SHOULD BE MILDEW-RESISTANT FOR HUMID AREAS.
OUTSIDE WALLS	CLEAN & DRY	1 COAT WOOD PRIMER FOR LATEX	2 COATS LATEX HOUSE PAINT	
FLOORS	SANDED, CLEAN & Dry	3 COATS URETHANE FLOOR VARNISH		
INSULATION COVERINGS CANVAS	CLEAN	2 COATS EMULSION-TYPE FIRE RETARDANT INSULATION SEALER		
FIRETARD	CLEAN & DRY	1 OR 2 COATS FIRE-RETARDANT PAINT		MAY BE PAINTED LATER.
BITUMEN MASTICS	NOT NORMALLY REQUIRED UNLESS COLOR IS IMPORTANT			
URETHANE FOAM	IN ACCORDANCE WITH FOAM MANUFACTURERS RECOMMENDATIONS			ELASTOMERIC COATING MOST USEFUL

Note:

Film thicknesses shown are to be measured dry.
Color of finish coat to be selected with reference to table 3 paint color schedule. All coatings to be applied strictly in accordance with manufacturer's recommendations.

*** To be applied in number of coats required to achieve this film thickness,but in no case shall this be less than 2 coats.**

APPENDIX E

TYPICAL PAINTING SYSTEMS FOR FRESH WATER MARINE VESSELS

SURFACE TO BE PAINTED	TYPICAL PAINT SYSTEMS
TOWBOAT AND BARGE HULL EXTERIORS	3C, 6G, 7E, 7L
TOWBOAT AND BARGE DECKS AND COVERS	3B, 6F, 7E
TOWBOAT SUPERSTRUCTURES AND INTERIORS	3B, 6E, 7C, 7E
COAL AND ACID-CARRYING BARGE DECKS AND HOPPERS	3C, 6G, 7D
BARGE RAKE INTERIORS	1D
BARGE INNERBOTTOMS AND WINGS	1D

APPENDIX F

TYPICAL SHIP PAINT SYSTEMS

TABLE F.1 - TYPICAL SHIPBOTTOM PAINTING SYSTEM

NUMBER	PAINT SYSTEM	ANTI-FOULING	REPAINTING PROCEDURE	APPLICATION EQUIPMENT
1	10A OR 10B	ROSIN BASE, COUPROUS OXIDE TOXIC 75 MICRON MDFT*	FRESH WATER SPOT BLAST OR POWER TOOL CLEAN BAD AREAS CLEAN BAD AREAS	SPRAY RECOMMENDED, MAY BE ROLLED
2	3C	VINYL-ROSIN BASE 100 MICRONS. MDFT* TOXIC USUALLY CUPROUS OXIDE	FRESH WATER WASH, SPOT BLAST BAD AREAS	SPRAY RECOMMENDED, SMALL AREAS CAN BE ROLLED OR BRUSHED
3	7B	VINYL ANTI-FOULING 100 MICRONS MDFT	FRESH WATER WASH, SPOT BLAST BAD AREAS, STEP BACK ANTIFOULING IN WAY OF REPAIR	EPOXY AIRLESS SPRAY RECOMMEND ANTI-FOULING SPRAY SMALL AREAS CAN BE ROLLED
4	6E	CHLORINATED RUBBER ANTI-FOULING, 100 MICRONS MDFT*	FRESH WATER WASH, SPOT BLAST BAD AREAS	AIRLESS SPRAY RECOMMENDED, SMALL AREAS CAN BE ROLLED
5	7L	VINYL ANTI-FOULING, 100 MICRONS, MDFT*	FRESH WATER WASH, SPOT BLAST BAD AREAS, STEP BACK ANTI-FOULING IN WAY OR REPAIR	AIRLESS SPRAY RECOMMENDED FOR EPOXY SPRAY ANTI-FOULING SMALL AREAS CAN BE ROLLED

MDFT = Minimum Dry Film Thickness

TABLE F.2 - TYPICAL BOOTTOP AND TOPSIDE PAINTING SYSTEM

NUMBER	PAINT SYSTEM	REPAINTING PROCEDURE	APPLICATION EQUIPMENT
1	7E OR 6B	WASH AND REMOVE CONTAMINANTES -ABRASIVE BLAST OR POWER TOOL CLEAN DAMAGED OR FAILED AREAS. TOUCH UP USING SAME SYSTEM AS APPLIED DURING CONSTRUCTION	AIRLESS SPRAY PREFERRED-AIR SPRAY CAN BE USED ALSO ROLLER AND BRUSH FOR SMALL AREAS
2	7C OR 7F	"	"
3	3C	"	"

*** MDFT = Minimum Dry Film Thickness**