8 PAINTING AND PROTECTIVE COATINGS

8.1 GENERAL

8.1.1 Scope

1 This part includes the specification for the Provision of protective coatings and painting to protect the surfaces of structures, materials and equipment in interior, exterior, process, operating, and maintenance service environments as classified in this Part.

2 Related Parts and Sections are as follows:

This Section

Part 1, ... General
Part 3, ... Pipes and Fittings Materials
Part 5, ... Valves, Penstocks and Appurtenances
Part 6, ... Miscellaneous Metal Work

Section 1, General
Section 5, Concrete
Section 6, Road works
Section 9, Mechanical and Electrical Equipment
Section 10, Instrumentation, Control and Automation
Section 16, Structural Metalwork
Section 17, Metalwork
Section 21, Electrical Works
Section 26, Painting and Decorating.

8.1.2 References

1 The following standards and other documents are referred to in this Part:

ASTM C97.....Standard Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone

BS 245.....Mineral solvents (white spirit and related hydrocarbon solvents) for paints and other purposes

BS 1336 .....Knotting

BS 1710 .....Identification of pipelines and services

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

BS 4652 .....Zinc-rich priming paint (organic media)

BS 4756 .....Ready mixed aluminium priming paints for woodwork

BS 4800 .....Paint colours for building purposes

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

BS 6150 .....Code of practice for painting of buildings

BS 7079 .....Preparation of steel substrates before application of paints and related products

BS 7956 .....Specification for primers for woodwork

EN 10300 .....Steel tubes and fittings for onshore and offshore pipelines - Bituminous hot applied materials for external coating

ISO 1461 .....Hot dipped galvanised coatings on iron and steel articles

SIS 055900 .....Rust grades for steel surfaces and preparation grades prior to protective coating

8.1.3 Definitions

1 Paints, protective coatings, and coatings: paints, enamels, stains, varnishes, lacquers, sealers, fillers and other types of coatings whether used as primers, intermediate or finish coats.

8.1.4 System Description

1 For purposes of identifying protective coating and painting systems to be applied as specified in this Part, service environments are classified in Table 8.2.

2 The classification of areas and surfaces to be coated or painted shall be as designated in the Project Specification.

3 Painting in unclassified areas shall be carried out as specified in Section 26.

4 Surfaces to be Coated or Painted. In general, the following surfaces are to be coated or painted:

(a) all exposed piping and other metal surfaces, interior and exterior

(b) all submerged metal surfaces

(c) all structural and miscellaneous steel work, including tanks

(d) interior of tanks, chambers and wet wells that are not protected with GRP or PVC liners

(e) exterior above ground concrete as Table 8.5 unless otherwise designated in the Project Specification

(f) exterior above ground brick masonry as designated in the Project Specification

(g) interior of structures as designated in the Project Specification.

(h) equipment furnished with and without shop finished surfaces, except as specified in Clause 8.1.8

5 Surfaces Not to be Painted or Coated. The following surfaces in general shall not be coated or painted unless otherwise designated:

(a) plastic surfaces

(b) non-ferrous metal (Galvanised metal shall not be considered a non-ferrous metal)

(c) mechanical equipment with approved, designated shop finish

(d) electrical equipment with shop finishes designated in the contract specific documentation

(e) piping to be galvanised as designated in the Project Specification

(f) chain link fencing.

6 In no case shall any concrete, wood, metal, or any other surface requiring protection be left unpainted unless otherwise directed by the Engineer or designated in the Project Specification.

8.1.5 Submittals

1 Manufacturer's Data. The manufacturer's specifications and application instructions for paint materials and systems, including certifications, verification of specified thickness and other data to show compliance with these specifications shall be submitted to the Engineer.

2 Painting Programme. A detailed painting programme including method statements shall be submitted for the Engineer's approval. This programme shall be prepared on the basis of service environments, surfaces, surface preparation, types of paint materials, types of primers and sealers, and number of coats. The brand name of the product of the manufacturer for each use shall be listed.

3 Samples. When required by the Engineer, samples for colour and texture as hereinafter listed shall be submitted for the Engineer's approval. The Contractor shall be responsible for compliance with all other requirements.

4 Letter of guarantee required under Clause 8.1.8 of this Part.

8.1.6 Quality Assurance

1 Protective painting shall be carried out only by approved prequalified subcontractors as designated in the Project Specification. Protective coating shall be carried out by specialist subcontractor as designated in the Project Specification.

2 Applicator Qualifications: The Contractor shall provide information demonstrating that applicators have successfully completed coating system applications similar in material and extent to those included in the Works. Only applicators for which such information has been provided shall be employed.

3 Single-Source Responsibility: The Contractor shall provide primers and undercoat material produce by the same manufacturer as the finish coats for each type of coating. Only thinners recommended by the manufacturer shall be used, and only within the manufacturer's recommended limits.

Field Samples: Where required by the Engineer field samples shall be provided as follows:

(a) Sample Boards. The Engineer's colour chips on 300 mm by 300 mm hardboard shall be matched with colour, texture and sheen duplicated to simulate actual conditions. Sample boards shall be resubmitted as necessary for selection by the Engineer.

(b) Sample Areas. Where required by the Engineer, partial areas shall be prepared and finished as directed by the Engineer, using selected 300 mm by 300 mm sample boards as a guide for final approval of colour, texture and sheen. After approval, the sample areas shall serve as the standard for workmanship, appearance and materials for similar areas throughout the project.

4 All epoxy coating work shall be carried out by a specialist firm or contractor approved by the Engineer. The specialist firm shall be required to submit a letter of guarantee that the product it proposes to supply when applied in accordance with this specification and any additional specifications which shall be quoted by the firm will withstand the environmental service conditions to be encountered. The Contractor shall provide a guarantee of at least three years in relation to this coating from the time of application of the coating.

8.1.7 Delivery, Storage and Handling

1 Except as otherwise specified in this Part, delivery storage and handling of coating and paint material shall be carried out as specified for paint material in Section 26.

2 Coating and painting materials and apparatus shall be stored in areas approved by the Engineer. When not in use, storage areas shall be kept locked and inaccessible to those not employed in protective coatings and painting work. Each storage space shall be provided with fire extinguishers.

3 Coating and paint containers shall be opened only when required for use. Unless otherwise specified in this Part, no materials shall be reduced, changed, or used except in accordance with the manufacturer's label or tag on container.

4 All coating materials and thinners shall be furnished by the Contractor in original, unopened containers bearing the manufacturers label and instructions. For materials having a limited shelf life, the date of manufacture and the length of life shall be shown. The oldest paint of each kind shall be used first.

5 All coating materials shall be stirred in a container with a power mixer before use to thoroughly remix the pigments and vehicles. Only thinners specified by the manufacturer shall be used. Mixing and thinning directions as furnished by the manufacturer shall be followed unless modified by the Engineer's Representative.

6 Mixing in open containers shall be done in a well ventilated area. When use of thinner is permitted, thinner shall be added during the mixing process.

7 If a coating material requires the addition of a curing agent, the pot life under application conditions stated on the container label shall not be exceeded. When the pot life limit is reached, the spray equipment shall be emptied, remaining material discarded, the equipment cleaned and the new material prepared.

8 For paints and thinners, records shall be kept of:

(a) Date of manufacture.

(b) Shelf life.

(c) Date of use.

(d) Daily usage of thinners.

9 Preparation of the paint for application shall be as BS 5493 and the Manufacturers recommendations.

10 Coating materials, other than thixotropic materials, which have livered, gelled or otherwise deteriorated shall not be used.

11 No paint shall be used on expiry of the manufactures recommended shelf life nor when the paint solids cannot be dispersed by mixing after a maximum of 5% thinners has been added.

8.1.8 Warranty

1 Before beginning coating and specialist paint work, the Contractor shall provide the Engineer with a letter of guarantee from the specialist subcontractor that the products proposed for use when applied in accordance with the specifications of this Part and the manufacturer's instructions will withstand the environmental service conditions to be encountered for a period of 10 years.

8.1.9 Safety

1 The implementation of manufacturer's recommendations concerning health and safety aspects of paints approved by the Engineer for use on the works shall be mandatory.

2 Respirators shall be worn by all persons engaged in, and assisting in, spray painting. In addition, workers engaged in or near the work during sandblasting shall wear eye and face protection devices meeting the Engineer's approval for sandblasting operations and approved air-purifying, half-mask or mouthpiece respirator with appropriate filter.

3 Where ventilation is used to control potential exposure to workers, ventilation shall be adequate to reduce the concentration of the air contaminant to such safe limits that a hazard to the worker does not exist. Methods of ventilation shall meet with the approval of the Engineer.

4 Cloths and cotton waste that may constitute a fire hazard shall be placed in closed metal containers or destroyed at the end of each work day.

8.2 MATERIALS

8.2.1 Coating and Painting Materials

1 Epoxy coating and painting materials shall be as follows:

(a) Primer

(i) solvent-free low viscosity

(ii) two or three pack

(iii) compatible with and have complete intercoat adhesion with the first coat of high build epoxy paint

(b) Protective coats

(i) high build straight aromatic amine cured epoxy

(ii) two or three pack

(iii) solvent free type

(iv) completely resistant to the corrosion conditions to be encountered.

Certain types of coal tar epoxy may also be approved by the Engineer for this purpose in which case the Contractor shall state the type of coal tar and the curing agent to be used and the percentage content of coal tar.

2 Stone Paint. Stone paint to be used on exposed external concrete surfaces shall be single component silane siloxane based water repellent system with not more than 1% water absorption when tested in accordance with ASTM C97.

3 Fungus and Mould Resistant Finishes. Where a fungus and mould resistant surface is designated, the surface shall be treated with a fungicide paint in accordance with the manufacturer's instructions.

4 Varnish: Varnish shall comply with the relevant provisions of ISO 150.

5 Where a surface is to receive more than one type of coating or painting material, each different material used on that particular surface shall have a different colour in order to facilitate inspection. Colour schedules for coating and painting materials shall be prepared by the Contractor and submitted to the Engineer for approval.

6 The list of manufacturers of all paints/coatings/corrosion control systems shall be submitted for approval by the Engineer.

7 All materials for lining/multiple coat work, e.g., priming, undercoat and finishing coat shall be obtained from the same manufacturer and shall be suitable for using together and for the surface concerned.

8 All materials shall be used strictly in accordance with manufacturer's instructions.

9 Manufacturer's samples of all paints, varnishes, etc., shall be submitted, free of cost, in sealed containers to the Engineer for approval before bulk deliveries are made and before any paintwork is started.

8.2.2 Coating and Painting Systems

1 The materials, application and use of coating and painting systems are specified in Tables 8.1 to 8.5. Surfaces in Location A shall receive a total paint thickness of not less than 200 micron and the surfaces in Location B, C and D shall receive a total paint thickness of not less than 300 micron. The first coat of paint to be applied not more than 4 hours after substrate preparation. Subsequent coats of paint to be applied within 48 hours of previous coat. Approval to factory application of this final coat to be sought from the Engineer where delay in application is liable to cause adhesion problems.

2 Formulate paints with colorants free of lead, lead compounds, or other materials that might be affected by presence of hydrogen sulfide or other gas likely to be present at Site.

3 Identification of pipelines shall be generally in accordance with the Contract Drawings or Specification or as selected by the Engineer.

4 Pipelines shall be identified by the colours in Table 8.6. These shall be applied as follows:

(a) Painting the basic identification colour on the pipe or duct over the whole length and super-imposing the colour code identifications at intervals; or

(b) Painting the pipe or duct in bands.

5 Where banding is adopted, the decorative or protective colour along the rest of the pipe or duct shall not be any of the basic identification colours.

6 The basic identification colours shall be placed at all junctions at both sides of valves, service appliances, bulkheads, wall penetrations and any other place where identification is necessary.

7 Any information regarding the fluid such as pressure, temperature, etc., shall be placed on the basic identification colour or next to the basic identification colour band. The names, abbreviations or chemicals symbols shall be either in black or white in order to contrast clearly with the colour of the pipe or with the basic identification colour. The direction of flow of the fluid shall be indicated by an arrow situated in the proximity of the basic identification colour and painted black or white in order to contrast clearly with basic identification colour.

8 For closed circuits, the flow and return pipes shall be indicated by the use of the word "Flow" on the one pipe and the word "Return" on the other.

Table 8.1
Schedule of Paints and Film Thickness per Coat (DFT)

Ref.	Description	DFT microns
P1	Zinc phosphate epoxy corrosion resistant primer Two pack polyamide cured.	50
P2	Zinc Chromate ditto	50
P3	Zinc phosphate epoxy prefabrication primer. Two pack	50
P4	Zinc chromate ditto	50
T	T-wash pretreatment for galvanised surfaces as described in BS 5493	50
U1	Epoxy micaceous iron oxide. Two pack. Polyamide cured.	125
U2	Pure epoxy resin. Two pack. Amine adduct cured.	125
U3	Coal tar epoxy. Two pack. Polyamide cured	125
U4	Epoxy tie coat	-
F1	Silicone alkyd enamel	25
F2	Urethane. Two pack.	-
X	Hot dip bitumen solution to BS 4147, Type 1 Grade D*	-
Y	Aluminium sealer. Single pack	-

Table 8.2
Key to Preparation and Painting Schedule

Item	Locations
A	Surfaces above process liquid level and not liable to splashing. Non-aggressive atmospheres.
B	Surfaces in contact with untreated or treated water for potable use.
C	Surfaces below process liquid level or liable to splashing. Non aggressive solutions and/or atmospheres.
D	Surfaces in contact with aggressive solutions and/or atmospheres.

Table 8.3
Preparation Standards for substrates

Item	Preparation Standards for substrates
GB	Grit blast to Swedish Standards Sa 2 1/2
Z	Clean and degrease
G	Pickle and hot dip galvanise to BS 729 (applied to items which may be pieced sufficiently small and excludes stainless steel).

Table 8.4
Preparation and Painting Schedule for Metal Surfaces (Not Buried Pipes)

Item	Item Location	Item Assembly Completed at	Factory Operations		
			Prep.	Coatings	
				1st	2nd
Steel and Ferrous metal parts	A	Factory	GB	P1 (a) or P2 (a)	U1 (b)
			or G	-	-
		Site	GB	P3 (a) or P4 (a)	-
	B	Factory	GB	P1 (a)	U2 (b)
			or G	-	-
		Site	GB	P3 (a)	-
	C	Factory	GB	P1 (a) or P2 (a)	U3 (b)
			or G	-	-
		Site	GB	P3 (a) or P4 (a)	-
	D		G	T and P1	-
Cast iron and cast steel including headstocks	A		GB	P1 (a) or P2 (a)	U1 (b)
	B		GB	P1 (a)	U2 (b)
	C		GB	P1 (a) or P2 (a)	U3 (b)
Non-ferrous metal (except copper)	A		Z	P1 (a) or P2 (a)	U1 (b)
	B		Z	P1 (a)	U2 (b)
	C		Z	P1 (a) or P2 (a)	U3 (b)
Steel pipes	A/B/C/D		G	-	-
Iron and steel	A/C/D		Z	-	X
	B		GB	P1 (a)	U2 (b)
Penstocks and valves of cast iron	A/C/D		Z	-	X
	B		GB	P1 (a)	U2 (b)
Steel stairways and supporting	A/B/C/D		G	-	-
Structures					
Bridge rail and pin rack rail					
Water Towers (Exterior)	D	Site	GB	P1 (a)	U1 (b)

Table 8.4 (Cont'd)
Preparation and Painting Schedule for Metal Surfaces (Not Buried Pipes)

Item	Item Location	Item Assembly Completed at	Site Operations and Coatings			
			1st	2nd	3rd	4th
Steel and Ferrous metal parts	A	Factory	F1	F1	-	-
			-	-	-	-
		Site	P1 (f) or P2 (f)	U1 (b)	F1	F1
	B	Factory	U2 (c)	-	-	-
			-	-	-	-
		Site	P1 (f)	U2 (b)	U2 (b)	-
	C	Factory	U3 (c)	-	-	-
			-	-	-	-
		Site	P1 (f) or P2 (f)	U3	U3 (b)	-
	D		P1 (f)	U3	U3 (b)	-
Cast iron and cast steel including Headstocks	A		F1	F1	-	-
	B		U2 (c)	-	-	-
	C		U3 (c)	-	-	-
Non-ferrous metal (except copper)	A		F1	F1	-	-
	B		U2 (c)	-	-	-
	C		U3 (c)	-	-	-
Steel pipes	A/B/C/D		-	-	-	-
Iron and steel	A/C/D		Y	Y	F1	F1
	B		U2 (b)	-	-	-
Penstocks and valves of cast iron	A/C/D		X	-	-	-
	B		U2 (c)	-	-	-
Steel stairways and supporting Structures Bridge rail and pin rack rail	A/B/C/D		-	-	-	-
Water Towers (Exterior)	D	Site	U4	F2	-	-

Qualifying Notes:

(a) To be applied not more than 4 hours after substrate preparation.

(b) To be applied within 48 hours of previous coat.

(c) Approval to factory application of this final coat to be sought from the Engineer's Representative where delay in application is liable to cause adhesion problems.

(d) Refer to Clause 8.3.5.35

Table 8.5
Preparation and Painting Schedules for Surfaces Other Than Metal

Surface	Location	Finish	Particular Preparation	Primer	Final Treatment
Hard Wood and Soft Wood (primed or unprimed)	Interior	Gloss	Sand down Treat Knots	Q.D. Acrylic Wood primer	Alkyd undercoat Alkyd topcoat
	Exterior	Gloss	Sand down Treat Knots	Lead free Wood primer	Alkyd undercoat Alkyd topcoat (2 coats)
Plaster (including Plasterboard)	Interior	Flat	Degrease Sand down	Emulsion thinned to manufacturer's instructions	High opacity acrylic emulsion (2 coats)
	Interior	Gloss	Ditto	Alkali resistant primer	Alkyd undercoat Alkyd topcoat
	Interior	Multi-colour	Ditto	Primer	Multi-colour wall finish
Cement Rendering, Concrete - (fair-faced), Brickwork	Interior	Flat	-	Emulsion thinned to manufacturer's instructions	High opacity acrylic emulsion (2 coats)
	Interior	Gloss	-	Alkali resistant primer	Alkyd undercoat Alkyd topcoat
	Immersed & splash zone Aggressive atmospheres		(Refer to the clause entitled Epoxy Coatings for Concrete and Rendered Surfaces)		
	Exterior	Masonry paint	Stiff brush	Stabilising primer	Textured emulsion masonry paint (2 coats)
Hardboard	Interior	Flat	Zinc chromate spot primer to screw and nail heads	High opacity acrylic emulsion	High opacity acrylic emulsion (2 coats)
	Interior	Gloss	Ditto	Stabilising primer	Alkyd undercoat Alkyd topcoat

Table 8.6
Standard Colours
The following colours to BS 4800 shall be used for mechanical and electrical equipment. For equipment not listed the colour shall be agreed with the Engineer.

	Material / Equipment	Properties			Colour
(a)	External machinery	18	E	53	Green-Yellow
(b)	Motors and Pumps	14	E	53	Green – Yellow
(c)	Panels	14	E	53	Green – Yellow
(d)	GRP Covers	08	B	15	Yellow-Red
(e)	Sewage Pipework	00	E	53	Black
(f)	Airlines	20	E	51	Light Blue
(g)	Sewage valves	00	E	53	Black
(h)	Airline Valves	20	E	51	Light Blue
(j)	Water Pipework	12	D	45	Green
(k)	Water Valves	12	D	45	Green
(l)	Potable Water/Pipes/Valves	12	D	45	Green/18 E 53 Auxiliary Blue (colour code)
(m)	Surge Vessels	08	E	51	Yellow
(n)	Fire Extinguishing Systems	04	E	53	Red
(o)	Bulk Storage Tanks				Aluminium
(p)	Electrical Services	06	E	51	Yellow-Red
(q)	Cranes	08	E	53	Yellow
(r)	Control Panels, relay panels, Instrumentation enclosures, fuse switches, distribution boards, marshalling cubicles etc.	14	E	53	Green-Yellow

8.2.3 Abrasive Blasting Materials

1 The abrasive employed in blasting shall be grades steel grit, ball shot, silica safe sand or similar and shall be such that it will provide a surface roughness complying with the one specified by the manufacturer for the primer concerned. The abrasive shall be dry, clean and free from soluble contaminants and shall be selected as specified in BS 4232.

2 The type and size of abrasive used for blast cleaning shall comply with the requirements of BS 4323 Table 2. When directed by the Engineer, the Contractor shall carry out a series of tests using various sizes of abrasives smaller than the maximum defined in BS 4232 Table 2 to determine which gives the best profile. This size of abrasive shall be used for all subsequent blast cleaning. The grading of abrasives for equipment which uses abrasives more than once shall be checked at regular intervals and fresh abrasives added to ensure that the correct grading is maintained.

3 The roughness of blast cleaned surfaces measured at the amplitude by any of the methods defined in BS 4232 shall not exceed 75 microns.

4 The pH value shall not be less than 4 or greater than 10 when mixed in neutral water. The material shall not contain soluble chloride.

5 The level of trace toxic contaminants shall meet Government regulations.

6 Dune sand shall not be used.

8.3 WORKMANSHIP

8.3.1 General

1 Unless otherwise specified in this Part, the preparation coating and painting of surfaces shall be carried out as specified in Part 26 and in accordance with the recommendations of BS 6150 subject to the approval of the Engineer.

2 All coatings and paint shall be applied in a workmanlike manner to produce a uniform film of the specified thickness. Edges, corners, crevices, and joints shall receive special attention to ensure that they have been thoroughly cleaned and that they receive an adequate thickness of paint. The finished surfaces shall be free from runs, drops, ridges, waves, laps, brush marks, and variations in colour, texture, and finish.

3 Before beginning coating and painting work, the Contractor shall take precautions to protect the Works and existing facilities from damage or disfigurement. Where necessary, the Contractor shall protect equipment by providing clean cover sheets. If in the opinion of the Engineer the precautions are inadequate, the Contractor shall at his own expense make such improvements as the Engineer directs.

4 The specified film thickness shall be attained. Particular attention shall be paid to the attainment of specified film thickness on edges. In hot weather, additional precautions shall be taken as necessary to ensure the attainment of specified film thickness. Film thickness shall be checked with a paint inspection gauge furnished by the Contractor. The Contractor shall calibrate the gauge for the thickness range to be checked at least twice a day. When measured film thickness is less than specified, additional coats shall be applied as necessary to attain compliance.

5 Manual grit blasting equipment shall be approved by the Engineer before use. Air compressors shall be capable of supplying a continuous air volume of at least 6 m^3/min at a maximum pressure of 7 MPa to each blasting nozzle. The compressed air supply shall be free of water and oil. Adequate separators and traps shall be provided. Accumulations of oil and water shall be removed from air receivers by regular purging.

6 On completion of the works, which may have become spotted or touched with paint shall be cleaned down and all left clean to the satisfaction of the Engineer.

8.3.2 Manufacturer's Recommendations

1 Unless otherwise specified, the coating and paint manufacturer's written recommendations and instructions for storage, thinning, mixing, handling, surface preparation, protection of other surfaces, application and protection of coated and painted surfaces and for all other procedures for providing protective coatings and painting shall be strictly observed. No substitution or other deviation will be permitted without the written permission of the Engineer.

8.3.3 Mixing and Thinning

1 Coating materials and paint shall be mixed only in designated rooms or spaces in the presence of the Engineer.

2 Paint and coating materials shall be protected from exposure to extreme weather, and shall be thoroughly stirred or agitated, strained, and kept at a uniform smooth consistency during application. Materials shall be prepared and handled in a manner to prevent deterioration and inclusion of foreign matter.

3 Paint and coating materials of different manufacturers shall not be mixed together.

4 Packaged paint and coating materials may be thinned immediately before application in accordance with the manufacturer's directions. Only thinners recommended by the paint and coating manufacturer shall be used.

8.3.4 Items Not to be Painted During Coating and Painting Operations

1 Hardware, hardware accessories, name plates, data tags, machined surfaces and similar items in contact with coated surfaces shall not be coated and shall be removed or masked before surface preparation and painting operations. Following completion of coating of each piece, removed items shall be reinstalled. Such removal and reinstallation shall be done by workmen skilled in the trades involved.

2 That portion of steel to be embedded in concrete or masonry shall not be painted and shall be cleaned as designated for steel surfaces before fixing.

8.3.5 Surface Preparation

1 General

(a) The specified standard of surface preparation shall be attained. Surface preparation shall have no detrimental effect on the material being protected and shall not be prejudicial to subsequent coating and painting operations.

(b) In addition to complying with the specifications of this Clause and the manufacturer's instructions the Contractor shall take such other measures needed to ensure that all surfaces are clean, and free of deleterious material including but not limited to dirt, grease, and oil, before the application of primer and between coats.

(c) All surfaces prepared for coating and painting shall be prepared to the specified standard and approved by the Engineer before coating and painting work begins.

(d) Cleaning and painting shall be so arranged that dust or spray from the cleaning process will not fall on wet, newly painted surfaces. The sharp edges of steel surfaces shall be dulled, rough welds made smooth and weld splatter removed. Hardware, electrical fixtures and similar accessories shall be removed or suitably masked during preparation and painting, or shall be suitably protected. Equipment adjacent to walls shall be disconnected and moved to permit cleaning and painting of wall surfaces, and shall be replaced and reconnected after the painting has been completed. Notwithstanding anything in this Section, all surfaces shall be prepared in strict accordance with the approved paint manufacturer's recommendations.

(e) Do not apply paint in temperatures or moisture conditions outside of manufacturer's recommended maximum or minimum allowable.

(f) Overcoating intervals recommended by the paint manufacturer must be strictly adhered to. The manufacturer must be consulted if and when there is a necessity for a change in overcoating intervals.

(g) Where a high quality finish is required, the surfaces shall be filled with an approved filler 24 hours after the final priming coat has been applied. When the surface is hard the whole shall be rubbed down with wet and dry abrasive paper to a uniform flat surface and left clean and free of abrasions and powdered filler.

(h) All surfaces are to be completely dry and above a temperature of 4 degrees C. No painting shall be carried out during damp or inclement weather.

(i) When required by equipment specifications, such equipment shall be primed and finish coated in shop by manufacturer and touched up in field with identical material after installation.

(j) Where manufacturer's standard coating is not suitable for intended service condition, Engineer may approve use of a tie-coat to be used between manufacturer's standard coating and specified field finish. In such cases, tie-coat shall be surface tolerant epoxy as recommended by manufacturer of specified field finish coat. Coordinate details of equipment manufacturer's standard coating with field coating manufacturer.

2 Metal

(a) Except as otherwise specified in this Clause, preparation of metal surfaces shall be in accordance with the relevant provisions of BS 4232, BS 5493, BS 7079, and SIS 055900.

(b) Steel to be embedded in concrete, other than reinforcing steel, shall be cleaned to SIS 055900 St. 2 and shall not be primed.

(c) Surfaces shall be clean and dry before application of coatings and paint. If coating or painting takes place over a zinc rich shop primer which has been exposed for an extended period, the entire coated surface shall be sweep blasted to remove "white rust" and other contaminants before application of the first coat.

(d) After the surface has been prepared as specified, the surface shall be further cleaned by vacuum, clean and dry compressed air, or by clean brush to remove accumulated grit, shot and dust leaving the surface clean, dry and free of scale, rust and other forms of contamination.

(e) In the event that rusting occurs after the completion of the surface preparation, the surface shall again be prepared to the specified standard.

(f) When items are to be shop primed or shop primed and finish coated in the shop, surface preparation shall be as specified herein. The Engineer shall have the right to witness, inspect, and reject any sandblasting or other surface preparation done in the shop.

(g) Blast Cleaning. Blast cleaning shall not be carried out

(i) on surfaces that are wet or damp surfaces, or may become wet or damp before the application of primer,

(ii) when metal surface temperatures are less than 3 °C above the dew point

(iii) or the relative humidity exceeds 80 percent.

(iv) In close proximity to subsequent coating operations or near other surfaces susceptible to dust or particle contamination.

(h) In the event of shot or grit blasting not being possible due to interference, the steel surface may, with the prior written approval of the Engineer, be thoroughly cleaned by mechanical means in accordance with ISO 8504-3 to remove all loose rust and mill scales and primed with one coat of an alkyd type zinc phosphate primer to 60 microns dry film thickness.

(i) Where blast cleaning is to be carried out outdoors at an exposed (not under cover) location, preliminary blast cleaning may be done at night with the prior approval of the Engineer, provided that all surfaces so treated shall be reblasted during daylight hours to the specified standard before coating or painting materials are applied. This paragraph does not apply where automatic centrifugal or manual grit blasting is carried out under adequate cover, provided the specified preparation standard is attained.

(j) Oil or grease contamination shall be removed by solvent wash before blast cleaning. If necessary, contaminated areas shall be rewashed and reblasted until contamination is removed.

(k) When sandblasting is carried out on Site, care shall be taken to prevent damage to structures and equipment. Pumps, motors, and other equipment shall be shielded, covered, or otherwise protected to prevent the entrance of sand and dust. No sandblasting shall commence before the Engineer inspects and approves the protective measures.

(l) After sandblasting, dust and spent sand shall be removed from the surfaces by brushing or vacuum cleaning.

(m) Blast cleaned surfaces that are later to be joined by welding and where shop primer is to be applied shall not be primed to a distance of 100 mm from the area to be welded. After welding, the area shall be reblasted and primed as specified.

(n) Areas that are blast cleaned and shop primed before fabrication and are later welded on Site shall be reblasted to remove all weld slag and splatter and any other foreign elements and reprimed as specified.

(o) Fabricated metal work shall not be blast cleaned in the shop until machining and fabrication has been completed, including continuous welds, with all exposed surfaces accessible for subsequent treatment. All slag and spatter shall be removed from the area of the welds by chipping hammer before blast cleaning.

3 Concrete and Rendered Surfaces for Epoxy Coatings

(a) Concrete and rendered surfaces shall be thoroughly cured, thoroughly dry and free from moisture before the application of epoxy filler, primer or paint.

(b) Areas of concrete contaminated with substances deleterious to the application of epoxy coatings including machine oil or grease for example shall be cut out as necessary to remove all traces of such substances. The voids so created shall be filled with an approved epoxy mortar. Areas contaminated with form release agent shall be scrubbed with suitable emulsion cleaners. Mould growth shall be treated using a water soluble fungicide. All surfaces so treated and any other water soluble substances on the surface, such as salt, shall be rinsed with potable water until clean.

(c) Where membranes have been used for the curing of concrete these must be removed and the surfaces thoroughly cleaned before the application of painting and protective coatings.

(d) All concrete and rendered surfaces to be coated shall be lightly blast cleaned to remove the cement rich surface layer. Grit and detritus shall be removed by vacuum immediately prior to priming.

(e) Blow holes and honeycombed areas in the concrete which in the opinion of the Engineer are not capable of being levelled at the primer stage shall be filled with epoxy mortar supplied by the coating manufacturer to obtain a smooth uniform surface. Such mortar shall be knifed into the surface to level the area and leave no excess.

4 Preparation of Plaster, Brickwork and Concrete Surfaces for Coatings and Paint other than Epoxy

(a) Efflorescence present on the surface of plaster, brickwork and concrete shall be removed by scraping and brushing before any paint is applied. When efflorescence has been removed surfaces shall be left for at least three days before priming. Priming shall be deferred repeatedly, if necessary, until three days after any further efflorescence which has appeared is removed.

(b) Plaster surfaces to be painted shall be cleaned down smooth as necessary and all cracks filled in with stopping for plaster. Filling shall be carried out for the entire surface before paint is applied to the surface.

(c) Brickwork, blockwork and concrete surfaces shall be cleaned of contaminating matter before being primed. Subject to the approval of the Engineer, large holes which would cause a break in the paint film shall be filled with mortar and the surface rubbed down to match the surrounding areas.

5 Wood

(a) Wood surfaces shall not be painted when the moisture content of the wood measured with an electric moisture meter exceeds 12 % for interior surfaces and 18 % for exterior surfaces.

(b) Hardwoods or softwoods shall be rubbed down with abrasive paper to give a smooth surface free of contaminating substances, scratches and other imperfections.

(c) Surfaces which are to be painted shall be rubbed down to remove all contaminating substances and imperfections which would be visible in the finished paint film. The surfaces of knots and resinous streaks shall be painted with two coats of knotting, the first being allowed to dry before the second is applied. Knotting shall conform with BS 1336.

(d) The surfaces of timber treated with waterborne preservative by an impregnation process shall be rubbed down and dry-brushed to remove all traces of efflorescence before the primer is applied.

(e) Where surfaces are suspected of being infected with mould, they shall be treated with a fungicide.

6 Galvanised Surfaces

(a) Dirt and other adhering contaminating material shall be removed by wire brushing, brushing with bristle brushes, or by other methods approved by the Engineer. Cleaning shall not damage the galvanising. Zinc corrosion products remaining shall be removed by washing with potable water and scrubbing with hard bristle brushes.

(b) After being cleaned and degreased, galvanised surfaces shall be etched with T-wash as described in BS 5493. If any surface fails to turn black, the cleaning, degreasing, etching, and T-wash processes shall be repeated as often as necessary.

7 Damaged Surfaces

(a) Factory prepared surfaces, other than galvanised surfaces, during handling, site fabrication or erection shall be treated as follows:

(i) all slag and spatter shall be removed from areas of welds by chipping hammer

(ii) all areas of damaged primer or other coat shall be thoroughly mechanically wire brushed and given one priming coat as detailed in Table 8.3

(iii) the priming coat shall be applied by brush taking care to completely cover uneven
surfaces particularly those of welds

(iv) subsequent coats shall be applied as specified in this Part.

8.3.6 Application of Protective Coatings and Paint

1 All paint and coating materials shall be applied in accordance with the manufacturer's printed specifications or instructions; where these differ from the specification of this Part, the more stringent requirements shall apply. The Contractor shall issue copies of appropriate data sheets and of the relevant parts of this specification shall be issued to all supervisory personnel. Where such instructions conflict with this specification a ruling shall be sought from the Engineer's Representative.

2 Unless in conflict with the manufacturer's printed instructions or otherwise specified, the Contractor may use brush, roller or air spray. Application by spray painting shall be with the prior approval of the Engineer. Rollers for applying enamel shall have a short nap. Areas inaccessible to spray coating or rolling shall be coated by brushing or other suitable means.

3 The Contractor shall ensure that edges, corners, crevices, welds, bolts, and other areas, as determined by the Engineer, receive a film thickness equivalent to that of adjacent coated surfaces and not less than the specified thickness.

4 On beams and irregular surfaces, edges shall be stripe coated first and an extra pass made later.

5 Application of paint and condition of work shall be in accordance with manufacturer's recommendations and with BS 6150 and ISO 12944.

6 The designated dry film thickness (DFT) shall be attained for each coat.

7 Each coat shall be applied evenly, at the proper consistency, and be free of brush marks, sags, runs, and other evidence of poor workmanship. When these occur, they shall be brushed out immediately or the materials shall be removed and the surface recoated. Finished coated surfaces shall be free from defects or blemishes.

8 Care shall be exercised to avoid lapping paint on glass or hardware. Coatings shall be sharply cut to lines. Whenever two coats of a dark coloured paint are designated, the first coat shall contain sufficient powdered aluminium to act as an indicator of proper coverage, or the two coatings shall be of a contrasting colour.

9 All coatings shall be cleaned as specified by the manufacturer before the next coat is applied.

10 Manufacturer's recommended time between coats shall be strictly complied with. Sufficient time shall be allowed to elapse between successive coats to permit satisfactory application of subsequent coats. Once begun, the entire coating operation shall be completed without delay. Without specific permission of the Engineer, no additional coating of any structure, equipment, or other item designated to be painted shall be undertaken until the previous coating has been completed for the entire item. Piping shall not be finish coated until it has been pressure tested and approved. Exposure of intermediate coats of paint for periods in excess of a few days shall not be permitted except in the case of work delivered to the Site in a primed condition and suitably protected.

11 Final coats shall not be applied until after other trades whose operations would be detrimental to finish painting have finished their work in the area to be painted, and the areas have been released for final painting.

12 All parts such as pipe supports, seatings and cleats, and back-to-back sections which will become inaccessible after fabrication shall be treated on both surfaces with the full paint system before final assembly.

13 Touch-up of all surfaces shall be performed after installation, and all surfaces shall be clean and dry at the time of application.

14 All paints shall be prepared and applied in strict accordance with the manufacture instructions. Copies of appropriate data sheets and of the relevant parts of this specification shall be issued to all the supervisors and foremen concerned with surface preparation and coating. Where such instructions conflict with this specification a ruling shall be sought from the Engineer's Representative.

15 Except where otherwise specified or approved by the Engineer's Representative all priming paints shall be applied by brush. Airless spray application only shall be used for painting pipe lining and is the preferred method for the application of epoxy resin based paint.

16 The dried films shall be free from bloom, shrinkage, sheeriness, wrinkling, sagging, curtaining, discolouration and extraneous matter.

17 Any primer coat exposed to freezing, excess humidity, rain, dust etc. before drying, shall be permitted to dry and the damaged area of primer shall be removed and surface again prepared and primed.

18 Bolted site connections other than facing surfaces of Grip Bolts shall be brought together wet.

8.3.7 Maintenance of Prepared Surfaces

1 Primer or other initial coat shall be applied to all prepared surfaces before deterioration or oxidation of the surface. In the case of metals, primer or other initial coat shall be applied within one hour or such shorter period of time which may be recommended by the manufacturer, but always before the metal temperature drops to less than 3 °C above the dewpoint and before any rusting occurs. Unless otherwise approved by the Engineer for surfaces other than metal, primer or other initial coat shall be applied within 4h of completion of surface preparation. No prepared surfaces shall be allowed to remain uncoated overnight.

8.3.8 Environmental Conditions

1 Coatings and paint shall be applied in a dry and dust-free environment. Coatings and paint shall not be applied to wet or damp surfaces or when, in the opinion of the Engineer, application or drying of paint is likely to be adversely affected.

2 No exterior or exposed paint work shall be carried out under adverse weather conditions; i.e., during rain, mist, windstorms, sandstorms, or when the relative humidity exceeds 80 %. Paint and coatings shall not be applied when it is expected that the relative humidity will exceed 80 % within 18 hours after the application of the coating or paint. Dew or moisture condensation should be anticipated and if such conditions are prevalent, application of paint and coatings shall be delayed to be certain that the surfaces are dry. The paint or coating shall be completed well in advance of the probable time of day when condensation is expected to occur.

3 During application, painting shall insofar as practicable be shaded from direct sunlight to prevent wrinkling and blistering. Exterior painting shall be carried out in shade during the day.

8.3.9 Spray Application

1 All equipment for spray application shall be inspected and approved by the Engineer before application begins. Spray guns hoses and pumps shall be clean before new material is added. Adequate moisture and oil traps shall be installed between the air supply and each application unit.

2 Suitable pressure regulators and gauges shall be provided for the air supply to the application units. Spray equipment and operating pressures shall comply with the manufacturer's recommendations.

3 Heavy pigments which are likely to settle shall be kept in suspension during application by the use of power driven, continuous agitator.

4 The spray gun shall be held at right angles to the surface. Each pass shall overlap the previous one by approximately 50 %.

8.3.10 Brush Application

1 When coatings are applied by brush, brushes shall be pure hair bristles and shall be of a style and quality that will permit proper application of the material. Flat brushes shall not be more that 100 mm wide. Brushes shall be approved by the Engineer. Extending handles shall not be used.

2 Brushing shall be affected so that a smooth coat, as nearly uniform in thickness is obtained. There shall be no deep or detrimental brush marks.

3 Paint shall be worked into all corners and crevices. When applying solvent type coating, care shall be taken to prevent lifting of previous coats.

8.3.11 Shop Coatings

1 Electrical and mechanical equipment shall be coated and painted as specified in this Part and in Section 9. The location of coating and painting; i.e., in the shop or on Site, shall be as specified in Section 9.

8.3.12 Site Painting of Manufactured Items

1 Steel pipework or fabrication shall be works cleaned and painted in accordance with Tables 8.1 through 8.4. Total dry film thickness shall be in accordance with the location of surfaces of painted as specified in Table 8.2

2 Steel, cast or ductile iron encased in concrete (chamber walls and anchor blocks) shall be prepared and coated as specified under Tables 8.1 through 8.4.

3 Non-ferrous parts shall be protected using the same finishing system as that specified in Tables 8.1 through 8.4 for the adjacent ferrous metal structure.

4 When any coating which has been applied at a manufacturer's works is considered by the Engineer to be unsound or incompatible with the specified system, it shall be rejected. The surfaces shall be recoated to a finish satisfactory to the Engineer.

5 When the Engineer's Representative does not require the removal of the manufacturer's coating the equipment shall be solvent cleaned.

6 Hard baked finishes shall be abraded or softened by application of a strong solvent.

7 All polished and bright parts shall be coated with an approved rust preventative before despatch and during erection, and this coating shall be cleaned off and the parts polished before being handed over.

8 Manufactured items such as pumps motors, compressors, air vessels, conduits, etc. shall be coated at works to the specification laid down for the environment in which they are to operate. If this is impractical they may be paint coated to the manufacturer's standard but when on site the Contractor shall apply a sealing paint and top coats specified in Table 8.1 to Table 8.4. Final site painting shall be in accordance with Table 8.1 to Table 8.4. The site coating shall be 150 microns minimum dry film thickness (DFT).

9 Pre-treatment and primers shall be suitable for the metal concerned and to BS 5493. Dry film thickness shall be a minimum of 200 microns for all conditions.

8.3.13 Site Application

1 Protective coverings shall be used to protect surfaces, fixtures, and equipment. Care shall be exercised to prevent paint from being spattered onto surfaces from which such paint cannot be removed satisfactorily. Surfaces from which paint cannot be removed satisfactorily shall be painted or repainted as required to produce a finish satisfactory to the Engineer.

2 Upon completion of the work, staging, scaffolding and containers shall be removed from the site in an approved manner. Paint spots, oil or stains upon adjacent surfaces shall be removed to the satisfaction of the Engineer. No paint, solvents, rags or other materials used by the Contractor shall be disposed of in any manner or location except as approved by the Engineer. The Contractor is specifically cautioned to prevent paint of solvents to be in contact with plants or liquid streams.

8.3.14 Epoxy Coating Work

1 In addition to the general requirements of this specification the following shall apply to epoxy coating works:

(a) illumination at work site the satisfaction of the Engineer's Representative

(b) forced draught ventilation to the approval of the Engineer shall be used wherever required for the needs of personnel or for drying out surfaces

(c) operatives shall work in pairs.

2 The Contractor shall demonstrate his methods equipment and materials before any work commences. Samples areas of substrate shall be prepared and coated as required by the Engineer and for his approval.

3 There shall be strict control of surface cleanliness between primer and epoxy coating and between coats of the same type. Vacuum removal of dust and sand shall be employed and contamination shall be removed as specified in appropriate surface preparation clauses herein. Dirt or dust trapped in the painted surface shall be removed with suitable abrasive paper. The surface being painted shall be completely dry and free of visible moisture throughout the operations.

4 The paint shall be applied only to clean dry primed or previously coated surfaces. Any thick runs or collections of paint shall be removed before they harden.

5 Not less than two coats shall be applied over the primer by airless spray; not less than three by brush.

6 Each coat shall be distinctly different in colour from the primer or previous coat. The colour of the final coat shall be as required by the Engineer. Each coat shall be seen to have completely covered the preceding coat without “misses” or pinholes or any areas visibly low in thickness. A high voltage pinhole detector shall also be used to determine the integrity of the coats.

7 The manufacturer of the coating shall stipulate primer and epoxy recoat intervals for all curing temperatures likely to be encountered and these shall be adopted with a maximum tolerance of +4 h. Where this is exceeded, the surfaces to be recoated shall first be suitably abraded to remove gloss and provide a key.

8 Wet thickness gauges shall be used by the coating operators continually to check that sufficient paint is being applied to achieve the desired dry film thickness.

8.3.15 Epoxy Coatings for Concrete and Rendered Surfaces

1 No priming shall commence until the moisture content of the cementitious surface is less than 5 % measured by instruments approved by the Engineer.

2 Similarly moisture measurements over the primer or any epoxy intercoat shall not exceed 1 % on the concrete scale of the instrument when the probe tips are held against such painted surfaces just prior to recoating.

3 The primer shall be applied by suitable nylon bristle brush or spray over the whole area to be coated at such thickness that it may then be squeezed into the pores of the concrete. Excess shall be removed by the most suitable means before application of the high build epoxy.

4 The Engineer may approve an alternative application method where the Contractor can demonstrate a suitable technique.

5 The total dry film thickness of the paint layer shall have a minimum value of 0.75 mm.

6 Whenever the Paint Inspection Gauge has been used and wherever the coating has been otherwise damaged for 50 mm around such damage the surface shall be abraded and the area touched in with not less than two thick applications to restore the coating integrity and thickness to that specified.

7 Adhesion tests will be carried out on the cured coating surface using the test equipment supplied under the Contract in accordance with the best practice. The resulting test specimens shall show no indication of poor adhesion to the substrate, residual laitance or intercoat adhesion weakness.

8 Where required in the Project Specification or on a written request by the Engineer, the following instruments shall be provided for the Engineer sole use for the duration of the Contract:

(a) one adhesion tester (0-35 kg/cm^2)

(b) one DC high voltage Holiday detector No. 105

(c) one paint inspection gauge

(d) one moisture meter.

8.3.16 Galvanising and Other Finishes of Metals

1 Galvanising and other finishes of metals shall be carried out as specified in Parts 3 and 6 of Section 8.

8.3.17 Inspection and Testing

1 The Contractor shall conduct dry film thickness (DFT) measurements and other inspections of all painted work, on completion of which the Engineer will make his own measurements, examinations and inspections. If painted works are found unsatisfactory, the contractor shall carryout remedial works as necessary at his expense and the works shall be retested by the Engineer until such time the works are found satisfactory.

2 The Contractor shall provide and maintain two sets of the following inspection devices in good working condition until final acceptance of painting and coating. One set shall be for the Contractor's use and the other for the sole use of the Engineer. On final acceptance of painting and coating, the inspection devices will be handed back to the Contractor.

(a) Svensk Photographic Standard in accordance with SIS 055900

(b) non-destructive magnetic-type DFT gauge

(c) wet fill thickness combs

(d) surface profile meter

(e) non-destructive type electrical holiday detector

(f) low-voltage detector of the wet-sponge type and a non-sudsing type wetting agent, for testing discontinuities and voids in epoxy and thin film coatings

(g) high-voltage, low-current, spark type detector for electrical inspection of coal-tar enamel only

(h) maximum and minimum thermometer

(i) hygrometer

(j) flow cup type B No. 4 and timer.

END OF PART