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Corrosion Protection Specification for Civil, Mechanical and Electrical Engineering Construction

2006 Edition

FOREWORD

Golder Associates Africa (Pty) Ltd require that the series of Code of Practice for Corrosion Protection (SANS 10120–HC) and Standardized Specifications for Corrosion Protection (SANS 1200 -HC) be applied in their designs and contracts

The series covers the following disciplines:

A. General
B. Site investigation
C. Site clearance
D. Earthworks
E. Geotechnical processes
F. Piling, caissons and cylinders
G. Concrete
H. Steel and other metalwork
J. Structural timber
K. Brickwork and masonry work
L. Pipework
M. Road surfacing and paving
N. Railway track work
R. Harbour and marine works
S. Electrical works
T. Mechanical work
U. Building work
V. Sundries

Each discipline has several sub-sections written or being written for it. The Corrosion Protection sub-section has so far been written for Structural Steelwork (10120-HC and 1200HC). These specifications, however, do not cover all the other disciplines adequately.

This document contains the supplementary requirements of **Golder Associates Africa (Pty) Ltd** to cover the Corrosion Protection of more disciplines of Civil Engineering Construction.

It is required to be used by

- Engineers commissioned by **Golder Associates Africa (Pty) Ltd** to design and provide particular specifications for Corrosion Protection and Painting of Civil Engineering Works, and / or
- Tenderers invited by **Golder Associates Africa (Pty) Ltd** to design or design and construct, amongst others, the Corrosion Protection and Painting of Civil Engineering Works

NOTE:
Where any clause in this document is in conflict with any of those in the SANS documents, the meaning and requirements of the clause in this document shall prevail

NOTICE

Conditions of acquisition or purchase of this document

It is expressly agreed that any person acquiring this document does so for the sole purpose of the submission of a *bona fide* tender to **Golder Associates Africa (Pty) Ltd**. He shall not disclose, furnish or otherwise allow use to be made of the whole or any part of the contents of the document or the document itself to any person other than that for the purpose of allowing that person to assist in or fulfil the necessary requirements relating to the submission of a *bona fide* tender for **Golder Associates Africa (Pty) Ltd**

COMMENTS and ERRATA to be notified to:

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Where conflict exists between this document and any National or International Standard, the requirements of this document shall take precedence, unless otherwise agreed by the Engineer.

CONTENTS

This document comprises:-

GENERAL REQUIREMENTS

CONTENTS OF

GENERAL REQUIREMENTS

1 SCOPE

This specification covers materials and procedures used for corrosion protection of materials of construction in various environments. The specification is intended for use with mechanical, civil and electrical engineering contract documentation and provides specific information and instructions on how to optimise the corrosion resistance of the materials of construction.

NOTE: The standards referred to in the specification are listed in Appendix A

2 INTERPRETATIONS

2.1 REFERENCES

2.1.1 Code of Practice

The recommendations of SABS 0l20, have been incorporated into this specification in so far as they are applicable

2.1.2 Supporting Specifications

Where this specification is required for a project, the following specifications shall, inter-alia, form part of the contract document:

(i) Project specification

(ii) SANS 1200 A, SANS 1200 AA or SANS 1200 AH, as applicable

(iii) SANS 1200 H, SANS 1200 HA and/or SANS 1200 HB, as applicable

(iv) SANS 1200 HC, as applicable

2.1.3 Date of issue of specifications and data sheets

The latest issue of specifications and data sheets shall be applicable

2.2 DEFINITIONS:

ACCEPTABLE - Acceptable to the Engineer

ACCEPTABLE QUALITY LEVEL (AQL) - The maximum percentage defective or the maximum number of defects per 100 items that, for the purpose of sampling inspection, can be considered satisfactory as a process average

COATING - A continuous material, which may be metallic or non metallic, applied and bonded to a surface for the purpose of protecting the surface from degradation by the environment or for the purpose of improved appearance or for identification

CONCESSION - A written authorisation from the Engineer to accept an item that is found to have departed from the specified requirements but nevertheless is considered suitable for use 'as is' or after rework by an approved method, in which case a re-inspection will be required

CONFORMANCE - the fulfilment by a product, process, or service of specified requirements

DEFECTIVE - a coating or lining that fails to meet one or more of the requirements of the specification

DELTA LAYER - the second layer of zinc-iron alloy growth from the base steel formed during the galvanizing process; the Delta layer's chemical composition is approximately 90% zinc and 10% iron; the Delta layer is 60% harder than the base steel it protects from abrasion and corrosion

DRY FILM THICKNESS (D.F.T.) - the thickness of a coating or lining after it is hard dry

ELECTRICAL INSULATION DEFECT (E.I.D.) - Defects in a coating or lining that impair the protective properties of the coating or lining and that are detected instrumentally by either:

(i) a low-voltage, wet-sponge detector, or

(ii) a high-voltage, sparking detector, operated in each case within the parameters specified

NOTE: E.I.D's include such defects as steel projections from the substrate, conductive particles embedded in the coatings or linings, voids and those defects commonly known as pinholes and holidays

ENGINEER - The Engineer responsible to the Purchaser for the execution of the contract

IDENTIFICATION - A means of identifying a specific item by means of a unique combination of numbers and/or letters that will enable subsequent traceability of the item

INDUCTION PERIOD - The period after the proper amounts of base and curing agent components of a two-pack coating material have been added together and thoroughly mixed, and then allowed to stand to enable the initiation of the chemical reaction, prior to any necessary thinning and the application of the coating material

INSPECTOR - A person authorised by the Engineer to act as his representative in examining the work and materials and in drawing such samples and carrying out such tests as may be necessary to ensure compliance with specification

LINING - A coating applied to the inside of a component such as a pipe, valve or pump body, for the purpose of protection of the inside surface. A lining may also be applied in order to reduce wall friction

LOT - A number of similar or related items submitted for inspection at one time by the contractor and of such size that the inspector can reasonably be expected to examine adequately in not more than one working day

PAINT - A liquid material that, when applied as a thin film to a suitably prepared surface by an appropriate method, undergoes a physical or chemical change (or both) that converts it to a solid coating or lining bonded to the surface to which it is applied

POT LIFE - The period, after the contents of the packs of a two-pack coating material have been mixed together, during which the paint remains suitable for use without the addition of further solvent

POWDER COATING - A material in the form of a dry, free flowing powder that, when applied to a suitably prepared steel surface by an appropriate method, can be fused by application of heat and subsequent cooling to form a continuous coating or lining that is bonded to the surface

QUALITY - Totality of features, properties and characteristics of a product, process or service that bear on its ability to satisfy the stated or implied needs

QUALITY ASSURANCE - All those planned and systematic actions necessary to provide adequate confidence that a product, process or service will satisfy given quality requirements

QUALITY AUDIT - A systematic and independent examination to determine whether quality activities and results comply with planned arrangements and whether these arrangements are effectively implemented and are suitable to achieve objectives. The intent of a Quality Audit is an independent review and evaluation so that needed corrective action can be obtained

QUALITY CONTROL - the operational techniques and activities that are employed by the contractor to ensure the required quality of a product, process or service

QUALITY PLAN - A document setting out the specific quality practices, resources and activities relevant to a particular contract or project

QUALITY PROGRAM - A documented set of activities, resources and events serving to implement the Quality System to a time schedule

QUALITY SURVEILLANCE - the continuing evaluation of procedures, methods, conditions, products, processes and services and analysis of records to assure that quality requirements will be met

ROCKGUARD OR ROCKSHIELD - Material intended to be wrapped around the outside of a coated pipe to prevent physical damage to the coating, but that otherwise plays no part in the corrosion protection of the pipe

SOLVENT (i) That part of a liquid coating material that volatilises from the film during the drying process, or

(ii) a Volatile liquid compatible with a coating material and used for the purpose of cleaning equipment used in the application of a coating material

(iii) The active component of a degreasing material

NOTE - The coating manufacturer's recommended solvent for each application and for each product shall be strictly followed.

TAINT - The property of imparting or having an objectionable odour or taste, or both

TOTAL DRY FILM THICKNESS - the thickness of all the coats in a coating or lining system measured after the last coat is hard dry

TOXICITY - the ability of a substance to produce injury to a living being

TRACEABILITY - the ability to trace the history, application or location of an item or activity and like items or activities by means of recorded identification

WATER BREAK FREE - A surface which, when wetted all over with plain potable water, maintains a continuously wet surface and the water does not break up into islands of un-wetted surface

WEBER-RIELLY TEST – a test for water soluble salts remaining in pitted steel after abrasive blast cleaning. (Water soluble salts result in the formation of osmotic blistering of the coating after immersion). A white indicator paint is sprayed on the surface. If ferrous salts are present, the indicator turns pink or red, depending on the salt concentration. (This is a test for iron salts in the ferrous state and is not a test for chloride ions)

WET FILM THICKNESS (W.F.T.) - the thickness of a coating or lining immediately after application and before any volatile matter has evaporated

3 MATERIALS OF CONSTRUCTION

The engineer of the 21st Century has at his disposal a vast array of materials of construction and a great many ways of preserving these materials against deterioration.

Quality, availability and price will always dictate the extent of the use of any particular raw material.

The materials covered in this specification are those readily available in Southern Africa viz.

Stainless steel

Corrosion resistance steel

Aluminium

Galvanized mild steel

Painted mild steel

- and materials of civil construction, such as reinforced concrete, cement plaster finishes, fibre cement products and timber.

Materials not covered in this specification are polymers and plastics - e.g. rubbers, polycarbonates, glass reinforced plastics, high, medium and low density polyethylene(LDPE), polyvinylchloride (PVC), nylon, Teflon, Kynar® - etc, etc. which are generally corrosion resistant materials in their own right but it is nevertheless advisable to seek advice as to their exact use and suitability for any particular environment. For example PVCs and polyvinyledene chlorides are degraded by high heat conditions and can produce chlorine, which is itself a highly corrosive gas.

Mild steel is the metal most used for fabrication because of its relatively low price, easy availability and ease of fabrication. However mild steel corrodes (reverts to the oxide form in the presence of oxygen and water). There are two principal ways to prevent this, i.e. cathodic protection which reverses the electrochemical reaction (this only works if the metal is immersed or buried in a conductive medium) or coating (painting) which insulates the steel from the corrosive environment.

As there are many environments and very many coatings available, much of this specification is devoted to classifying the environments and detailing the use of the few reliable coating systems which are known to give good service in these environments. It is not easy to achieve good coating quality! The specification details quality control and testing procedures necessary to produce lasting performance.

It must be added that the original Specifications in this Document have been used for the last 20 years with excellent results.

4 DESIGN

4.1 THE EFFECT OF DESIGN ON CORROSION FREE LIFE

All items shall be designed to minimise corrosion in the environment to which they will be exposed. The following notes may be used as guidelines:

4.1.1 Water Retention Areas

Water retention areas shall be avoided wherever possible. For example, angle or U section steel should be used with the toes pointing downwards. The concrete base of steel columns should be sloped away from the steel and the sloping edge should be painted (sealed) to avoid water ingress at the steel/concrete interface

4.1.2 Crevices

Crevices give rise to accelerated corrosion by forming an oxygen concentration cell. Crevices shall be avoided by using:

(i) Continuous welding should preferably be used. Where discontinuous welding (space welding) is used the gap should be wide enough to allow abrasive blast cleaning and correct painting or, if the gap is too narrow it should be designed so that it may be effectively sealed with a mastic or sealant.

(ii) Mastics or sealants to seal unavoidable crevices such as bolted connections

(iii) Insertion rubber or suitable impermeable gasket material between mating surfaces

4.1.3 Bimetallic Couples

Electrical contact between dissimilar metals gives rise to a corrosion cell when an electrolyte such as water is present. Junctions between dissimilar metals shall be insulated or effectively sealed against water ingress. Where insulation is not possible cathodic protection should be employed.

4.1.4 Accessibility

Whenever possible, the surfaces of corrodible materials such as mild steel shall be accessible for maintenance. The use of back to back angles, partially open box sections or inaccessible stiffeners should be avoided

4.1.5 Differential Aeration

Posts buried in soil are subject to accelerated corrosion due to differential aeration. Additional protection shall be given to that part which is buried and up to at least 800mm above ground. Similarly, tanks should not stand on the ground or on a concrete bed but shall be fitted with legs to ensure that there is no contact between the tank base and its bed. Where legs cannot be used, the tank shall stand on a concrete base, after coating the base of the tank with the full Corrosion Protection System. The edges of the concrete base shall be sloped away from the tank. The joint between tank and base shall be sealed with suitable mastic or sealant. As an additional precaution cathodic protection may be employed to protect the underside of the tank bottom.

4.1.6 Sharp edges and welds

The designer shall specify that all sharp edges shall be ground to a radius not less than 3mm or half the steel thickness and that all rough welds, undercuts, weld spatter and weld slag shall be removed by the Fabricator. (Refer also to Clause 5.2)

4.1.7 Cathodic Protection

Where cathodic protection is to be used on buried or immersed items or items imbedded in concrete, care shall be taken to ensure that the necessary bond continuity or insulation, as required, is included in the design. Provision must be made in the design stages to provide access for cables, reference electrodes and test point connections prior to construction. A qualified and experienced cathodic protection engineer should be employed at the design stage

4.1.8 Components to be galvanised

The design of components which have to be galvanised is very important to both the quality of the galvanising which will be achieved and to the integrity of the component i.e. with regard to distortion due to uneven expansion during dipping into molten zinc at 450°C - there is also a risk of explosion if the items are not vented or positioned correctly!

Design parameters are thoroughly covered by existing specifications which are mentioned in Section 6.2 below.

5 METAL FABRICATION

5.1 WELD QUALITY

All welding shall be carried out by coded welders to International Welding Standards. Weld quality shall comply with the requirements of the Engineer

5.2 WELDS SMOOTH

All welds shall be smooth, continuous and free from porosity, projections or undercuts. Rough welds shall be ground where necessary to achieve the required smooth profile. Undercuts or blowholes shall be re-welded and ground to a smooth surface.

5.3 CUT EDGES

All cut edges and drilled holes shall be de-burred and ground to a radius of not less than 3mm. If the steel thickness is less than 6mm, the radius of curvature of the edge shall be 50% of the thickness

5.4 WELD PICKLING AND PASSIVATION

All welds and heat affected areas of stainless and corrosion resistant steel shall be pickled and passivated as specified in Clause 7.2

5.5 COMPONENTS TO BE GALVANISED

If the component is required to be hot dip galvanized, refer to Clause 6

5.6 SAFETY PRECAUTIONS

The Contractor shall, at all times, observe all applicable legislation according to the **Occupational Health and Safety Act, No. 85 of 1993** and any relevant municipal bylaws and environmental legislation.

6 HOT DIP GALVANIZING

6.1 THE HOT DIP GALVANIZING PROCESS

6.1.1 Specifications

Hot dip galvanizing shall comply with SANS 121:2000/ISO 1461:1999 for fabricated articles and pipes, SANS 3575:1996/ISO 3575:1996 for strip galvanized sheet or SANS 675:1997 for fencing wire.

NOTE that the thickness of zinc coating varies according to the substrate galvanized:

Rolled steel sections – SANS 121:2000 / ISO 1461:1999 specifies minimum thickness according to the thickness of the substrate, e.g. steel of 5mm and greater thickness shall have a coating not less than 85 microns thick (normal grade) or minimum 105 microns if Heavy Duty is specified. Steel of less than 2 mm thickness is specified to have a minimum coating thickness of 45 microns (55 microns for Heavy Duty)

Sheet steel – SANS 3575:1996/ISO 3575:1996 or SANS 4998 :1996 / ISO 4998:1996 (structural quality) for strip coated sheet steel allows the purchaser to select the thickness required. For the purposes of this specification, only the following two grades need be considered:

- Z275 (Commercial grade) shall be used only when the galvanized steel is to be painted for aesthetic appearance or for colour coding. Average zinc coating thickness is 20 microns with the minimum being 17 microns

- Z600 (Heavy duty grade) may be used where galvanizing is the only specified method of protection. This is specified as average thickness of 43 microns with a minimum of 36 microns

Plain or barbed fencing wire - SANS 675:1997 specifies different galvanizing thicknesses for different wire thicknesses. The range of average thickness is 30 - 40 microns. NOTE: Galvanizing wire to SANS 935 is not acceptable for the purposes of this specification since the galvanizing thickness is too low for adequate corrosion protection in sewage and water purification works.

Tubing for structural purposes – SANS 32 :1997 / EN10240:1997– for plain ended round or square tubing up to 200mm diameter.

6.1.2 Thickness of galvanizing on steels of different metallurgical composition

The above specifications were written around galvanizing on aluminium killed steels which build up a relatively thin 'delta' layer. However silicon killed steels build up a thick delta layer very quickly when immersed in molten zinc. This results in relatively high thicknesses of galvanizing. Whereas these thicker layers result in additional protection against corrosion they are also relatively brittle and tend to delaminate on impact.

NOTE: It is the responsibility of the contractor to determine the metallurgical nature of the components prior to galvanizing. Poor quality of corrosion protection due to excessive thicknesses of galvanizing will result in rejection of the items.

6.1.3 Mating Surfaces

Mating surfaces on fabricated or cast iron components shall be wiped or centrifuged on removal from the galvanizing bath to remove blobs, runs or excess metal that may impair the air/gas/water tightness of the joint. This requirement must be specified to the galvaniser when ordering.

6.1.4 Fasteners

Bolts, nuts and washers used for fixing galvanized components shall be hot dip galvanized to SANS 121:2000/ISO 1461:1999. Electroplated fasteners will not be accepted unless otherwise agreed by the Engineer in writing

6.2 DESIGN AND FABRICATION

Components for hot dip galvanizing shall be designed and fabricated as recommended in SANS 14713:1999/ ISO 14713:1999 except that the use of lead plugs is not permitted

It is recommended that the manufacturer consults the galvaniser before design and fabrication to ensure that the fabrication will be suitable for galvanizing

The main requirements are as follows:

(i) Overlap joints shall be avoided wherever possible. If essential, such overlap joints shall be thoroughly degreased before assembly and shall be vented by drilling holes through one or both overlapping materials

(ii) Closed sections shall be suitably vented. If the inside of a closed section is not to be galvanized, a snorkel vent tube of suitable length and bore shall be attached

(iii) Gussets and internal baffles in tanks shall be cropped to allow free flow of zinc and air

(iv) Joints shall be continuously welded, using balanced welding techniques to avoid stresses. Welds shall be free from cavities, undercutting, weld slag and spatter

(v) Symmetrical design shall be used whenever possible and the use of thin gauge steel adjacent to heavy section shall be avoided

(vi) Openings and the flanges of manholes and bosses shall finish flush on the inside to ensure complete drainage

(vii) Castings shall be designed to be of a uniform section as possible and shall be blast cleaned in accordance with Clause 10.5.3 before despatch to the galvaniser

6.3 REPAIR OF GALVANIZED ARTICLES

Welding, flame cutting, or other heat processes shall not be carried out on galvanized articles unless permission is granted by the Engineer

If such permission is given, or if mechanical damage has occurred, repairs shall be carried out as follows:

(i) All scale, spatter and flux shall be removed by grinding and washing with clean water. Edges shall be ground to a radius not less than 2mm

(ii) The preferred repair process is to blast clean to bare steel and apply zinc by the thermal spray process in accordance with SANS 1391, Part 1, Grade Zn150. On completion of metal spraying, burnish the surface by means of a mechanical wire brush to give a uniform appearance. Burnishing shall remove not more than 10 microns of zinc

(iii) Where small areas are to be repaired, clean the surface thoroughly with fine abrasive paper, remove all debris with a damp cloth and allow to dry. Repair by application of an approved solvent free zinc rich repair coating. A sufficient number of coats shall be applied such that the repair coating thickness is not less than the average zinc thickness specified in the appropriate galvanizing specifications. The repair shall extend not less than 5mm beyond the damaged area. On completion of the repair and when the zinc rich primer is completely dry, one coat of acrylic resin based aluminium paint may be applied.

NOTE: Repair of galvanized surfaces by application of aluminium paint alone is not permitted

6.4 STORAGE OF GALVANIZED COMPONENTS

Galvanized components shall be stored to avoid the formation of 'white rust' or other forms of storage staining

Components shall be separated and supported on wooden battens to ensure adequate ventilation of all surfaces and in such a manner to avoid 'ponding' by rainwater

If storage staining does occur, remove the stains by scrubbing with detergent solution and bristle brush or nylon pad. The use of steel wool or other metallic abrasives is not permitted.

Rinse thoroughly and allow to dry. If the residual zinc thickness complies with the requirements of the appropriate grade in the relevant specification, no further action is required unless instructed by the Engineer

If the cleaned zinc thickness is below specification, the article shall be re-galvanized or repaired in accordance with Clause 6.3, as decided by the Engineer

7 STAINLESS STEEL FABRICATIONS

7.1 GRADE AND WELDING TECHNIQUES

The grade of stainless steel to be used shall be as specified in the appropriate section of the specification or drawings. Where welding is necessary, the appropriate "L" grade (low carbon content) shall be used. Plate used in fabrication shall be supplied as No.1 Finish in accordance with BS EN 10151

Welding procedures shall be only those recommended by the stainless steel manufacturer or by the South African Institute of Welding. Only welders coded to ASME IX, 2004 shall be employed

Welds shall be smooth and free from blowholes, undercuts, sharp projections and similar visual defects

Fabrication of stainless steel components shall be carried out in clean work places where there is no contamination by mild steel. Grinding and polishing equipment shall be dedicated and shall not be contaminated with iron or mild steel

Stainless steel shall be suitably handled to avoid scratching the surface

7.2 PICKLING AND PASSIVATION

Cut edges, welds and heat affected surfaces shall be pickled and passivated to remove all discolouration. Proprietary pickling and passivating pastes (as supplied by Duva Chemicals (Pty) Limited, or other approved supplier) shall be used in accordance with the manufacturer's recommendations. Care shall be taken not to exceed the maximum contact time recommended. No heat discolouration shall remain after completion of pickling and passivating

After passivation, surfaces shall be very thoroughly washed with clean potable water to remove all traces of acid. The surface shall be allowed to dry, then polished where necessary, using polishing compounds recommended by the stainless steel manufacturers or the South African Stainless Steel Development Association

7.3 SAFETY PRECAUTIONS

(i) Operatives shall wear protective aprons, gloves and safety glasses during pickling and passivating

(ii) Splashes on the skin shall be thoroughly washed with clean water immediately after contact. A weak solution of sodium bicarbonate shall be kept available for neutralization. Seek medical attention if in doubt

(iii) Disposal of effluent shall be in accordance with the requirements of the local authority in whose area the work is being carried out

Note: these pickling chemicals are solutions of nitric and fluoric acid and must be treated with extreme care! The Material Safety Data Sheets (MSDS) shall be supplied by the manufacturers of the chemicals used, for reference in case of emergencies

8 CORROSION RESISTANT STEEL 3CR12 FABRICATIONS

8.1 ACCEPTABLE QUALITY OF PLATE

The 3CR12 plate shall be of an acceptable quality, free from inclusions from the rolling process or any other defects which may affect the long term corrosion resistance of the fabricated item. If necessary the plates shall be hand selected for fabrication by the Engineer's metallurgical inspector.

8.2 WELDING TECHNIQUES

Welds shall be full penetration welds, using 309 austenitic electrodes or filler wire, or special electrodes as recommended by Columbus (Pty) Limited

Welders shall be suitably coded for welding similar thickness of austenitic stainless steel, in accordance with ASME IX, 2004

Welding procedures shall comply with the recommendations of Columbus (Pty) Limited

Welds shall be smooth and free from blow-holes, undercuts, sharp projections and similar visual defects

8.3 PICKLING AND PASSIVATION

8.3.1 Areas to be cleaned

After completion of welding, both weld and heat affected zones shall be cleaned, pickled and passivated. Any heat scale, including that on the reverse side of the weld, shall be removed by pickling and passivation.

8.3.2 Procedure

(i) Grind or wire brush, using dedicated grinders or stainless steel wire brushes to achieve the required smooth profile or remove scale

(ii) Pickle with a proprietary thixotropic paste containing 15-20% nitric acid and 1-2% hydrofluoric acid, with a contact time of 10 to 15 minutes

(iii) Rinse thoroughly with clean water until the pH of the washings is the same as that of the wash water

(iv) Repeat the above process, if necessary, to remove all discolouration

(v) Passivate with 10% nitric acid solution, or a proprietary passivating paste, for a contact time of 10 - 15 minutes, keeping the surface wet during this period

(vi) Neutralise thoroughly with an approximate 10% solution of sodium bicarbonate in water, scrubbing the solution into the surface using 'Scotchbrite®' abrasive pads. Rinse thoroughly using clean potable water until washings are the same pH as the wash water.

8.3.3 Safety Precautions

(i) Operatives shall wear protective aprons, gloves and safety glasses during pickling and passivating (it should be noted that these pickling chemicals are solutions of nitric and hydrofluoric acid and must be treated with extreme care!!)

(ii) Splashes on the skin shall be thoroughly washed with clean water immediately after contact. A weak solution of sodium bicarbonate shall be kept available for neutralisation. Seek medical attention if in doubt

(iii) Disposal of effluent shall be in accordance with the environmental requirements of the local authority in whose area the work is being carried out (See Clause 5.6)

9 ALUMINIUM FABRICATIONS

9.1 GRADE OF ALUMINIUM

The grade of aluminium or aluminium alloy shall be as specified by the Engineer or as recommended by the aluminium manufacturer for the specific application

9.2 ANODIZING

Aluminium components where specified as anodized shall be natural anodized and sealed in accordance with SANS 999 Grade 25. The corrosion resistance of the coating shall be not less than 8 when tested in accordance with 3.6 of specification SANS 999. Anodizing shall be carried out after completion of all welding

9.3 POWDER COATING

When specified by the Engineer, aluminium fabrications may be coated with exterior grade polyester powder. Such coating may only be carried out by contractors with the necessary plant, equipment and experience to pre-treat and powder coat aluminium effectively. The coating shall comply with SANS 1578 Part 1 and 2, or BS. 6496

9.4 CONTACT WITH CONCRETE

Whenever aluminium components, such as hand rail posts, come into contact with concrete or grout, the surface of the aluminium in contact with the concrete shall be coated with two coats of an approved epoxy tar composition, prior to the grouting.

9.5 CONTACT WITH MILD STEEL

When aluminium components are bolted to mild steel, plastic or rubber inserts shall be used to insulate the aluminium from mild steel. Fasteners shall be 304 stainless steel bolts, nuts and washers.

9.6 ALUMINIUM ROOF SHEETING

Aluminium roof sheeting should be used exactly according to the manufacturer's directions for use. Only approved contractors qualified to erect aluminium roofing shall be used. The fixing of the sheets is critical - far more so than the fixing of mild steel painted sheet because of the fact that aluminium is anodic to steel - i.e. it will sacrifice itself to protect the steel with which it is in contact. Therefore holes will get larger to the point where the roof/cladding sheets will detach from the fixings. This corrosion is accelerated by the accumulation of dust and dirt especially if the build-up is acid or alkaline or contains conductive ions e.g. salt

The manufacturers recommend the use of insulated stainless steel fixings and insulation tape separating the sheets from the supporting purlins/girts. Where this type of sheeting is used in corrosive environments it should be specified to be painted with PVF_2 on both sides and the sheeting should be designed to not allow accumulations of product or dirt to be in contact with the sheets. The sheets must not be in contact with the ground. This type of sheeting may only be used where high standards of cleanliness and maintenance are kept.

10 PAINTING AND APPLICATION OF ORGANIC COATINGS

10.1 MATERIALS

10.1.1 Paint Supplier

All materials in a paint system shall be purchased from one supplier. The contractor shall supply the paint supplier with a copy of the relevant sections of the specification. The paint supplier shall certify, by completion of the Form given in Appendix C, that the materials to be supplied comply with the relevant specification and are suitable for the intended purpose. The manufacturer shall preferably be a supplier of assessed capability listed under SANS ISO 9002 - 2000

10.1.2 Approval of paints

The Contractor shall submit with his tender, the appropriate form (See Appendix B) giving details of the paints he intends using and shall only proceed with the purchase of the paints upon receipt of written approval from the Engineer. Manufacturers' data sheets or legible copies thereof for each product shall be attached to the form

10.1.3 SABS compliance

Materials shall comply with the appropriate SANS specifications when relevant

10.1.4 Paint not changed without approval

No variation in brand or materials quoted in the tender documents and approved by the Engineer shall be permitted without the approval of the Engineer in writing

10.1.5 Containers

All coating materials shall be delivered in the manufacturer's original sealed containers, clearly marked with the following:

(i) Manufacturer's name

(ii) Product Brand and Reference Number

(iii) Volume of contents

(iv) Batch Number which may incorporate the date of manufacture

(v) Date of manufacture, unless already incorporated in the batch number

(vi) Abbreviated instructions for storage and use of the material, and/or reference to an appropriate data sheet which shall include mixing ratios of components of multi-component materials, minimum temperature of application, method of application, and minimum and maximum over coating times, where applicable

(vii) The SANS mark where applicable

10.1.6 Manufacturer's instructions:

Recommendations supplied by the manufacturer in the form of the latest edition of printed data sheets, or given in writing on the manufacturer's letterhead, shall be followed. Any conflict between the manufacturer's data sheet and the specification shall be referred to the Engineer for adjudication

Verbal information by the manufacturer's representative will not be accepted unless confirmed in writing by the company, on their printed letterhead, and signed by an authorised officer of the company

10.2 STORAGE

10.2.1 Approved store

All coating materials shall be kept in an approved store, which shall be dry, enclosed and where the temperature will not exceed 40°C or drop below 0°C

10.2.2 Paint freshness

Usage of materials shall be on a first in, first out basis and no materials may be used which have exceeded the shelf life recommended by the manufacturer

10.2.3 No smoking

No smoking shall be permitted in or near a paint store

10.2.4 Combustibles separate

Solvent containers shall be kept sealed in the store with adequate air circulation and floor level vents. Solvent or paint soaked rags, cotton waste or other spontaneously combustible material shall not be kept in or near the store. Precautions shall be taken to prevent the discharge of static electricity in areas where flammable solvent is stored.

10.2.5 Further safety requirements

Stores shall be provided with adequate and suitable fire extinguishers placed outside the entrance in a prominent position. A separate store shall be provided for tools, equipment, protective clothing and personnel. The paint store shall not be used to accommodate personnel at any time

10.3 COATED MANUFACTURED ITEMS

When items are purchased already coated, the contractor shall supply to the Engineer full details of materials used, method and standard of surface preparation, method of application and curing, and total dry film thickness of the coating. Such items will be subject to inspection and approval by the Engineer before acceptance

10.4 GENERAL

(i) The contractor shall ensure that he has available the latest edition of all the relevant National Specifications and Codes of Practice and the manufacturer's data sheets for materials to be used

(ii) Requirements specified in Clause 3 shall be adhered to

(iii) Strict attention shall be paid to fettling of surfaces by the Fabricator (see Clause 5 above) prior to coating. Should the painting contractor receive components not fettled in accordance with Clause 5, he shall arrange with the Fabricator to have the work carried out before commencement of painting. In case of dispute, the decision of the Engineer shall be final.

(iv) Areas which are inaccessible after assembly shall be prepared and fully coated with the specified system and to the specified requirements before assembly. The coating shall be fully hard dry and every care shall be taken to avoid damage to the coating during assembly.

(v) Mating surfaces (other than friction grip surfaces) shall be coated with primer or first coat only. The coating shall be uniform in thickness and shall not interfere with the mechanical tolerances. After assembly the joint shall be fully coated and if to be immersed, shall be totally sealed

(vi) The painting sub-contractor shall provide evidence of his competence to apply the specified materials in the specified manner and to apply the necessary Quality Control procedures. The Engineer, at his discretion, may demand a Quality Audit of the Contractor's facilities by a technically competent and independent organization. The audit shall be carried out at the Contractor's cost

If consistent and satisfactory results are not achieved with the plant and equipment used by the Contractor, the Engineer may order the Contractor to obtain and use such plant and equipment as may be necessary to achieve the required results

All plant, equipment and temporary works which are supplied by the Contractor shall at all times be maintained in good working order

On completion of the Contract, all such plant, equipment and temporary works shall be removed from the site

(vii) The Contractor shall provide a Quality Plan to show the stages at which Quality Control will be carried out. Further details are given in Section 13. The Quality Plan is subject to approval by the Engineer, who may require it to be revised if considered inadequate. The cost of revision shall be borne by the Contractor

(viii) The Engineer will require a Program of Work so that Quality Surveillance inspection can be planned and executed at the appropriate time according to the Contractor's program

10.5 SURFACE PREPARATION OF MILD STEEL FOR PAINTING

10.5.1 Oil and Grease Contamination

Oil and grease shall be removed by a bio-degradable, water rinsable, emulsion solvent degreaser, followed by rinsing with clean potable water, after which the surface shall be allowed to dry

10.5.2 For Mild, Non-Corrosive Conditions

Manually or mechanically clean the surface to remove all loose millscale, rust and solid contaminants in accordance with SANS 10064, Section 4.4. The standard of cleaning shall be not less than St 2 of ISO Standard 8501:1

10.5.3 For Corrosive and Highly Corrosive (Underwater) Conditions

Mild steel shall be blast cleaned in accordance with Section 4.3 of SANS 10064 Code of Practice for "The Preparation of Steel Surfaces for Coating"

WARNING: Steel less than 2mm thick may distort if blasted incorrectly

Note: Compressed air used for blast cleaning shall be dry, clean and free from oil

An additional requirement is that water soluble salts present in the steel after blast cleaning shall not exceed the values given in Table 1. Should these values be exceeded, the steel shall be cleaned by washing with clean potable water or by water shrouded or water injected blast cleaning until the soluble salts are within the limits specified in Table 1.

The steel shall then be allowed to dry, after which it shall be dry flash blast cleaned to achieve the required degree of cleanliness

Immediately before painting, the steel surface shall comply with the appropriate requirements of Table 1

TABLE 1 - STANDARDS OF BLAST CLEANING REQUIRED

Property:	Above water	Immersed surfaces
Cleanliness -ISO 8501:1:	Sa 2½ min	Sa 3 min
Residual dust and debris -ISO 8502:3:	0.5%	0.3%
Oil, grease and perspiration:	Nil	Nil
Surface profile -ISO Method 8503:2 1992: Grit Comparator - Refer Table 2	Medium (G) 50 - 70µm	Course (G) 85 - 115µm
Water soluble iron salts Maximum at any point -Weber Rielly test:	500 mg/m²	50 mg/m²

The cleaned surface shall be coated as soon as possible and not later than the times given in Table 2

TABLE 2 - MAXIMUM TIME INTERVAL BETWEEN CLEANING AND COATING

Ambient relative humidity	Maximum time (hours)
Below 50%	6
50-70%	4
70-85%	2
Over 85%	Coating not permitted – Re-blast and coat when relative humidity is again below 85%

10.6 SURFACE PREPARATION OF CAST METALS FOR PAINTING

Surfaces of cast metals to be painted shall be blast cleaned with new iron slag, copper slag, or platinum slag abrasives designed for blast cleaning. THE ABRASIVE SHALL NOT BE RE-CYCLED OR RE-USED. Cast iron shall be blast cleaned until all sand particles, residual burnt on sand and casting skin have been completely removed.

When castings are required to be coated with organic materials, any blowholes exposed in blast cleaning shall be filled with engineering grade metal filled epoxy filler, finished flush with the surface, before coating. Polyester fillers are NOT PERMITTED

10.7 SURFACE PREPARATION OF GALVANIZED STEEL FOR PAINTING

Galvanized steel surfaces shall be thoroughly degreased prior to painting, using either a water rinsable solvent degreaser, or a mild acid-detergent degreasing solution, both used in accordance with the manufacturer's instructions. In both cases care shall be taken to avoid entrapment of cleaning agent in recesses or other retention areas. In both cases, the surface shall be thoroughly washed until a 'water break free' surface is achieved. If necessary, the process shall be repeated until a 'water break free' surface is obtained

After degreasing, the surface shall be lightly abraded by one of the following methods:

(i) On small areas by the use of abrasive paper not coarser than 120 grade, or by using non-metallic abrasive pads

(ii) On large areas by 'sweep blast cleaning', using a nozzle pressure not greater than 300kPa and ultra fine abrasive (particle size not exceeding 1,0mm). Cracking, flaking or any form of delamination of the zinc coating due to excessive blast cleaning shall not be permitted. Removal of zinc by blast cleaning shall not exceed 15 microns

Finally, all dust and debris shall be removed by vacuum cleaning, or by washing, and the surface shall be allowed to dry before coating. Coating shall take place within the time limits given in Table 2 of Clause 10.5

10.8 SURFACE PREPARATION OF ALUMINIUM FOR PAINTING

Generally, aluminium surfaces will be anodized or powder coated and will require no further treatment.

Where painting is required, the aluminium surface must be smooth, clean and free of corrosion product. If the surface is corroded (white/grey corrosion product very adherent to the surface) it must be cleaned using fine grade (200 - 400#) ‘waterpaper’ to expose bright metal. The surface shall then be thoroughly degreased using a water rinsable degreaser, then rinsed with clean potable water. If the surface is not water break free, repeat the degreasing process until a water break free surface is obtained. Allow to dry completely, then apply a thin coat (8 to 13 microns dry film thickness) of two-pack wash primer complying with SANS 723, mixed and applied in accordance with the manufacturer's instructions.

Note: Wash primer is an adhesion promoter and does not replace the primer specified in the paint system.

10.9 SURFACE PREPARATION OF STAINLESS STEEL FOR PAINTING

Components fabricated from stainless steel shall not be contaminated with iron or mild steel from contact with equipment which has already been used for mild steel fabrication. Sheared edges, welds or surfaces subjected to any form of heat treatment shall be pickled and passivated. Stainless steel surfaces shall not be scratched or stressed

When it is required to paint stainless steel, the surface shall be blast cleaned, when practical, with an approved non-metallic abrasive such as aluminium oxide or platinum slag. The use of steel shot, steel grit or cast iron grit is strictly prohibited

Where blasting is impractical, the surface shall be cleaned with and roughened manually to the use by 'Scotchbrite®' abrasive pads, followed by washing with clean potable water to a 'water break free' surface. If a 'water break free' surface is not obtained, detergent cleaning shall be repeated until the surface is 'water break free'. Allow the surface to dry before coating.

Note:It is not advisable to paint a highly polished stainless steel surface such as bright annealed finish without some sort of roughening.

10.10 SURFACE PREPARATION OF 3CR12 CORROSION RESISTANT STEEL

Black Mill Finish - Degrease and blast clean the whole surface using an approved abrasive if painting is required

No.1 Mill Finish - Pickle and passivate weld areas in accordance with Clause 8.3. Thoroughly degrease with a water rinsable detergent and allow to dry.

Cold Rolled - As for No.1 Mill Finish.

10.11 SURFACE PREPARATION OF PAINTED SURFACES

Fully Painted Surfaces to be repaired; - bare areas shall be cleaned with abrasive paper to bright metal surface. The surrounding paint, which must be intact, shall be feathered for a distance of 20mm beyond the damaged areas. Dust and debris shall be removed by the use of a clean rag dampened with water or clean solvent that will not attack the coating. Wetted areas shall be allowed to dry, after which spot repairs shall be carried out with all the coats previously applied and shall overlap the undamaged area by 20mm. However, for epoxies, etc. to be immersed, the abraded area must not be overlapped (Refer to Clause 20.1 – repair procedure). The requirements of the spot repair shall be not less than that specified for the undamaged coating

Fully painted Surfaces to be over-coated; - Where additional coats are required over the whole surface, the surface shall be degreased with a water rinsable detergent, rinsed with potable water and then abraded to a uniform matt finish.. The surface shall be washed to remove all contamination and then allowed to dry. Further coats shall then be applied as specified to give the required coating thickness and specified finish

Note: Abrasion is particularly important for pure epoxy, coal tar epoxy and polyurethane systems but is not necessary for vinyl systems or other recoatable finishes

Primed Surfaces; - Shop applied primers shall be thoroughly sanded with fine abrasive paper (220 - 320#) where necessary to achieve a uniform matt surface. The surface shall be scrubbed with a solution of suitable water based detergent-degreaser using a bristle brush, followed by potable water rinses to remove all grease and water soluble matter. The surface shall be allowed to dry completely before application of the specified coating system over the whole surface

10.12 SURFACE PREPARATION OF PLASTIC AND GRP SURFACES FOR PAINTING

Sand the surface thoroughly with 320-400# waterproof abrasive paper to achieve a uniform matt finish. Remove all debris, oil and grease by scrubbing with a solution of a suitable water based detergent. When the surface is well wetted, rinse off very thoroughly with clean potable water to remove all residues. Allow to dry completely before painting

11 APPLICATION OF PAINTS AND ORGANIC COATINGS

11.1 ENVIRONMENTAL CONDITIONS

Paint shall not be applied in high wind and/or dusty conditions that will cause dust to settle on the surface of the paint before it has dried, nor when the steel surface temperature is less than 3°C above dewpoint, nor higher than the maximum advised by the paint manufacturer, nor when humidity is greater than 85%*, nor when the ambient temperature is less than the minimum or greater than the maximum specified by the manufacturer of the coating material

11.2 MIXING

All coating materials shall be very thoroughly mixed until completely homogeneous preferably by power stirrer (care must be taken to not entrain air). With all paints the stirred paint should be left to diffuse for 5 minutes and then re-stirred.

In the case of two-pack materials, each component containing pigments shall be thoroughly mixed. The two components shall then be mixed together in the proportions supplied by the manufacturer until the mixture is completely homogeneous. In the case of solvent based epoxy materials, it is recommended that the mixed material be allowed to stand for an induction period of 20 to 30 minutes before use and then re-stirred prior to use.

For two-pack materials, the use of part of the contents (split packs) is strictly forbidden

The time and date must be noted at the time of mixing and at the time of applying the material so that:

I. The usable potlife will not be exceeded and

II. The maximum overcoating interval will not be exceeded.

Note: - There are services available to re-pack two component paints into small packs

11.3 METHOD OF APPLICATION

Application shall be by brush, roller, spray, airless spray or other suitable equipment as appropriate for the surfaces to be coated and in accordance with the recommendations of the manufacturer. Application equipment shall be maintained in clean condition and in good working order. The use of equipment not maintained in good clean condition may lead to rejection of the coating

11.4 OVER COATING

Over coating times shall be not less than the minimum nor greater than the maximum specified by the manufacturer, relevant to the ambient temperature. Where over coating times in the data sheet relates to 25°C, the contractors must acquaint themselves with the correct over coating times for lower and higher temperatures. Strict adherence to over coating times is particularly important for two pack coatings that are subsequently immersed. The Contractor will be held responsible for delamination or blistering of paint coatings on immersion.

11.5 MAINTENANCE OF CLEANLINESS

All surfaces to be coated shall be clean and free from dust, oil, moisture and perspiration before over-coating.

11.6 FILM THICKNESS

Whilst final assessment is determined by dry film thickness measurement, the use of wet film thickness gauges is recommended to ensure correct thickness during application. The wet film thickness required may be calculated by the formula DFT=WFT/VS x100, where VS = volume solids, corrected for added solvent where necessary. The manufacturer will supply the volume solids of the paint.

11.7 FILM THICKNESS TOLERANCE

(i) Individual Coats - At least 90% of all thicknesses measured shall comply with the minimum requirements of the project specification. Up to 10% of all readings may be below the specified minimum thickness, but may not be less than 70% of the specified minimum thickness

(ii) Total Dry Film Thickness - Not more than 10% of readings shall be less than the minimum specified and no reading shall be less than 90% of the specified minimum. The mean of 10 readings taken within any $1m^2$ of the coated area shall not be less than the minimum DFT specified. No reading shall exceed the mean specified thickness by greater than 50%, unless a concession is granted by the Engineer

(iii) Maximum Film Thickness - For solvent borne coatings to be immersed, the total DFT shall not exceed the mean specified thickness by greater than 50%, unless a concession is granted by the Engineer. For non-immersed coatings or for solvent free systems, the maximum film thickness measured may be greater than the maximum specified but any over thickness shall not be deleterious to the long-term performance of the coating and written support of this fact must be supplied by the paint manufacturer

(iv) Multicoat applications – For solvent borne coatings to be immersed, further coats may applied only after the full curing period for the specified system has been achieved. This is a precaution to ensure that solvent retention does not occur.

Example: If a contractor has applied a system generally conforming with (i), (ii) & (iii) above but under-thickness areas are located at the time of inspection, additional coats may not be applied until the full curing time has been achieved.

12 HANDLING

12.1 DURING SURFACE PREPARATION AND COATING / PROTECTION OF NAME PLATES

All steel shall be supported not less than 100mm clear of the floor for coating prior to erection. The floor shall be clean concrete, brick or other non-dust producing material. Equipment name-plates and identification plates shall be protected from damage or obliteration. For service in corrosive environments, where complete protection of the substrate is required, the plates shall be removed prior to cleaning and shall be replaced after the complete coating is hard dry. For mildly corrosive conditions, name plates shall be protected by masking with suitable masking tape, which shall be removed and the name plate cleaned free of adhesive after completion of coating

12.2 AFTER COMPLETION OF COATING

Coated components shall not be handled earlier than the hard dry time recommended by the manufacturer, relevant to the ambient temperature. Coated components shall be handled with broad band fabric slings and shall be transported with suitable packing to minimise damage to the coating

All flanged pipes and components with projecting parts shall be stored and transported in such a manner that will prevent projecting parts such as flanges from contacting coated surfaces such as the body of the pipes

12.3 AFTER COMPLETION OF ERECTION OR INSTALLATION

All damage caused in handling, transportation and erection or installation shall be repaired in accordance with the requirements of the relevant system and to the satisfaction of the Engineer, at no extra cost

13 QUALITY ASSURANCE

13.1 CONTRACTOR QUALIFICATION

The Tenderer shall state on Form marked Appendix B in his tender the name of the painting sub-contractor that he proposes to use to carry out the painting or coating.

The Contractor shall ensure that all his sub-contractors have obtained a copy of this specification.

The Engineer may, at his discretion, require a Quality Audit of the painting sub-contractor to ensure that he has the management, facilities, skilled staff and quality control facilities and staff to carry out quality control during application of coatings to ensure compliance with specification

The contractor shall accept full responsibility for the quality of his work and of materials used, irrespective of any quality surveillance that may be carried out by the Engineer or his representative

The contractor shall obtain confirmation from the material supplier that materials to be used comply with the specification and are suitable for the intended purpose by having Form marked Appendix C completed by the material supplier

13.2 NOMINATED PERSON IN CHARGE OF QUALITY CONTROL

The painting sub-contractor shall appoint one member of staff to be in charge of all quality testing, recording and management. This person and all site records will be made available to the Engineer or his inspectorate at the time of inspections.

13.3 DATA SHEETS, SPECIFICATIONS AND CODES OF PRACTICE

The contractor shall have available the latest issues of each of the manufacturer's data sheets for the materials to be used, National Specifications and Codes of Practice relevant to the work to be carried out, as well as a copy of this Specification, all of which shall be available to the Contractor's Quality Control Manager

13.4 QUALITY CONTROL

The contractor shall have the necessary equipment and staff knowledgeable in test procedures to carry out all the quality control required to ensure compliance with the specification.

The contractor shall :

(i) supply a Quality Plan and Quality Program at the time of tendering, both of which are subject to acceptance by the Engineer,

(ii) maintain Quality Control records in accordance with the Quality Plan during execution of the contract. Such records shall be available to the Engineer or his representative at each Quality Surveillance visit,

(iii) mark or securely label each component with a unique identification and

(iv) carry out such tests as are required to ensure compliance with the specification

The cost of Quality Control shall be inclusive in the contractor's tender price

13.5 QUALITY SURVEILLANCE

13.5.1 Independent Surveillance

The Engineer may employ an independent, technically qualified organization to carry out quality surveillance of the work on his behalf. In the event of dispute, the Engineer's decision shall be final

13.5.2 Program

The contractor shall advise the Engineer timeously, in writing, when and where the following processes will be carried out

(i) Completion of fettling or dressing prior to leaving the fabricator's works

(ii) Blast cleaning and application of the first or primer coat

(iii) After completion of all coats to be applied at the contractor's works

(iv) At the commencement of repairs to be carried out on site

Failure of the contractor to advise the Engineer of his program may result in rejection of the work

13.5.3 Access for Surveillance

For the purpose of carrying out quality surveillance, the Engineer or his representative shall be granted access to any part of the contractor's premises relevant to the work being carried out, at any reasonable time. The contractor shall provide, at his own cost, any equipment or labour necessary to gain access to surfaces which are coated, to be coated or are in the process of being coated

13.5.4 Samples

The Engineer or his representative may remove any reasonable samples of materials to be used in the coating application. Rejection of the sample will place a hold on the use of material of the same batch number and may lead to rejection of all that batch of material and the reworking of any components that have already been coated with rejected material

13.5.5 Destructive Testing

The Engineer or his representative may carry out reasonable destructive tests to ascertain compliance with the specification. Areas thus damaged shall be repaired by the Contractor to the satisfaction of the Engineer at no additional cost

13.5.6 Cost of Quality Surveillance

Cost of Quality Surveillance will be borne by the Employer, except when surveillance results in rejection of the lot or when notice by the contractor results in a fruitless trip, in which cases the cost of surveillance shall be debited against the Contractor's account

13.5.7 Quality Surveillance Report

The inspector shall complete a report at each visit. A copy of the report will be given to the contractor on completion of each surveillance visit. A copy of the report approving the components shall be included with the delivery note. No payments will be authorised by the Engineer unless he has received a copy of an approval report. The Engineer may withhold payment until a final report has been issued, giving approval to the components after installation on site and repair of damage to the coating

13.5.8 Quality Control Records

The contractor shall maintain proper and adequate quality control records for all stages of the work. These records shall be available for inspection by the Engineer or his representative at the time of Quality Surveillance. Incomplete, inaccurate or inadequate records shall be regarded as non-compliance with the specification, and the cost of additional surveillance will be back charged to the contractor

13.5.9 Variation From Specification

No variation from specification, or change of sub-contractor or materials to be used from those stated in the tender documents, shall be permitted without written approval of the Engineer. Products equivalent to those specified may be submitted for approval. For the Engineer to assess the material, the manufacturer shall supply adequate technical data and case histories to support his claim to equivalence

13.5.10 Non-conformance and request for concession

The inspector may deem the corrosion protection acceptable or non-acceptable.

'Non acceptable' means that, in the view of the inspectorate, the work does not conform to specification. The inspector may reject the contractor's work. Any non-conformance shall be immediately relayed to the Engineer.

If the contractor considers that the corrosion protection or non-conforming items will not be deleterious to the performance of the items in service the contractor may submit a concession request (form applicable on request to the Engineer) to the Engineer for consideration of the Engineer accepting the non-conforming quality.

14 TEST METHODS

Unless otherwise agreed in writing by the Engineer, the following test methods shall be used

14.1 Visual assessment of surface cleanliness: - ISO 8501-1:1988

14.2 Grading of surface profile - comparator procedure: - ISO 8503-2:1988

14.3 Assessment of dust on steel surfaces prepared for painting: - ISO 8502-3:1992

14.4 Field test for soluble iron corrosion products (soluble salts test used on ISO 8501-1 rust grades C or D):

I. ISO/TR 8502-1:1991

II. As the above method is not readily available the following proprietary test is acceptable: *Weber Rielly Soluble Salts Test* -as per the manufacturer's instructions.

14.5 Determination of chloride on cleaned surfaces.

I. Laboratory determination of chloride on cleaned surfaces: - ISO 8502-2:1992

(Note: The substances and procedures used in this method may be injurious to health if adequate precautions are not taken and these tests should be carried out by qualified personnel)

II. As the above method is not readily available the following proprietary test is acceptable: *Chlorid*® salt test

14.6 Measurement of wet film thickness:

I. ISO 2808:1991 - Method N^{o}. 7a - Wheel gauge

II. ISO 2808:1991 - Method N^{o}. 7b - Comb gauge

14.7 Measurement of dry film thickness:-

I. Magnetic metallic substances (iron, mild steel, ferritic stainless steel etc.): - ISO 2808:1991 - Method Nº. 6A(10.3.2) – Electro-magnetic instrument

II Non-magnetic metallic substances (aluminium, copper, austenitic stainless steel etc.): - ISO 2808:1991 - Method Nº. 6B (10.4.2.1) – Eddy current instrument

Note: - Instruments are to be calibrated and used according to the manufacturer's instructions. Instruments are to be re- calibrated at least every 6 months or when abnormalities are evident over a range of 500µm measurements on calibrated standard shims

III Non- metallic substances (concrete, timber, plastic etc.): - ISO 2808:1991 - Method Nº. 4

Note: -This is a destructive method and damage will be required to be repaired.

COATING SYSTEMS

CONTENTS OF COATING SYSTEMS

15 CATEGORIES

A - ALKYD SYSTEMS for use in environments of low corrosivity. These oil based paints - (gloss enamels, eggshell enamels, polyurethane alkyds, alkyd undercoats and primers etc.) are easy to use, economical and have good weathering characteristics. They must not be applied directly to alkaline surfaces (cement and concrete) or to galvanized surfaces. They dry by solvent evaporation and then cure by reaction with atmospheric oxygen. They therefore do not re-dissolve in their original solvent and require abrasion prior to over-coating.

B - TWO PACK SOLVENT BORNE CHEMICALLY CURED SYSTEMS, EPOXY, EPOXY PHENOLIC AND POLYURETHANE, for use under water and in corrosive environments. These systems have long maintenance free life when correctly applied. The pure systems for use underwater require strict control of over-coating times and preparation procedures.- Modified systems used above water are re-coatable and have improved resistance to chalking

C - TWO PACK COAL TAR EPOXY. These systems have excellent resistance to water and mild acids but chalk severely on exposure to sunlight and are very difficult to re-coat. For use underwater they require strict control of over-coating times and preparation procedures.

D - ONE PACK VINYL RESIN BASED SYSTEMS for use in corrosive environments, excluding immersion. These systems have good resistance to inorganic chemicals but are softened by fats and other organic materials (e.g. solvents). Due to their permanent solubility, they are easily re-coated with similar material for maintenance purposes. This characteristic causes the entire film to soften back on over-coating and hard dry times are extended when additional coats are applied.

E - TWO PACK SOLVENT FREE CHEMICALLY CURED SYSTEMS, EPOXY, EPOXY PHENOLICS AND POLYURETHANE, for use primarily in immersion and abrasive conditions. Special equipment is required for the application of these materials and considerable experience is necessary for their correct application. Due to the absence of solvent, thick films can be applied, hence enabling good protection to be obtained in short time schedules. These systems have long maintenance free life when correctly applied but are difficult to re-coat in the maintenance situation

F - POWDER COATING. These are free flowing powders applied by fluidised bed or electrostatic spray, then melted and cured by heat. They are therefore only suitable for application to metallic surfaces under factory conditions. Low build powder coatings for exterior use and application to galvanizing require a primer (Zinc-rich epoxy powder coating primers are now available as an alternative to galvanizing). For pipes, pumps and valves, only the high film thickness coatings are specified (FBE powder coatings). Application of powder may only be carried out by specialist contractors with the necessary heating and curing facilities and the required experience. No further cure time is required after completion of the full cure cycle; hence components can be handled immediately on completion. Care must be taken that the full cure cycle is completed to ensure that the powder coating develops its full properties. This is not easily discernable and requires special laboratory testing

G - TAPE WRAPPING SYSTEMS Tape wrapping is a method of corrosion protection which utilises preformed strips of adhesive plastic, in the form of rolls, to wind around the item to be protected, with a suitable overlap, in order to 'blot out' the corrosive environment. It is used primarily for underground pipes and their ancillaries such as couplings, valves, etc. The method is used primarily on site although for certain types, wrapping can be carried out on individual pipes at a factory or site yard. There are many types of tape but for the purposes of this specification, only two types are given, namely petrolatum tape and rubber modified bitumen with polyethylene outer coating

16 CATEGORY A - ALKYD SYSTEMS

Preamble: Alkyd Systems are intended for use in environments of low corrosivity, where a good decorative finish is required. Materials shall therefore be applied with due cognisance of appearance and protection.

16.1 SYSTEM A1 ALKYD ON TO BARE METAL SURFACES

(i) The surface to be coated shall be prepared by degreasing and manual or mechanical cleaning as specified in Clause 10.5.2

(ii) Apply one coat of *alkyd metal primer* to a film thickness of not less than 40 microns. Allow to dry for a minimum of 8 hours

(iii) Apply one coat *alkyd based enamel*, in the colour specified by the Engineer, to give a dry film thickness of not less than 25 or greater than 35 microns. Allow to dry for a minimum of 16 hours

(iv) On exterior surfaces, apply a second coat of *alkyd enamel*, within 48 hours, to give a further dry film thickness of not less than 25 or greater than 35 microns in the final colour specified by the Engineer. Allow to dry for a minimum of 16 hours

Requirements

The finished system shall be smooth, glossy, free from excessive runs, sags, blisters, wrinkling, dirt, occlusions or other visual defects and shall be a commercial match to the colour specified by the Engineer. Runs, sags, curtaining, shrivelling, wrinkling or other visible defects will not be permitted

The dry film thickness of the finished system shall not be less than the following:

Exterior surfaces - 80 microns

Interior surfaces - 65 microns

16.2 SYSTEM A2 ALKYD ON SURFACES ALREADY CLEANED AND PRIMED

(i) Clean and prepare the surface by degreasing, sanding and removal of dust as specified in Clause 10.11

(ii) Touch up bare areas with a alkyd metal primer

(iii) Apply one coat all over of alkyd metal primer

(iv) Continue the system as given in System A1 (iii) to (v) inclusive

16.3 SYSTEM A3 ALKYD ON FACTORY FINISHED COMPONENTS

The contractor shall ensure that the system to be applied is compatible with the existing coating

(i) Prepare the surface by degreasing, abrading and removal of dust as specified in Clause 10.5.1 or 10.11, as appropriate

(ii) On interior surfaces apply one coat of alkyd enamel, in the colour specified by the Engineer, to give an applied dry film thickness of not less than 25 microns. Total dry film thickness to be not less than 65 microns

(iii) On exterior surfaces, apply two coats alkyd enamel, with overnight drying between coats, to give an applied dry film thickness of not less than 50 microns. Total dry film thickness of the system shall not be less than 80 microns

(iv) In both cases a further coat of enamel shall be applied after installation, to the final colour selected by the Engineer

16.4 SYSTEM A4 ALKYD ON GALVANIZED SURFACES ABOVE WATER

(i) Prepare the surface by degreasing, abrading and removal of dust as specified in Clause 10.7

(ii) Apply one coat of the paint manufacturer's recommended primer for galvanized surfaces Water based styrene acrylic emulsion primer, water based two pack epoxy, etch primer, epoxy holding primer can be used (The use of Calcium Plumbate Primer is excluded from these Specifications). Allow to dry for the over coating time recommended by the manufacturer.

NOTE: The purpose of the primer is to provide adhesion onto the substrate for the topcoat and to insulate the alkyd topcoat from direct contact with the galvanized surface to prevent saponification from occurring

(ii) Continue the system as given in A1 (iv) (two enamel coats). The total dry film thickness shall be a minimum of 75 microns over the galvanizing

16.5 SYSTEM A5 ALKYD ON PLASTIC AND BITUMEN COATED SURFACES

(i) Prepare the surface by degreasing, abrading and removal of dust as specified in Clause 10.12.

(ii) Apply one coat of a water borne coating e.g. water based styrene acrylic emulsion primer, water based two pack epoxy or as recommended by the manufacturer. Allow to dry for a minimum of 16 hours at 25°C

NOTE: The good adhesion to substrate must be verified before continuing

(iii) Apply one coat of alkyd enamel in the colour required by the Engineer

16.6 SITE REPAIR OF ALKYD SYSTEMS

Any site repair required by the Engineer shall be carried out in accordance with surface preparation method given in Clause 10.11, followed by all the coats required to restore the damaged area to the original system requirements. Since patch application of the final coat rarely gives an acceptable uniform finish, the whole area in which damage has occurred shall be cleaned, abraded with fine wet or dry abrasive paper (not coarser than 220 grit) and given one coat of enamel all over, unless otherwise accepted by the Engineer

17 CATEGORY B - TWO PACK, SOLVENT BORNE, EPOXY, EPOXY PHENOLIC AND POLYURETHANE SYSTEMS

Preamble: Two-component solvent borne chemically cured systems are the most commonly used coating system for corrosion protection of steel. EPOXIES are fast curing and adhere extremely well to clean surfaces. They are tough, durable, and water resistant but chalk badly on exposure to sunlight. The EPOXY PHENOLIC coatings are resistant to inorganic acids and many other chemicals. They have short overcoating times and discolour and chalk on exterior exposure. POLYURETHANES (aliphatic isocyanate cured) have excellent gloss and colour retention and are used as topcoats . All are supplied in two parts, which must be mixed together before use to allow the chemical reaction to take place

These materials can retain solvent if the material is applied too thickly in one application, if the time between coats is too short or if there is inadequate ventilation or low temperatures during curing. This solvent retention causes osmotic blistering on immersion

The applicator may not exceed the maximum film thickness per coat, or the maximum over coating time specified by the manufacturer. Since over coating are frequently quoted at 20° or 25°C, longer over coating times shall be allowed at lower temperatures. As a rough guide, increase time by 50% for a 5°C decrease or by 100% for a 10°C decrease in ambient temperature below the quoted temperature

Epoxy and epoxy phenolic materials shall not be applied when the ambient temperature is below 10°C

Solvent based epoxy materials shall be allowed 28 days to cure before immersion, or as recommended by the manufacturer. At temperatures below 20°C, longer periods shall be allowed, as for over coating times

Two pack solvent borne aliphatic polyurethane materials are similar in application and over coating properties to solvent based epoxies, but they have much improved gloss and colour retention. The curing agents are based on aliphatic isocyanates. The latter and their mixtures must not be mixed with water or with any solvent (especially epoxy solvents) other than that recommended by the supplier. The aliphatic polyurethanes are somewhat slower curing than epoxy enamels at 25°C but will cure at lower temperatures. They have outstanding weathering properties, and good dilute acid resistance. They are not recommended for immersion service.

Epoxy/polyurethane systems utilize primers for non-immersion corrosion protection use. These primers may contain a corrosion inhibitive or sacrificial pigment. Zinc metal powder is included in epoxy zinc rich primers and inorganic zinc primers to protect the mild steel substrate. MIO or Micaceous Iron Oxide is a flaky, lamellar pigment which provides a multi-layer tile like protection within the paint coating, thereby greatly increasing the waterproof properties of the system. The aluminium pigmented epoxy mastics utilise epoxy/amine components and modifiers which render the products tolerant to wire brushed surfaces. They are used where abrasive blasting is not possible or practical.

17.1 SYSTEM B1 PURE EPOXY COATINGS FOR IMMERSION SERVICE ON BARE STEEL AND CAST IRON SURFACES

Material to be used shall be a *two-component, high solids, solvent-based, epoxy coating* suitable for permanent immersion in water

(i) Prepare surfaces as specified in Clause 10.5.1 or 10.5.2 as appropriate, to achieve a blast cleaned surface of cleanliness Sa3, a profile of 50-100 microns, dust quantity rating of no greater than 2 (Figure 1 - ISO 8502-3:1992) and soluble salts not more than 100mg/m^2 (Weber Rielly Test)

(ii) Mix base and curing agent individually until homogeneous, then mix together in the proportions supplied or specified by the manufacturer and again mix until homogeneous. SPLIT PACKS, i.e. the use of part containers is not permitted.

(iii) Apply two or three coats of the mixed material as required to give a total dry film thickness of not less than 300 microns nor greater than 450 microns

The coating shall be applied at the correct spraying viscosity and by the equipment recommended by the manufacturer to minimise the porosity of the applied film

Each coat shall differ in colour from the preceding coat

Each coat shall be applied to a thickness not less than the minimum nor greater than the maximum recommended by the manufacturer

The time interval between coats shall be not less than the minimum nor greater than the maximum recommended by the manufacturer for the prevailing ambient temperature. Should the overcoat time be exceeded, the surface shall be prepared as specified under REPAIR before over-coating

Requirements

The coating system shall be smooth, glossy, free from excess orange peel effect, bubbling, excessive runs and sags or other visible defects

The dry film thickness shall be minimum 300, maximum 450 microns

The coating shall be free from electrical insulation defects when tested with an approved wet sponge detector set to operate at 90 Volts, 2 Megohms. Repair of defects is permissible by the procedure given in 10.11, provided that the repaired area complies with all the requirements given above

The film examined in cross section shall not exceed the porosity of scale 2 as given in the Canadian Standards Association CAN/CSA-Z245.20-M86 Section 12.11

17.2 SYSTEM B1A RECOATABLE SYSTEM FOR ABOVE WATER USE IN CORROSIVE ENVIRONMENTS

Material used shall be a *high build two component epoxy coating*, followed by one or two coats of *recoatable, two component, aliphatic isocyanate cured polyurethane*

Surface preparation

As for System B1 except that surface preparation to Sa 2 ½ will be acceptable. All other requirements of System B1 shall be applicable, except that testing for electrical insulation defects is not required except when specifically called for by the Engineer.

Requirements

The coating system shall be smooth, glossy, free from excess orange peel effect, bubbling, excessive runs and sags or other visible defects

The dry film thickness shall be minimum 300, maximum 450 microns

17.3 SYSTEM B2A RECOATABLE SYSTEM FOR USE ABOVE WATER IN CORROSIVE ENVIRONMENTS ON GALVANISED SURFACES

Material used shall be a *two pack epoxy primer specifically designed for application to galvanized steel*, followed by one or two coats of *recoatable, two component, aliphatic isocyanate cured polyurethane*

(i) Prepare the surface as specified in Clause 10.7, by degreasing and light abrading, or sweep blasting

(ii) Apply an *epoxy primer* specifically designed by the manufacturer for use on galvanized steel to a dry film thickness of 40 to 80 microns

(iii) Apply one coat of the a *recoatable two-pack polyurethane finish coat* to a dry film thickness minimum 40, maximum 60 microns

Requirements

The coating system shall be smooth, glossy, free from orange peel effect, bubbling, excessive runs and sags or other visible defects

The dry film thickness shall be minimum 80, maximum 140 microns over galvanizing. Electrical insulation testing is not required

17.4 SYSTEM B3 EPOXY PRIMER/ EPOXY MIO PRIMER/RECOATABLE POLYURETHANE –HIGH BUILD SYSTEM FOR EXTERIOR USE IN CORROSIVE ENVIRONMENTS

Material used shall be a *high build anti-corrosive epoxy primer*, followed by a coat of high build MIO containing epoxy intermediate coat, followed by a *recoatable two component aliphatic isocyanate cured polyurethane*.

(i) Prepare surfaces as specified in Clause 10.5.1 or 10.5.3 as appropriate, to achieve a blast cleaned surface of cleanliness Sa2 ½ , a profile grade of medium (50 -70µm) as per ISO 8503-3, dust quantity rating of no greater than 2 (Figure 1 - ISO 8502-3:1992) and soluble salts not more than 100 mg/m^2 (Weber Rielly Test)

(ii) Mix each base and curing agent individually until homogeneous, then mix together in the proportions supplied or specified by the manufacturer and again mix until homogeneous. SPLIT PACKS, i.e. the use of part containers is not permitted unless Engineer approved suitably accurate measuring equipment is available.

(iv) Apply one coat of the *two component, high build epoxy primer* to give a minimum dry film thickness of 115µm, as per the manufacturer's instructions.

(v) Apply one coat of the *two component, high build epoxy MIO intermediate coat* to give a minimum dry film thickness of 100µm, as per the manufacturer's instructions.

(iv) After the prescribed interval for the environmental conditions, apply a single coat of two component, high gloss, high solids *recoatable two component aliphatic isocyanate cured polyurethane* to give a minimum dry film thickness of 40µm and a maximum dry film thickness of 60µm as per the manufacturer's instructions.

Requirements

The coating system shall be smooth, glossy, free from excess orange peel effect, bubbling, excessive runs and sags or other visible defects.

The dry film thickness shall be minimum 255, maximum 400 microns.

17.5 SYSTEM B4 - ZINC RICH PRIMER, EPOXY MIO PRIMER / RECOATABLE POLYURETHANE –HIGH BUILD SYSTEM FOR EXTERIOR USE IN NON ACIDIC ENVIRONMENTS

Material used shall be a *zinc rich epoxy primer containing a minimum 92% zinc metal (mass %), or alternatively an inorganic zinc primer containing a minimum 85% zinc metal (mass %),* followed by a coat of *high build MIO containing epoxy intermediate coat*, followed by a *recoatable two component aliphatic isocyanate cured polyurethane*.

(i) Prepare surfaces as specified in Clause 10.5.1 or 10.5.3 as appropriate, to achieve a blast cleaned surface of cleanliness Sa2 ½ , a profile grade of medium (50 -70µm) as per ISO 8503-3, dust quantity rating of no greater than 2 (Figure 1 - ISO 8502-3:1992) and soluble salts not more than 100 mg/m^2 (Weber Rielly Test)^2

(ii) Mix each base and curing agent individually until homogeneous, then mix together in the proportions supplied or specified by the manufacturer and again mix until homogeneous. SPLIT PACKS, i.e. the use of part containers is not permitted unless Engineer approved suitably accurate measuring equipment is available

(vi) Apply one coat of the *two component, rich epoxy primer* to give a minimum dry film thickness of 50µm, as per the manufacturer's instructions.

(vii) Alternatively, apply one coat of the *two component, inorganic zinc primer* to give a minimum dry film thickness of 50µm, as per the manufacturer's instructions.

(viii) Apply one coat of the *two component, high build epoxy MIO intermediate coat* to give a minimum dry film thickness of 100µm, as per the manufacturer's instructions

(iv) After the prescribed interval for the environmental conditions, apply a single coat of two component, high gloss, high solids *recoatable two component aliphatic isocyanate cured polyurethane* to give a minimum dry film thickness of 40µm and a maximum dry film thickness of 60µm as per the manufacturer's instructions.

Requirements

The coating system shall be smooth, glossy, free from excess orange peel effect, bubbling, excessive runs and sags or other visible defects

The dry film thickness shall be minimum 190, maximum 300 microns

17.6 SYSTEM B5 PHENOLIC MODIFIED EPOXY SYSTEM FOR STEELWORK AND EQUIPMENT IN CHEMICAL ENVIRONMENTS

Material used shall be a *solvent based epoxy-phenolic chemical resistant primer*, followed by a coat of *solvent based epoxy-phenolic chemical resistant intermediate coat*, followed by a *solvent based epoxy-phenolic chemical resistant topcoat*.

(i) Prepare surfaces as specified in Clause 10.5.1 or 10.5.3 as appropriate, to achieve a blast cleaned surface of cleanliness Sa2 ½ , a profile grade of medium (50 -70µm) as per ISO 8503-3, dust quantity rating of no greater than 2 (Figure 1 - ISO 8502-3:1992) and soluble salts not more than 100 mg/m^2 (Weber Rielly Test)

(ii) Mix each base and curing agent individually until homogeneous, then mix together in the proportions supplied or specified by the manufacturer and again mix until homogeneous. SPLIT PACKS, i.e. the use of part containers is not permitted unless Engineer approved suitably accurate measuring equipment is available

(ix) After the prescribed interval for the environmental conditions, apply one coat of the *solvent based epoxy-phenolic chemical resistant primer* to give a minimum dry film thickness of 100µm, as per the manufacturer's instructions.

(x) Apply one coat of the *solvent based epoxy-phenolic chemical resistant intermediate coat* to give a minimum dry film thickness of 100µm, as per the manufacturer's instructions

(iv) After the prescribed interval for the environmental conditions, apply a single coat of two component, high gloss, *solvent based epoxy-phenolic chemical resistant topcoat* to give a minimum dry film thickness of 100µm and a maximum dry film thickness of 60µm as per the manufacturer's instructions.

Requirements

The coating system shall be smooth, glossy, free from excess orange peel effect, bubbling, excessive runs and sags or other visible defects

The dry film thickness shall be minimum 300, maximum 400 microns

The coating shall be free from electrical insulation defects when tested with an approved wet sponge detector set to operate at 90 Volts, 2 Megohms. Repair of defects is permissible by the procedure given in 10.11, provided that the repaired area complies with all the requirements given above

17.7 SYSTEM B6 – ALUMINIUM PIGMENTED EPOXY MASTIC / RE-COATABLE POLYURETHANE FOR UPGRADING OF COATINGS ON ELECTRICAL EQUIPMENT, GEARBOXES, PUMPS, VALVES AND OTHER PROPRIETARY EQUIPMENT

Material used shall be ***aluminium pigmented epoxy mastic***, followed by a *recoatable two component aliphatic isocyanate cured polyurethane*.

(i) Prepare the surface by degreasing, abrading and removal of dust as specified in Clause 10.5.1 or 10.11, as appropriate

(ii) Mix each base and curing agent individually until homogeneous, then mix together in the proportions supplied or specified by the manufacturer and again mix until homogeneous. SPLIT PACKS, i.e. the use of part containers is not permitted unless Engineer approved suitably accurate measuring equipment is available

(xi) Apply one coat of the *aluminium pigmented epoxy mastic* to give a minimum dry film thickness of 125µm, as per the manufacturer's instructions.

(iv) After the prescribed interval for the environmental conditions, apply a single coat of two component, high gloss, high solids *recoatable two component aliphatic isocyanate cured polyurethane* to give a minimum dry film thickness of 40µm and a maximum dry film thickness of 60µm as per the manufacturer's instructions.

Requirements

The coating system shall be smooth, glossy, free from excess orange peel effect, bubbling, excessive runs and sags or other visible defects

The dry film thickness shall be minimum 165, maximum 200 microns

17.8 REPAIR OF PURE EPOXY AND POLYURETHANE SYSTEMS

Unmodified epoxy or polyurethane coatings are difficult to repair when fully cured. Careful attention to the following repair procedure is required to ensure adequate adhesion of the material used for repair:

Prepare the surface by abrading to a uniform matt finish, followed by wiping the surface with methyl ethyl ketone (MEK) solvent, to give a contact time of 30 seconds. Allow to dry, then wipe off any residual dust with a clean rag. Apply as many coats of repair material as are necessary to achieve the specified film thickness. When using solvent borne materials, note the need for adequate time between coats as specified under System B1. Solvent borne coatings can be repaired using solvent free epoxy repair kits which are pre-measured and easy to use.

17.9 REPAIR OF RECOATABLE EPOXIES AND POLYURETHANES

These do not require abrading and solvent wiping but the surface must be cleaned as per Clause 10.5.1 before overcoating.

18 CATEGORY C - COAL TAR EPOXY BASED SYSTEMS

Preamble: Coal tar epoxy and urethanes are modified with selected grades of coal tar (imported source only) to reduce the costs and enhance certain properties such as waterproofing and chemical resistance characteristics. Some of the coal tar components react with the curing agent but some act as a diluent which imparts thermoplastic (softens with heat) properties to the coating

THE COAL TAR EPOXIES RECOMMENDED ARE SOLVENT BASED. They can therefore retain solvent if the materials are sprayed too thickly. The precautions given in Section 11.2 must be applied to these coatings. Due to their tendency to bloom within 24 hours, the surface preparation and over coating are all the more critical

As the coal tar is permanently soluble, 'bleeding' occurs when over coated with solvent based paints.

Coal tar epoxies have good water and dilute acid resistance and are very suitable for items such as rake arms in clarifiers. Coal tar repels root growth; hence these coatings are suitable for exterior buried pipe protection.

18.1 SYSTEM C1 SOLVENT BASED COAL TAR EPOXY ON METAL SURFACES

Material used shall be a *high build two component solvent based coal tar epoxy* composition using only selected imported coal tar.

The system

(i) Prepare surfaces as specified in Clause 10.5.1 or 10.5.2 as appropriate

(ii) Apply three to four coats of the *coal tar epoxy* material, mixed as recommended by the manufacturer and within his specified over coating times, as required to give a total dry film thickness not less than 300 microns. Should the overcoat time be exceeded, the surface shall be prepared as specified in Clause 10.11 before overcoating. Each coat shall be applied to a thickness not less than the minimum nor greater than the maximum recommended by the manufacturer

Requirements

The coating system shall be smooth, semi-glossy, free from orange peel effect, bubbling or excessive runs and sags or other visible defects

The dry film thickness shall be minimum 300, maximum 600 microns

The intercoat adhesion between layers shall be proven by a suitable adhesion test (ISO 2409)

The coating shall be free from electrical insulation defects when tested with an approved wet sponge detector set to operate at 90 Volts, 2 Megohms. Repair of defects is permissible provided that the repaired area complies with all the requirements given above

The film examined in cross section shall not exceed the porosity of scale 2 as given in the Canadian Standards Association CAN/CSA-Z245.20-M86 Section 12.11

19 CATEGORY D - VINYL BASED SYSTEMS

Vinyl resin based paints (the medium shall not contain alkyd resin or other saponifiable matter) are solvent based, single component materials with excellent resistance to water, dilute acids and hypochlorites. Their resistance to heat is poor and must never be used on surfaces continually operating at 70°C or higher. They are not resistant to solvents and should not be used where there may be contact with oils, fats, kerosene, petrol etc

The main advantage of vinyls is their easy maintainability. Vinyls may be recoated after any period of time, provided that the surface is cleaned, and is free from chalking, dust, grease and general grime. Because they are soluble in their own solvents, the under layers are quickly softened by over coating. Experienced operators using special techniques must be employed when brushing

Vinyls are therefore recommended for interior and exterior use where they are subject to chemical fumes, as in chlorination rooms. For exterior use the topcoat may be modified with acrylic resin for improved colour retention. Such modified types usually have a semi gloss finish rather than full gloss

19.1 SYSTEM D1 VINYL ON BARE STEEL OR CAST IRON SURFACES

Material shall be solvent containing, based on *polymerised vinyl chloride / vinyl acetate copolymer* or *vinyl chloride / iso-butyl ether resins*. The material shall not contain alkyd resin or other saponifiable matter. For exterior use, the final coat may be modified with acrylic resin to give improved gloss and colour retention

The system

(i) Prepare surfaces by blast cleaning as specified in Clause 10.5 to achieve a surface not less clean than Sa 2 ½ and a profile of 25 to 50 microns (fine)

(ii) Apply one coat of the manufacturer's recommended primer for vinyl systems to a dry film thickness not less than 40 and not greater than 80 microns. Allow 16 hours to dry, or longer in humid conditions

(iii) Apply one coat of *high build vinyl intermediate coat* to a dry film thickness of not less than 60 or greater than 80 microns

(iv) Apply one or two coats of *vinyl enamel* to a dry film thickness of not less than 25 or greater than 35 microns per coat

(v) On completion of installation and all repairs on site, apply one additional coat of vinyl enamel

Requirements

The coating system shall be smooth, uniform, glossy or semi-glossy, free from excessive runs, sags, blisters, wrinkling or other visual defects. The total dry film thickness shall be not less than 125 nor greater than 195 microns

19.2 SYSTEM D2 VINYL ON PAINTED OR PLASTIC ITEMS IN CHLORINATION ROOMS

Material used as a primer/barrier coat shall be a *water based epoxy (two pack)* or *styrenated acrylic primer (single pack)*. Being water based, the drying time is extended in humid conditions. Care shall be taken to avoid excessive film thickness and to allow adequate drying time before overcoating. Full drying and coalescence throughout the thickness of the film is essential. Do not apply at temperatures below 5°C or where such temperatures are likely to be encountered before full cure. Do not apply to wet surfaces

The system

(i) Prepare surface by abrasion and removal of oil, grease and dust as specified in Clause 10.11 or 10.12, as appropriate

(ii) Apply one coat *water based primer* to give a dry film thickness not less than 25 and not greater than 50 microns

Allow a minimum of 16 hours to cure before overcoating. Since this material is water based, drying time will be extended under humid conditions

(iii) Apply one coat *vinyl intermediate coat* to a dry film thickness of not less than 60 or greater than 80 microns

(iv) On completion of installation and all repairs on site, apply one or two final coats of vinyl enamel to a dry film thickness of not less than 25 or greater than 35 microns per coat in the colour selected by the Engineer, complying with the requirements stated in Section 19 above.

Requirements

The total dry film thickness shall be not less than 110 or greater than 165 microns

When required for protection on pre-primed or painted components such as valves, the full system as above shall be applied, when the total coating thickness shall be not less than 100 microns.

(When required on plastic items such as pipes, for identification purposes only, the above system may be used but it is simpler to use an appropriate coloured self adhesive vinyl or polyurethane tape, as specified by the Engineer. In this case the tape shall be applied uniformly to the surface, with uniform width of overlaps.

19.3 SYSTEM D3 VINYL ON GALVANIZED STEEL

Material used as primer shall be a *solvent based two pack epoxy* based primer specifically designed for use on galvanized steel

The system

(i) Prepare surface as specified in Clause 10.5.3

(ii) Apply a *solvent based two pack epoxy primer* specifically designed for galvanised steel to the clean surface at a thickness within the range specified by the paint manufacturer. Correct overcoating time for the prevailing ambient conditions is important

(iii) Apply one coat *vinyl high build intermediate coat* at a dry film thickness not less than 60 or greater than 80 microns. Allow not less than 16 hours before overcoating

(iv) Apply one coat *vinyl enamel* at a dry film thickness not less than 25 or greater than 35 microns

Requirements

The finished system shall be smooth, glossy or semi- glossy, free from excessive runs, sags, blisters, wrinkling or other visual defects

The total dry film thickness over the galvanizing shall be not less than 125 or greater than 195 microns

19.4 REPAIR OF VINYL SYSTEMS

Since there is no chemical cure of vinyl systems, abrasion of exposed steel only is required for repair. Wash the old coating with detergent and water (do not use emulsion degreasers). Rinse with clean water. Abrasion and solvent wiping of the coating are unnecessary and shall not be carried out. Abrade any exposed metal and feather the edges. Remove all debris by brushing with a clean dry brush

Apply the specified primer to bare steel, followed by the number of coats to restore the damaged area to meet the requirements of the appropriate specification.

NOTE: the topcoat shall not be applied directly to the steel without the use of the primer!

20 CATEGORY E SOLVENT FREE EPOXY, EPOXY PHENOLIC AND POLYURETHANE SYSTEMS

These materials consist of two components, base and activator which must be mixed prior to application in the correct proportions as supplied by the manufacturer.

The rate of cure can be designed to be slow for hand application or fast for machine application, taking into consideration the ambient temperature. The faster the cure, the shorter the touch dry time but the potlife of the mixed material will also be shorter.

The slower the cure, the longer the touch dry time but the potlife of the mixed material will be longer. The potlife is designed for the mass of the material to be mixed at one time and the method of application.

The slower curing epoxies can be premixed and sprayed through airless spray equipment. The faster curing epoxies and polyurethanes can only be applied through specialized dual component equipment, by contractors with the necessary know-how.

Solvent free materials may be applied in thick coats, hence only one or two applications are necessary to achieve the specified coating thickness. The dangers of solvent entrapment described in Clause 11.2 are therefore eliminated.

An important difference between epoxies and polyurethanes is that the latter can cure at sub-zero temperatures whereas epoxies require temperatures above 0ºC.

Both types can be formulated to produce varying degrees of hardness, flexibility and chemical resistance. Epoxies generally have excellent adhesion due to their highly polar nature. The bisphenol F/novolac phenolic epoxies cured with modified amines are available in solvent free form and provide outstanding resistance to many aggressive chemicals, including concentrated inorganic acids

Solvent free polyurethanes may be divided into two main classes although there may be wide variations depending on the particular formulation used. The two main classes are:

Elastomeric types, similar to rubber; these have very high flexibility and outstanding resistance to abrasion, but rather poor water resistance. When used on steel, the manufacturer's recommended primer must first be used. These are applied by casting, or, in the case of pipe lining, by spin casting

Semi rigid types, whose flexibility is much greater than epoxies but much less than the elastomeric polyurethanes,. However, their water resistance and chemical resistance is superior to the elastomeric types, hence they are used where corrosion protection is the primary consideration.

Specialized primers are recommended for polyurethane coatings applied to steel and mineral substrates.

Because solvent free materials require specialist application, only contractors with sophisticated equipment, facilities, quality control and experience, will be considered

20.1 SYSTEM E.1 SOLVENT FREE EPOXY

Material shall be based on *liquid epoxy resins* and shall comply with the requirements of SANS 1217 Type 1C. When used for potable water it shall also be non-toxic and non-tainting (See Clause 3.3 of SANS 1217). When required, the contractor shall obtain and submit to the Engineer acceptable certification of non- toxicity and non-tainting properties

The system

(i) Prepare surfaces as specified in Clause 10.5.1 or 10.5.3 as appropriate, to achieve a blast cleaned surface of cleanliness Sa3, a profile of 50-100 microns, dust quantity rating of no greater than 2 (Figure 1 - ISO 8502-3:1992) and soluble salts not more than 100mg/m^2 (Weber Rielly Test)

(ii) Apply one or two coats of *solvent free epoxy*, using appropriate equipment as described in Clause 27.5, as per the coating manufacturers prescribed method.

Requirements

The finished coating shall be smooth, uniform, glossy, free from orange peel effect, excessive runs and sags, blisters or other visual defects

The dry film thickness shall be not less than 300 or greater than 500 microns

The coating shall be free from electrical insulation defects when tested with a wet sponge detector, operated in accordance with Clause 8.12.1 of SANS 1217, using a potential of 90 volts and a sensitivity of 10 Megohms

The film examined in cross section shall not exceed the porosity of scale 2 as given in the Canadian Standards Association CAN/CSA-Z245.20-M86 Section 12.11

Repair procedure

The general procedure given in Clause 10.11 shall be followed, using a repair material recommended or supplied by the manufacturer of the solvent free epoxy material. The guidelines of the manufacturer's data sheet must be exactly followed. It is important that, for surfaces to be immersed, that the abraded, prepared area is not overlapped beyond the abraded area viz. a ‘ring’ of abraded coating must surround the repair.

20.2 SYSTEM E.3 SEMI-RIGID POLYURETHANE FOR UNDERWATER & MILDLY ABRASIVE CONDITIONS

Materials

The primer shall be suitable for steel and for the polyurethane material and be supplied by the manufacturer of the coating material. The coating material shall be a *solvent free, two component, semi-rigid polyurethane* based on polyether type polyol and aromatic isocyanate to reach the following requirements:

Tensile strength at 3mm thickness	(ASTM D 638)	> 15 MPa
Adhesion to correctly primed steel	(SABS Method 776)	> 10 MPa
Direct Impact resistance	(ASTM G 14)	> 9 Joules
Dielectric Strength	(SABS 1217)	> 20 kV/mm
Elongation at break	(ASTM D 638)	> 25%
Compressibility	(ASTM G-695)	> 25 MPa
Surface hardness of 5mm thick sample	(Shore 'D')	> 60& < 80
Water Vapour Permeability	(ASTM E-96)	<0,5g/24h/m²/mm
Cathodic disbonded area after 30 days	(ASTM G-8 Method A)	<500 mm²

The adhesive shall be a low viscosity polyurethane adhesive designed to maximise adhesion between cured polyurethane and freshly mixed polyurethane. It is required for repair of cured solvent free polyurethane systems

The system

(i) Prepare surfaces as specified in Clause 10.5.1 or 10.5.3 as appropriate, to achieve a blast cleaned surface of cleanliness Sa3, a profile of 50-100 microns, dust quantity rating of no greater than 2 (Figure 1 - ISO 8502-3:1992) and soluble salts not more than 100mg/m^2 (Weber Rielly Test)

(ii) Apply the *metal primer* recommended by the manufacturer to his specified thickness

(iii) Within the manufacturer's recommended over coating time, apply the specified thickness of *solvent free, semi-rigid polyurethane* by means of an airless spray machine fitted with metering pumps to ensure the correct mix ratio at the spray head. A qualified mechanic shall supervise the operation of the machine during spraying. The Contractor may be required to demonstrate to the Engineer that the machine is delivering components in the correct mixing ratio. Regular dismantling and cleaning of the machine is necessary to ensure correct volume ratios

Requirements

The coating shall be smooth, glossy, free from pinholes, excessive orange peel effect, bubbling, or excessive runs or sags. The coating shall be carefully examined after 24 hours cure for blisters and any uncured layers caused by blockages in the spray machine.

The dry film thickness shall be not less than 1,0mm

The coating shall be free from electrical insulation defects when tested with a high voltage holiday detector set at 5 kV and used in accordance with SANS 1217

The film examined in cross section shall not exceed the porosity of scale 2 as given in the Canadian Standards Association CAN/CSA-Z245.20-M86 Section 12.11

20.3 SYSTEM E.4 ELASTOPLASTIC POLYURETHANE, UNDERWATER; ABRASIVE CONDITIONS

Materials, system and **requirements** as for E.3, except that the coating thickness shall be not less than 2mm and there shall be no electrical insulation defects when tested with a high voltage holiday detector set at 10 kV

20.4 REPAIR PROCEDURE FOR POLYURETHANE SYSTEMS

Since polyurethane systems are chemically cured, very thorough abrasion of damaged or defective coating is required to ensure an adequate physical bond. If repair is carried out within 16h* of application of the last coat of polyurethane, abrade the surface with abrasive paper. Wipe free from dust and debris and then apply brush grade polyurethane, thoroughly mixed in the correct proportions, in as many coats as are required to achieve the specified thickness and freedom from holidays.

If repair is carried out later than 16h after application of the last coat, abrade the surface as above, remove debris, then apply the manufacturer's adhesive, thoroughly mixed in the correct proportions in a very thin layer, to the abraded surface only, NOT on any un-abraded area. Allow not less than 30* minutes nor more than 4h before application of brushing grade polyurethane, thoroughly mixed in the correct proportions, to the total thickness and freedom from electrical insulation defects as required by the relevant specification

*at 25°C and not more than 70%RH - as over-coating times are critical to achieve good adhesion, the manufacturer’s advice must be sought on every application.

20.5 SYSTEM E.6 SOLVENT FREE CERAMIC FILLED HIGH ABRASIVE EPOXY LINING SYSTEM

Material shall be based on a high performance, solvent free, ceramic filled epoxy coating designed for use as a resurfacing and lining system to improve the efficiency in fluid flow environments

The system

(i) Prepare surfaces as specified in Clause 10.5.1 or 10.5.3 as appropriate, to achieve a blast cleaned surface of cleanliness Sa3, a profile of 50-100 microns, dust quantity rating of no greater than 2 (Figure 1 - ISO 8502-3:1992) and soluble salts not more than 100mg/m^2 (Weber Rielly Test)

(ii) Apply one or two coats of a *solvent free ceramic filled epoxy*, using appropriate equipment and methods as described in the manufacturers Technical Data Sheet

Requirements

The finished coating shall be smooth, uniform, glossy and free from orange peel effect, excessive runs and sags, blisters or other visual defects

The dry film thickness shall be not less than 500µm or greater than 2mm

The coating shall be free from electrical insulation defects when tested with a wet sponge detector, operated in accordance with Clause 8.12.1 of SABS 1217, using a potential of 90 Volts and a sensitivity of 10 Megohms

The film examined in cross section shall not exceed the porosity of scale 2 as given in the Canadian Standards Association CAN/CSA-Z245.20-M86 Section 12.11

20.6. SYSTEM E.7 SOLVENT FREE EPOXY PHENOLIC FOR STEELWORK AND EQUIPMENT IN CHEMICAL ENVIRONMENTS

Material shall be based on a high performance, solvent free, epoxy/phenolic coating designed for use in corrosive chemical environments

The system

(ii) Prepare surfaces as specified in Clause 10.5.1 or 10.5.3 as appropriate, to achieve a blast cleaned surface of cleanliness Sa3, a profile of 50-100 microns, dust quantity rating of no greater than 2 (Figure 1 - ISO 8502-3:1992) and soluble salts not more than 100mg/m^2 (Weber Rielly Test)

(ii) Apply two or three coats of a *solvent free epoxy phenolic coating*, using appropriate equipment and methods as described in the manufacturers Technical Data Sheet.

NOTE: The overcoating times, as recommended, shall be strictly adhered to.

Requirements

The finished coating shall be smooth, uniform, glossy and free from orange peel effect, excessive runs and sags, blisters or other visual defects

The dry film thickness shall be not less than 300µm or greater than 500µm

The coating shall be free from electrical insulation defects when tested with a wet sponge detector, operated in accordance with Clause 8.12.1 of SABS 1217, using a potential of 90 Volts and a sensitivity of 10 Megohms

The film examined in cross section shall not exceed the porosity of scale 2 as given in the Canadian Standards Association CAN/CSA-Z245.20-M86 Section 12.11

21 CATEGORY F POWDER COATINGS

POWDER COATING may utilize a very wide range of materials, which may be broadly classified as follows :

Thermoplastic; such as Nylon, PVC, polyethylene, ethylene vinyl acetate, etc. These have the property of not changing their chemical composition during heating and cooling. They may therefore be reheated to become plastic or cooled to become solid as many times as may be necessary.

Generally the thermoplastic materials are applied in thicker coats than thermoset and have relatively poor adhesion; hence they are used primarily for articles that can be fully encapsulated.

Nylon (e.g. '*Rilsan*') has good exterior exposure resistance and excellent resistance to wet abrasion. It is semi-flexible in nature and therefore has good impact resistance. A primer is required for all applications and adhesion with use of the primer is good. The dip application into a fluidized bed is ideal for small diameter pipes and ensures complete coverage at film thicknesses of 300 microns. Facilities for coating items up to 6 metre x 900mm are available in South Africa.

Thermoset; such as epoxy, polyurethane or polyester. On heating these powders melt, flow out to a thin film, then change chemically during the heating cycle so that, when cooled, they can no longer be melted by heat. It is therefore important that these materials go through the complete curing process during heating, otherwise they will not give the required performance

The thermoset materials are harder, are more resistant to impact damage and exhibit good adhesion but correct application is essential to ensure full cure

Incorrect curing time or temperatures are responsible for the largest proportion of defects in powder coating application. Articles of high mass, such as castings, are particularly susceptible and the surface temperature of the article to be coated should always be measured and controlled. Improper curing results in brittle, solvent sensitive coatings and may show up as pinholes and bubbles in the coating, or it may not be visually detectable but results in poor performance. Improper curing of thermoset materials can be confirmed by laboratory test procedures on flakes of coating

For exterior use in South African conditions, exterior grade polyester powders are preferred for their excellent gloss and colour retention on exposure.

For immersion service in water, epoxy powders are preferred

Design is important when items are to be protected by powder coatings. Corners are difficult to coat and sharp edges must be avoided. Powder coatings generally have very high cohesive properties and do suffer from weak spots at sharp edges, especially the thermoplastic materials. The Designer should aim for a 'cocoon effect' that encapsulates the item in an even thickness of the powder coating. Design of items to be coated by fluidised bed techniques must ensure no 'traps' that may cause build up of powder on horizontal surfaces.

The application of powder coatings shall only be carried out by specialist contractors with the necessary plant, facilities and experience to carry out such work. Full details of cleaning method, type of powder to be used, type of primer to be used, method of application, cure cycle and coating thickness shall be supplied to the Engineer

21.1 SYSTEM F.1 FUSION BONDED EPOXY (FBE) PIPE COATING

Material shall be based upon *thermosetting epoxy resin pipe coating powder* and shall comply with the requirements of SANS 1217 Type 2*. When used for potable water, it shall also be non- toxic and non-tainting (See Clause 3.3 of SANS 1217). When required, the contractor shall obtain and submit to the Engineer acceptable certification of non-toxicity and non-tainting properties.

*SABS 1217 Edition 1.3 is still in use.

The system

(i) Prepare surfaces by blast cleaning as specified in Clauses 10.5 to Sa 3 finish

(ii) Apply a *silico-chromate metal pre-treatment* to an approved method prior to heating the item

(iii) Heat the component to the temperature recommended by the powder manufacturer (usually 220°C) and apply powder by electrostatic powder gun, by fluidised bed, or by electrostatic fluidised bed techniques to achieve adequate wetting of the surface and flow out to a smooth, uniform finish, complying with all the requirements given below

The applied powder shall be fully cured, either by residual heat, or by post curing (depending upon the powder formulation and heat capacity of the component), to meet the requirements given below

Requirements

The finished coating or lining shall be smooth, uniform, glossy or semi glossy, free from over spray, blisters or other visual defects

The dry film thickness shall be not less than 400 or greater than 600 microns

The coating or lining shall be free from electrical insulation defects when tested with a DC high voltage spark tester in accordance with SABS 1217, using a potential of 3.5 kV

The film shall be fully cured and shall show no softening or discolouration of the swab when tested for M.E.K. resistance in accordance with SANS 1217 Clause 8.9. In cases of dispute, degree of cure shall be determined by Differential Scanning Calorimetry, using the method described in British Gas Specification GBE/CW6, Part 1, Appendix B.2, when the difference in Glass Transition Temperature between the two runs shall not exceed 3°C

Impact Resistance of the applied coating or lining, when tested by ASTM G14 on a rigid substrate, shall be not less than 8 Joules. NOTE: large diameter and low wall thickness pipes must be supported internally at the point of impact to provide a rigid surface

Cathodic disbonding, when tested by ASTM G-8 Method B, for a period of 30 days, shall not exceed 500 mm^2, nor shall current flow at the end of test period, exceed 5 mA

The film examined in cross section shall not exceed the porosity of scale 2 as given in the Canadian Standards Association CAN/CSA-Z245.20-M86

21.2 SYSTEM F3 EXTERIOR DURABLE POLYESTER COATINGS ON PRIMED GALVANIZED STEEL FOR EXTERIOR USE

The system is intended for exterior use on galvanized sheet steel articles in corrosive environments. A primer designed for use on galvanized steel is required. *Exterior durable polyester powder* is preferred to give maximum gloss and colour retention on exposure to sunlight

Surface Preparation

The surface shall be chemically treated by a proprietary process to remove oil, grease and white rust and to leave a fine crystalline zinc phosphate surface layer

(If the surfaces to be coated are not going to be pre-treated by means of a chemical conversion, then the metal must be absolutely clean, and dry. If traces of white rust are present, it is recommended that these be removed by wire brushing prior to degreasing, to ensure the best possible corrosion protection and then, after degreasing, be lightly abraded with Scotchbrite®, to remove the oxide layer.)

Material shall be a *thermosetting exterior durable polyester powder* complying with SANS 1274 Part 6

Primer: A *twin pack Epoxy Strontium Chromate primer* shall be used on the prepared galvanized surfaces.

Apply by conventional liquid spraying equipment a mist coat of thinned *Epoxy Strontium Chromate Primer* to a dry film thickness of 10 - 20 microns.

Air dry for 60 -120 minutes to allow solvents to evaporate before over-coating with powder. Do not bake or allow the primer to cure for more than 4 hours.

The powder and the primer can then be baked together at the normal curing schedule for the powder coating in use.

Alternatively;

Use an approved 7 stage immersion tank pre-treatment process followed by application of an approved powder primer to a dry film thickness of 50 microns

Powder Application

The materials shall be applied and heated for the time and temperature cycle in accordance with the manufacturer's instructions

Requirements

The coating shall be smooth, glossy, free from over spray, blisters and other visual defects.

The dry film thickness shall be not less than 700 nor greater than 115 microns. The film shall be fully cured. It shall show no softening or discolouration, nor shall the swab show any significant discolouration, when tested with a cotton wool swab soaked in MEK for a contact time of 2 minutes. In cases of dispute, degree of cure shall be determined by Differential

Scanning Calorimetry, using the method described in British Gas Specification GBE/CW6 Part 1, Appendix B.2 when the difference in Glass Transition Temperature between the two runs shall not exceed 3°C

The coating system shall exhibit excellent adhesion when tested by the ISO 2409 method

21.3 SYSTEM F4 EXTERIOR DURABLE POWDER COATING ON EXTERIOR ARCHITECTURAL ALUMINIUM

The system is intended for use on architectural aluminium such as window frames, where colour and colour retention as well as chemical resistance are required

Material

Material shall be based on a *thermosetting polyester powder* complying with SANS 1578-Durable organic powder for coating of external architectural aluminium - Part 1 - Powder

The process

(i) Prepare surfaces by a multi stage chemical spray pre-treatment as specified by the manufacturer

(ii) Apply the powder by electrostatic powder gun to achieve adequate coverage of the surface

(iii) Heat the coated component in a suitable oven to achieve the curing temperature and time recommended by the manufacturer

Requirements

The applied powder shall be fully cured to meet the requirements of the SANS 1796 – Coatings of durable organic powder for external architectural aluminium.

21.4 SYSTEM F5 *SINTACOTE* - SINTERED LOW OR MEDIUM DENSITY POLYURETHANE PIPECOATING

This system has been in use in South Africa for the last 15 years with good success. It consists of a low or medium density polyethylene powder that is applied to the preheated pipe by the fluidised bed process. The coating thickness is in the order of 2 - 3 mm; hence additional rock guard is only necessary in very rocky terrain. Due to the complexity of the application of the powder, it is only practical for fairly long pipelines and is not generally an off-the-shelf item

Material

Material shall be low (or medium when available) density *Polyethylene powder* complying with the requirements of ASTM D-1248, Type 1, Category 3, modified to give improved ultra violet light resistance

Surface Preparation

Blast clean to minimum Sa 2 ½, remove dust and debris

Primer

No primer is required

Powder Application

Powder shall be applied by rolling the pipe preheated to a surface temperature of 350°C by means of a special mandrel in a fluidised bed of powder. The contact time shall be sufficient to ensure adequate film build.

Requirements

The coating shall be smooth, uniform, semi-glossy and free from dry powder, blisters and other visual defects. The dry film thickness shall be not less than 1.5mm. The coating shall comply with all the requirements of Australian Specification AS 2518

When tested with a high voltage EID detector operated at a test voltage not less than 5 kV over 100% of the surface, there shall be no defects. Defects found during Quality Control may be repaired provided that such defects do not exceed 1 per m^2 and that the repaired area meets all the requirements of the specification.

The film examined in cross section shall not exceed the porosity of scale 2 as given in the Canadian Standards Association CAN/CSA-Z245.20-M86 Section 12.11

21.5 SYSTEM F6 TWO LAYER - EPOXY ZINC RICH POWDER PRIMER OVERCOATED WITH A POLYESTER POWDER DESIGNED FOR EXTERIOR USE

The system is intended for use on mild steel interior, mildly corrosive conditions or exterior conditions where additional corrosion resistance is required.

Material shall be double powder coating - firstly a *zinc rich epoxy powder primer* overcoated with a *polyester powder coating* designed for an exterior environment.

The process

Preparation - Steel > 2mm thickness: Prepare the surface as per Section 10.5 - abrasive blast to a low profile (Refer 10.7.2)

Steel < 2mm thickness: Degreasing and phosphating followed by passivation, rinsing with demineralised water and drying. Follow the procedural advice of the chemical pre-treatment suppliers.

Primer application

The steel prepared as above shall be primed using a *thermosetting epoxy*, rich in zinc - designed as an anti-corrosive primer undercoat for powder topcoats. The primer shall be applied and cured exactly according to the manufacturer's recommendations.

Topcoat application

Within 4 hours of applying the primer coat (refer manufacturer's instructions for delays exceeding 4 hours) the topcoat of *polyester powder coating* designed for exterior environments shall be applied. To ensure the integrity of the system the whole system must be cured in accordance with the recommended curing conditions for the topcoat*.

*Note: Failure to comply with the final curing conditions may cause variations in colour and gloss and cause degradation of the coating properties of the system.

Requirements

The coating shall be smooth (the primer layer is slightly granular), slightly stippled film, glossy, free from over-spray, blisters and other visual defects.

The combined film thickness shall be 120 - 150μm

The film shall be fully cured. It shall show no softening or discolouration, nor shall the swab show any significant discolouration when tested with a cotton wool swab soaked in MEK for a contact time of 2 minutes. In cases of dispute degree of cure shall be determined by Differential Scanning Calorimetry, using the method described in British Gas Specification GBE/CW6 Part 1, Appendix B.2 when the difference in Glass Transition Temperature between the two runs shall not exceed 3°C

Impact resistance according to ISO 6272-1 shall pass 0.5kg.m (the system).

Adhesion according to ISO 2409 - 2mm cross hatch on the system shall not exceed 0

22 CATEGORY G TAPE WRAPPING SYSTEMS

Tape wrapping is a method of corrosion protection used primarily for underground pipes and their ancillaries such as couplings, valves, etc. The method is used primarily on site although for certain types, wrapping can be carried out on individual pipes at a factory or site yard. There are many types of tape but for the purposes of this specification, only two types are given, namely petrolatum tape and rubber modified bitumen with polyethylene outer coating

General

Prior to the Contractor commencing work he shall obtain clearance in writing from the Engineer that all necessary investigations for soil resistivity and stray current electrolysis have been carried out and that, where required, continuity bonds and anode cables have been correctly installed

Surface Preparation

Items to be wrapped to this specification shall be cleaned manually or mechanically in accordance with Clauses 10.5.1 and 10.5.2 to achieve a cleanliness of minimum St 2 of ISO 8201-1

Primer

The primer shall be supplied by the tape manufacturer for the specific tape to be used. It shall be applied in a uniformly thin film, free of runs and sags. The pipe surface shall be entirely covered and shall be dry to the “tacky to touch” stage at the time of tape wrapping application. Uncoated, flooded, or areas primed over improperly cleaned pipe, shall be thoroughly cleaned to the satisfaction of the Engineer and re-primed

Application

Straight runs of pipe shall have the tape spirally wrapped with a manual or power driven wrapping machine. Short lengths, couplings and valves may be wrapped by hand. The tape shall overlap the preceding spiral by a minimum of 25 mm, more usually by an overlap of 55% of the tape width. The inner and outer tape layers, where applicable, shall be applied in such a manner that the overlaps of the layers do not coincide. The tape shall be kept under constant tension to ensure a uniform, tightly adhered coating, free of wrinkles, puckers, voids and bubbles. Care shall be taken to assure that the overlap is maintained.

Tape Joins and Repairs

When making a tape join during hand-wrapping or hand-operated wrapping machine operations, make a complete turn from the new roll over the wrapping previously applied. In the case of line-travel machines where reversing is difficult, pull sufficient tape off the roll to enable the new roll end to be so positioned as to allow at least one full turn over the previously applied wrapping

Ensure that all joins are free from wrinkles and folds and all old roll ends free from delaminated cardboard core material. Where damage to the wrapping on a pipeline has occurred and where there are creases, wrinkles and folds in the wrapping, proceed as follows:

(i) If the width of the tape being used exceeds by at least 100mm the length of the section affected, cut the area of damaged wrapping away to bare metal leaving no raised edges or protrusions. Liberally prime the "window" thus exposed and apply a patch of tape, ensuring an overlap of the patch of at least 50mm on all sides onto the surrounding wrap. Apply primer (where applicable) over the patched area and, using a 55% overlap, apply by hand-wrapping a further layer of tape, commencing two turns before and continuing for two turns beyond the patch.

(ii) Where the extent of damaged or faulty wrapping is such that the tape cannot span the affected area and provide a 50mm overlap on all sides, completely remove the wrapping from the pipe over the affected section, clean, re-prime and using a 55% overlap, re-wrap the pipe, commencing two complete turns before and finishing two turns beyond the bared section

(iii) Where damage or a defect has occurred in a section that has been double wrapped and in the case of small holidays, use the appropriate procedure given in (i) or (ii) above

(iv) Where damage extends through an outer wrap/rockshield, this should be carefully removed for a distance equal to three times the width of the tape of the inner wrap on each side of the holiday without damaging the pipe wrapping, the repair carried out by the appropriate method given in (i) or (ii) above, and the outer wrap or rockshield suitably reinstated

Rockshield

Suitable rockshield shall be applied in accordance with SANS 10129 Section 6, when required by the Engineer

Backfill

Backfill adjacent to the coated and wrapped pipe shall be free of scraps, sticks, rocks, or other hard debris that may damage the coating

22.1 SYSTEM G1 PETROLATUM TAPE

Petrolatum is a stiff, grease-like material derived from the distillation of crude oil. It has been used for many years for corrosion protection of both underground and above ground surfaces in severe environments. By impregnating this material into synthetic fabrics, various tapes have been produced. Because the material is soft, the completed corrosion protection must be protected from mechanical damage by a suitable outer wrap such as polyethylene tape or sheet

The system

Single wrap and HDPE outerwrap

(i) Clean the pipe surface by manual or mechanical means as specified in Clause 10.5.1 and 10.5.2 to achieve a standard not less than St 2

(ii) Prime with the tape manufacturer's recommended *petrolatum primer* at a coverage rate specified by the manufacturer

(iii) All lengths of buried pipework are to be wrapped with *Petrolatum Impregnated Tape* of appropriate width. The tape shall be applied in a helical manner with a tape overlap of 25mm. The application shall be free of wrinkles, creases and air voids. Special care shall be taken to ensure that correct tension is used while applying the tape. All overlaps shall be suitably smoothed by hand to produce a smooth and continuous wrapping

(iv) On completion of the tape inner wrap, the pipework shall receive an outer wrap of HDPE pressure sensitive wrapping of appropriate width. The HDPE shall be applied in a helical manner, with a tape overlap of 25mm, or 55% of the tape width if additional thickness is required for the backfill material. The application shall be free of wrinkles, creases and air voids. Special care shall be taken to ensure that correct tension is used while applying this tape. In addition, the outer wrap shall be secured at 5 metre centres with suitable fastening / strapping to prevent excessive unwrapping in the event of accidental damage

Requirements

The wrapped pipe shall have a uniform appearance, free from bubbles, wrinkles, lifting at the overlaps, and other visible defects

The total thickness will vary considerably. A single wrap of petrolatum-impregnated tape will contribute 1.2mm per layer. A single layer of rockshield HDPE tape will contribute 300µm, i.e. total 1.5mm - 55% overlap effectively doubles this thickness.

22.2 SYSTEM G2 BUTYL RUBBER MODIFIED BITUMEN WITH POLYETHYLENE OUTER TAPE

Bitumen has been used for very many years for pipe coating but suffers some major disadvantages, particularly due to its high temperature sensitivity in South African conditions. By the addition of butyl rubber the properties have been modified to make the blend very suitable for the coating of buried pipes and pipelines. In combination with high density polyethylene, tapes with high bond strength, low water absorption, good UV resistance and unique plastic flow properties have been produced

The system

(i) Clean the pipe surface by manual or mechanical means as specified in Clause 10.5.1 and 10.5.2 to achieve a standard not less than St 2

(ii) Prime all surfaces with the manufacturer's specified primer, at the manufacturer's recommended coverage rate

(iii) Apply a *butyl rubber modified bitumen tape with polyethylene outer (butyl tape)* the tape in spiral fashion maintaining a minimum overlap of 25mm but may be up to 55%, according to the corrosivity of the soil. Care shall be taken to prevent air pockets and wrinkles. The tapes must be tensioned sufficiently to cause *slight* exudation of the bitumen mastic layer at the laps, *but not stretched*

(iv) Apply the outer wrap of modified *polyethylene / laminated pressure sensitive 'rockshield tape'* in a similar fashion, making sure that the overlaps of the outer wrap do not coincide with the overlaps of the inner wrap

Requirements

The wrapped pipe shall have a uniform appearance, free from bubbles, wrinkles, lifting at the overlaps, and other visible defects

The total thickness will vary considerably. A single wrap of 1mm thickness butyl tape will contribute from 1 mm per layer. A single layer of 'rockshield' outer tape will contribute 300µm, 55% overlap effectively doubles this thickness. The actual tape thicknesses to be applied in any given environment will be specified by the engineer.

22.3 SYSTEM G4 PETROLATUM INHIBITIVE PRIMER, FOLLOWED BY PETROLATUM MASTIC OR PETROLATUM BLANKET FOR FLANGES & COUPLINGS

(i) Clean the pipe surface by manual or mechanical means as specified in Clause 10.5.1 and 10.5.2 to achieve a standard not less than St 2

(ii) Prime with the tape manufacturer's recommended *petrolatum primer* at a coverage rate specified by the manufacturer

(iii) The entire item shall be packed using a *petrolatum mastic* to produce a smooth contour excluding all bubbles and voids

(iv) The mastic shall be carefully over-wrapped (so as not to distort the soft surface) with *petrolatum impregnated tape* of appropriate width. The tape shall be applied in a helical manner with a tape overlap of 25mm. The application shall be free of wrinkles, creases and air voids. Special care shall be taken to ensure that correct tension is used while applying the tape. All overlaps shall be suitably smoothed by hand to produce a smooth and continuous wrapping

(v). On completion of the petrolatum impregnated tape over-wrap apply a ‘rockshield’ HDPE tape or polyethylene layflat sheeting as recommended by SANS 10129 Section 5.3

Requirements of tape wrapped pipes and joints

Visual: The completed tape wrap system shall be smooth, uniform, with the specified overlap. It shall be free from bubbles, wrinkles, lifted edges and other visible defects

Thickness: The thickness of the tape wrap shall be not less than 80% of the specified number of layers multiplied by the manufacturer's specified thickness.

Holiday (E.I.D.) Detection: The whole surface of the pipe and couplings shall be tested with an approved high voltage holiday detector just prior to backfilling. The test voltage shall be not less than 50% nor greater than 80% of the breakdown voltage of the system. Breakdown voltage is given by the dielectric strength (kV/mm) of the tape, multiplied by the total thickness (mm). Generally, the test voltage will be not less than 18 kV

Holidays shall be marked out and repaired as specified. After repair, no holidays are permitted

23 SUMMARY OF COATING SYSTEMS

NOTE - These summaries are for ease of reference only. The contractor must comply with all the requirements given under SYSTEMS and in the GENERAL Clauses

CATEGORY A - ALKYD SYSTEMS FOR MILD ENVIRONMENTS

System	Substrate	Surface Prep	Coating System	Requirements
A1	bare steel	manual/ mechanical cleaning St 2 min.	1 coat high build primer for steel 1 coat alkyd enamel (interior) 2 coats alkyd enamel (exterior)	Smooth, glossy finish DFT interior - 65µm min DFT exterior - 80µm min
A2	primed steel	clean and touch-up	touch-up quick drying primer 1 coat high build primer all over 1 coat alkyd enamel (interior) 2 coats alkyd enamel (exterior)	Smooth, glossy finish DFT interior - 65µm min DFT exterior - 80µm min
A3	factory finished steel	abrade and clean	1 coat alkyd enamel (interior) 2 coats alkyd enamel (exterior)	Smooth, glossy finish DFT interior - 65µm min DFT exterior - 80 µm min
A4	galvanized steel	degrease and abrade	1 coat special primer 1 coat alkyd enamel	Smooth, glossy finish DFT over galv. - 75µm min
A5	plastic and bitumen coated	abrade and remove dust	1 coat water based primer 1 coat alkyd enamel	Alternative to tapes for colour coding

CATEGORY B - TWO PACK SOLVENT BORNE EPOXY AND POLYURETHANE SYSTEMS

System	Substrate	Surface Prep	Coating System	Requirements
B1	steel or cast iron	blast clean Sa 3, profile 50 - 100µm	2 -3 coats high build epoxy for underwater use	DFT min 300, max 450 µm no EIDs wet sponge 90v 2 Megohms
B1A	steel or cast iron	blast clean Sa 2½ profile 50 - 100µm	2 coats epoxy 2 coats recoatable polyurethane	DFT min 300, max 450 µm
B2A	galvanized steel	degrease and abrade	1 coat 2-pack special epoxy primer for galv steel 1 coat recoatable polyurethane	DFT min 150, max 250 µm over galvanizing
B3	steel or cast iron	blast clean Sa 2½, profile 50 - 100µm	1 coat HB epoxy primer 1 coat epoxy MIO int. coat 1 coat recoatable polyurethane	DFT min 255, max 400 µm
B4	steel or cast iron	blast clean Sa 2½, profile 50 -100µm	1 coat epoxy zinc rich primer (alt inorganic zinc) 1 coat epoxy MIO int. coat 1 coat recoatable polyurethane	DFT min 300, max 400 µm
B5	steel or cast iron	blast clean Sa 3, profile 50 - 100µm	1 coat epoxy phenolic primer 1 coat epoxy phenolic int. coat 1 coat epoxy phenolic topcoat	DFT min 250, max 400 µm no EIDs wet sponge 90v 2 Megohms
B6	factory finished steel	degrease and abrade	1 coat epoxy aluminium mastic 1 coat recoatable polyurethane	DFT min 165, max 200 µm

CATEGORY C - SOLVENT BORNE COAL TAR EPOXY SYSTEMS

System	Substrate	Surface Prep	Coating System	Requirements
C1	steel or cast iron	blast clean Sa 3	2 - 4 coats HB epoxy-tar	DFT 300, max 600 µm no EIDs wet sponge 90v 2 Megohms

CATEGORY D - VINYL SYSTEMS

System	Substrate	Surface Prep	Coating System	Requirements
D1	steel or cast iron	blast clean Sa 3	1 coat vinyl primer 1 coat HB vinyl intermediate 1 coat vinyl enamel	total DFT min 175, max 195 µm
D2	painted or plastic	degrease and abrade	1 coat water based primer 1 coat vinyl intermediate coat 1 coat vinyl enamel	DFT min 110 µm (on plastic pipes, coloured self adhesive tapes preferred)
D3	galvanized steel	degrease and abrade	1 coat 2-pack special epoxy primer 1 coat vinyl intermediate coat 1 coat vinyl enamel	DFT min 125 µm, max 195 µm

CATEGORY E - SOLVENT FREE EPOXY AND POLYURETHANE SYSTEMS

System	Substrate	Surface Prep	Coating System	Requirements
E1	steel or cast iron	blast clean Sa 3 profile 50 - 100µm	1 -2 coats solvent free epoxy for underwater use	DFT min 300, max 450µm no EIDs wet sponge 90v 10 Megaohms
E3	steel or cast iron	blast clean Sa 3 profile 50 - 100µm	1 coat special primer solvent free hybrid aromatic polyurethane	DFT min 1mm no blistering or uncured material no EIDs spark test 5 kV
E4	steel or cast iron	blast clean Sa 3 profile 50 - 100µm	1 coat special primer solvent free hybrid aromatic polyurethane	DFT min 2mm no blistering or uncured material no EIDs spark test 10 kV
E6	cast iron	blast clean Sa 3 profile 50 - 100µm	2 coats solvent free, ceramic filled highly abrasive resistant epoxy lining	DFT min 500, max 2mm no EIDs wet sponge 90v 10 Megaohms
E7	steel or cast iron	blast clean Sa 3 profile 50 - 100µm	2 -3 coats solvent free epoxy phenolic chemical resistant coating	DFT min 300, max 500 µm No EIDs wet sponge 90v 10 Megaohms

CATEGORY F - POWDER COATINGS

System	Substrate	Surface Prep	Coating System	Requirements
F1	steel pipes or cast iron	blast clean Sa 3 chemical treatment	fusion bonded epoxy pipe coating powder, applied by electrostatic spray	DFT min 400, max 600µm no EIDs high voltage 3.5 kV full chemical cure
F3	galvanized sheet steel	chemically clean and phosphate	liquid primer polyester powder	DFT min 50, max 100µm over galv. full chemical cure
F4	architectural aluminium	chemically clean SABS 1578	polyurethane powder SANS 1578 or BS 6496:1984	DFT 60 - 80µm SANS 1578 or BS 6496:1984 full chemical cure
F5	steel pipes (large bore)	blast clean Sa 2 ½	low density polyethylene powder, applied by fluidised bed	DFT min 1.5mm no EIDs high voltage 10kv Australian spec. as 2518
F6	steel or sheet steel	chemical clean or abrasive blast	zinc rich epoxy primer/ polyester powder for exterior exposure	DFT min 120µm - 150µm full chemical cure

CATEGORY G - TAPE WRAP SYSTEMS FOR PIPES AND PIPELINES

System	Substrate	Surface Prep	Coating System	Requirements
G1	steel and CI pipes and fittings	mechanical or manual clean min St 2	petrolatum primer petrolatum tape 55% overlap PVC or PE outer tape	DFT 1.5mm or higher to engineer's instructions no bubbles, wrinkles or lifting at overlaps no EIDs high voltage 18 kV
G2	steel and CI pipes and pipelines	mechanical or manual clean min St 2	rubber-bitumen primer rubber-bitumen tape polyethylene outer wrap	DFT min 1.3mm or higher to engineer's instructions no EIDs high voltage 18 kV
G4	flanges and couplings	mechanical or manual clean min St 2	petrolatum primer, then petrolatum mastic or blanket, polyethylene outer wrap	total encapsulation SANS 10129 Section 5.3

CIVIL AND ARCHITECTURAL COATING SYSTEMS

CONTENTS OF

CIVIL AND ARCHITECTURAL COATING SYSTEMS

24 GENERAL

The use of the coating systems given in the previous section, plus some systems applicable only to this section, are given as guidelines

The range of surfaces to be protected and the variation of exposure conditions are such that each plant must be considered as a unique installation

The recommendations given in this section shall be used if confirmed by the Engineer. The systems given in the Project Specification and drawings take precedence over the following recommendations

25 BUILDINGS

The contractor shall quote for the specification stipulated by the Engineer or Architect. Where alternative processes of equal technical merit are stipulated in the Project Specification, the contractor shall quote the lowest price in his tender and clearly state which system he intends to use. He may also offer his own alternative system in addition to his offer for the specified system, provided that he fully motivates the advantages of his system and supplies full technical details for evaluation by the Engineer

25.1 PAINTING WOODWORK

25.1.1 Softwood such as Pine

All wooden surfaces shall be planed and sanded to a smooth surface. Sanding debris shall be removed. Wood shall contain not more than 12% moisture before painting. Large or loose knots shall be removed and plugged with wood. When approved by the Engineer, large firm knots may be cut back below the surface and filled with approved acrylic resin based filler. The filler shall be allowed to dry fully and then sanded down to be flush with the surface. Small firm knots shall be sealed with shellac knotting or similar material that will seal without bleeding into the subsequent coats

System

The clean, dry, smooth surface shall be primed with primer for wood, aluminium base, complying with SANS 678 Type II

After at least 16 hours drying time, apply General Purpose Undercoat complying with SANS 681:1997 Grade 1

After a further minimum 16 hours drying, the surface shall be lightly sanded to remove nibs, dusted off, then one coat high gloss enamel complying with SANS 630 shall be applied

On exterior surfaces a second coat of high gloss enamel complying with SANS 630 shall be applied after 16 hours drying of the first coat

Requirements

The finished system shall be smooth, glossy and uniform in gloss and colour. It shall be free from nibs, occlusions, runs, sags, curtaining, blowholes, blisters or any other visible defect.

The colour shall be a close match to the colour specified by the Engineer

25.1.2 Hardwood, such as teak, oak, iroko etc

Surface Preparation

All hardwood shall be well sanded and dusted off and it shall be dry (not more than 12% moisture when tested with a suitable calibrated electrical conductance mater).

System

Any one of the following systems may be used provided that the contractor states in his tender document which system he intends to use and the reason for his choice

(i) The clean, smooth, dry surface shall be oiled with Pale Boiled Linseed Oil and rubbed well into the surface. The first coat shall be thinned with 10 to 15% Turpentine Substitute to aid penetration. All subsequent coats shall be applied neat. Apply copiously and after two hours, wipe off the surplus. Repeat the treatment after 48 hours and thereafter at weekly intervals for 5 or 6 weeks. The final application shall be followed with a brisk rub down with a soft cloth to produce a uniform sheen on the surface

(ii) The clean, dry, sanded surface may be treated with a preservative, developed by the Forestry Product Research Institute (USA) and approved by the Timber Section of SABS

Apply the preservative liberally by brush and allow to soak into the surface. Wipe off any runs or excess material and leave to dry for at least 48 hours. Apply a second coat uniformly and allow drying for a further 48 hours. Particular care shall be taken to preserve the end grain, where exposed, by thorough impregnation. This treatment requires a revival coat every two years

(iii) The clean, dry, sanded and de-dusted surface of the hardwood may be coated with at least two coats of clear moisture curing polyurethane, designed for use on hardwood, and applied in accordance with the manufacturer's instructions

Requirements

The surface shall have a smooth, uniform, high-gloss, semi-gloss or satin (as required by the Engineer) "luxury" finish, free from runs, sags, bubbles, milkiness or other visible defects and shall enhance the natural grain of the wood

25.2 PAINTING CEMENTITIOUS SURFACES

25.2.1 Ceilings

All gypsum plaster board ceilings, including cornices and cover strips shall be treated as follows:

(i) Nail heads shall be punched below the surface and spot primed with zinc phosphate primer for steel

(ii) Cracks, joints and depressions shall be filled with an approved acrylic based filler, to be slightly proud of the surface. After fully curing, the surface shall be sanded to a smooth finish flush with the surrounding area. Remove all dust and debris

(iii) Apply two coats interior quality synthetic polymer base emulsion paint complying with SANS 1586 Grade 3

25.2.2 Plastered and Concrete Surfaces

Walls shall be clean, free from oil and grease, shutter release agents, loose sand or friable surface layer

Interior surfaces - where indicated, shall be coated with two coats synthetic polymer base emulsion paint complying with SANS 1586, Grade 1 or Grade 2, as appropriate, for the colour selected. The first coat may be thinned if necessary, with not more than 10% water

Humid interior surfaces shall be treated as for exterior surfaces

Exterior surfaces - where indicated, be coated with two coats synthetic polymer base emulsion paint for exterior use, complying with SANS 1586 Grade 1. The first coat may be thinned, if necessary, to aid penetration with not more than 10% water

In either case, should the uniformity of colour and sheen be unacceptable to the Engineer, a third coat shall be applied at no extra cost

25.2.3 Fibre Cement Surfaces

Treat as for exterior plastered and concrete surfaces

25.3 PAINTING METALWORK

25.3.1 Non-galvanized

Non-galvanized window frames, door frames, steel doors, etc. shall be supplied coated with an acceptable factory primer

Window

Glazing shall be carried out in accordance with good practice, using glass as specified, well bedded in putty complying with SANS 680, self setting type. The putty shall be well worked before use to obtain adequate plasticity. On completion of glazing, the putty shall be well smoothed off, trimmed to a straight clean edge and sloping to an angle of approximately 60 degrees to the glass to ensure good water run off. Excess putty shall be removed from the window frame before painting. Putty shall not be painted less than 7 days after completion. All mortar splashes, putty, oil, grease, dirt and other contaminants shall be removed from the primed steel window frames

The window frames and putty in non-corrosive environments shall be prepared and coated as specified in Clause 16, using System A.3 (Alkyd System)

Window frames in chlorination rooms shall be prepared and coated as specified in Clause 19, using System D.2 (Vinyl System)

Structural Steel (internal corrosive conditions)

Steel in wet or chemically polluted environments such as chlorination rooms, shall be prepared and painted as specified in Clause 11, using System D1 (Vinyl System)

Structural Steel (immersed in water)

Immersed steel shall be prepared and painted as specified in Clause 17 using System B.1 (Two component solvent borne pure epoxy System)

Structural Steel in mild environments

Steel in mild environments shall be prepared and painted as specified in Clause 16, using System A1, A2 or A3, as appropriate

25.3.2 Galvanized

General - See Sub-Clause 10.7

Surfaces above water - Use System A.4, D.3 or B2A

26 BUND WALLS AND FLOORS

The coating must form a water impermeable tank with sufficient chemical resistance to withstand 40% Ferric Chloride solution and other aggressive chemicals. It must also have sufficient impact resistance that it will resist the impact of dropped hammers, spanners, delivery nozzles and the like. Complete sealing around entry and exit points of pipes, conduits, etc. is essential. This is normally carried out by the use of heavily filled two component epoxy grout. As with all coatings required to resist severe chemical exposure, correct surface preparation is essential. The surface must be dry before application of the coating system

Only specialist contractors may be employed for this work, as experience and technique are critical for successful results. The following is an abbreviated specification giving the essential stages only

Materials may be one of the following:-

An approved solvent free epoxy phenolic coating, resistant to 10% Hydrochloric Acid.

Use System B5, E7

In addition, glass fibre chopped strand mat and surfacing tissue made from 'C' glass, will be required. The primer to be used shall be as recommended by the manufacturer, compatible with the selected system and shall be low viscosity to penetrate the concrete

Surface Preparation

Acid wash all concrete surfaces with 10% hydrochloric acid to remove laitance, oil or grease and to achieve a surface profile provided by the aggregate. Water wash under high pressure to remove all loosened sand and soluble salts resulting from the acid etching process

A good drain of adequate capacity and approved for chemical cargo is essential. Wash until washings are free from soluble chlorides when tested with silver nitrate solution

Allow to dry thoroughly before coating

Procedure

Fill cavities or gaps with epoxy grout

Grind flush any protrusions

Prime all surfaces with low viscosity epoxy phenolic primer, depending on the system to be used

Lay up 300 g/m^2 of chopped strand C glass mat into either a special acid resistant solvent free epoxy phenolic coating.

Repeat once for epoxy phenolic coating to give a total glass content of 600 g/m^2.

Lay up glass fibre surfacing tissue with the appropriate resin

Apply one or two coats UV resistant polyurethane top coat, to give the colour required by the Engineer as well as resistance to UV light and the chemicals that may be contained in the bund (the pigment selected shall be resistant to acid)

Requirements

The coating system shall have a uniform appearance and colour approximating to that specified by the Engineer. The coating shall be well bonded to the substrate and shall be free from bubbles, occlusions and other defects detrimental to its performance. The coating system shall show no defects when tested over 100% of the coated area with a high voltage spark tester set at 10kV, or 50% of the breakdown voltage of the system, whichever is lower. Defects may be repaired by a method recommended by the resin manufacturer provided that the repair complies with the requirements of the specification

27 PIPES

Pipes may vary from very large to very small and may be constructed from a wide variety of materials such as mild steel, cast iron, concrete, fibre cement, glass reinforced plastic, etc. They may be exposed to a wide variety of environments from immersion in raw sewage to exposure to sunlight.

The recommendations in this specification cover only mild steel or cast iron pipes. For other types of pipe requiring lining and coating, separate specifications must be obtained

Pipes buried in aggressive soil require cathodic protection which is installed after the pipeline is laid and backfilled. If cathodic protection is considered, then steps must be taken to ensure continuity bonding across hydraulic couplings and valves chambers, or insulation where pipes join process vessels or leave the ground

27.1 FACTORY LINING AND COATING OF PIPES

The lining and coating of pipes is a specialized field of coating application, with specific requirements before, during and after coating. For this reason, only contractors with the necessary equipment, experience and Quality Control facilities will be considered for supply. Approval to ISO 9000 - 2000 is preferred

27.2 TYPES OF PIPE THAT MAY BE SPECIFIED BY THE ENGINEER.

Material may be mild steel or cast iron, in which case spheroidal graphite cast iron (S.G. iron) is preferred. Mild steel pipes may be seamless, longitudinally welded or spiral welded, as specified by the Engineer

Colour Coding, where required, shall be as specified in SANS 10140, Part 3

Pipes may be joined by flanges, flexible couplings or by circumferential welding or by proprietary jointing methods such as *Sintajoint*® or special bell and spigot type joint (*Hall Longmore Ltd*). The problem with all jointing methods is the treatment of the pipe ends and repair of the lining after joining on site

Circumferential welding is only recommended for pipes of nominal bore 450mm and over, unless an *in situ* pipe lining is employed, which is not covered in this specification

Bonding lugs shall be welded on to pipes where necessary for continuity bonding for cathodic protection

27.3 MECHANICAL PRE-TREATMENT BY THE PIPE MANUFACTURER

Pipes shall not be accepted for lining or coating, or both, unless they comply with the following requirements, which shall be notified to the pipe manufacturer

All weld spatter shall be removed by chipping or grinding to a smooth surface flush with the surrounding steel

All welds shall have a smooth contour, free from sharp edges, protrusions and undercuts. Longitudinally welded pipes shall have the internal weld scarfed flush with the wall of the pipe. No sharp edged projections are permitted

All sharp edges that are required to be coated shall be ground to a radius of curvature not less than 3mm

Hydraulic testing of the pipe shall be carried out after completion of the above processes

27.4 SURFACE PREPARATION BY THE LINING/COATING CONTRACTOR

The lining/coating contractor shall inspect pipes before surface preparation in accordance with Quality Control procedures to ensure that the requirements of 12.3 have been complied with

Degreasing Pipes shall be free from oil and grease. When necessary, local deposits of oil and grease shall be removed by the use of suitable solvents. In this case, care shall be taken to ensure that the contaminant is removed and not spread over a larger area. When pipes are extensively contaminated by oil or grease, they shall be completely degreased by one of the methods given in SANS 10064 Section 3

Blast Cleaning Pipes for lining or coating shall be blast cleaned by air blast or centrifugal equipment. Compressed air and abrasive shall be free from oil, grease and similar contaminants. The abrasive particle size and distribution shall be chosen to remove millscale and achieve the surface condition specified below:

Surface profile: 50 to 75 microns average, or ‘medium grade, when determined by ISO 8503 Part 2

For coatings exceeding 500 microns in thickness, the profile may be 50 - 150 microns or ‘course’, when measured as specified above

Cleanliness: Sa3 of ISO 8501-1

If laminations in the steel appear after blast cleaning, they shall be ground out and the ground area shall be blast cleaned. Where grinding is not practical or when the lamination requires grinding to a depth greater than 7% of the wall thickness, the pipe shall be rejected.

NOTE: Blast cleaning of CAST IRON PIPES requires that fine or medium grade mineral grit abrasives shall be used. Abrasive shall be new, unused and shall not be re-used. All sand particles, residual burnt on sand and casting skin shall be removed prior to galvanizing or painting

Removal of Dust and Debris Dust and debris from the blast cleaning process shall be removed by blowing with clean, dry compressed air, or preferably by vacuum cleaning, to achieve a residual dust and debris level not greater than Class 2 when tested by ISO 8502-3, or as agreed by the Engineer

Water Soluble Salts Surfaces to be lined or coated that will subsequently be immersed or buried shall show not more than 100 mg/m² soluble iron salts when tested with the Weber-Rielly Reagent

Masking of Ends to be Welded Pipes to be welded on site shall have the ends squared and machined to a 45° angle. After blast cleaning, ends to be welded shall be masked with good quality masking tape for a distance of 50mm from the end. During application of the masking tape, the adjacent surface of the blast cleaned pipe shall not be contaminated by perspiration, oil or grease. To prevent such contamination, operatives shall wear clean gloves when masking off. After site welding, all residual adhesive from the masking tape shall be completely removed by suitable solvents before the application of coating or lining repair material. The blast cleaned surface thus exposed shall be abraded with 80# abrasive paper prior to coating

Treatment of ends to be joined by flexible couplings The total thickness of lining of the coupling sleeve and coating of the pipe shall not be greater than 40% of the clearance allowed by the coupling manufacturer. In the event of this combined thickness being greater than the clearance, steps must be taken to reduce one or both of the thicknesses by the use of a suitable coating system which will provide adequate corrosion protection within the required thickness limits. Provided that these thickness limits have been catered for, the lining of the pipe should be continued to the end of the pipe, over the end and back along the outside of the pipe for sufficient length to cover the area to be covered by the coupling after joining on site

27.5 APPLICATION OF LINING OR COATING

Application of lining or coating shall be carried out as soon as possible and before any condensation, oxidation or contamination of the cleaned surface can take place

Lining or coating of pipes shall not be carried out unless the surface temperature is at least 15°C and 3°C above dew point

Mixing and proportioning of two component materials shall be strictly in accordance with the manufacturer's instructions. Split packs are not permitted

Final coating thickness shall comply with the requirements of the relevant specification

When solvent borne multicoat systems are used, the maximum thickness per coat and the time interval between coats shall be strictly in accordance with the manufacturer's instructions. Each successive coat shall differ in colour from the preceding and succeeding coat. Where solvent borne systems are used, a forced draught of warm air through the pipes may be necessary to prevent solvent retention

When solvent free two component materials are used, the application equipment shall be in accordance with the manufacturer's instructions. Tests shall be carried out frequently to ensure that the correct ratio of base to curing agent is maintained. Incorrect mix ratio of two component materials will lead to rejection of the coated articles

Powder shall be applied by the method stipulated in the relevant specification

Application equipment shall at all times be maintained in a clean condition such that there are no excessive occlusions of dry powder of dry over spray

27.6 RECOMMENDED SPECIFICATIONS

One of the following systems shall be used in accordance with the Project Specification:

27.6.1 Lining of pipes

In the factory

System B1 or E1 or Cement Mortar to SANS 1200 2000 for potable water, depending on pipe size and quantity

System C1 or E3 for sewage and acid waters

On site

Cement Mortar lining *in situ* (not covered in this specification) or System B1 for non-acidic waters only

Systems E3, or C1 for sewage and acid waters. NOTE: System C1 may not be used for potable water, due to its tainting properties

27.6.2 Coating of pipes

In the factory

Systems E1, E3, E4, E7 or F1 or F5 are all suitable for burial in soil. Due to their high cost, systems E3, E4 or E7 would only be used for extremely aggressive soil or pipe jacking

System B1A for pipes, valves, etc. aboveground in corrosive environments exposed to sunlight

On site

System G2 for pipe to be buried, with G1 or G4 for specials and couplings

28 FLANGES AND COUPLINGS

All flanges and couplings shall be protected from corrosion after tightening of all bolts and pressure testing as required by the Engineer. Pipes may be joined to each other and to ancillaries such as valves, tees, etc.

Methods of joining pipes

Circumferential welding: This is only practical on pipes of diameter in excess of 450mm (unless *in situ* cement mortar lining is to be applied) to allow man access to repair the pipe lining at the weld. The coating and lining of welding joints are normally repaired by the procedures given under the specific system used for coating and lining the pipes

Flanges: These are normally used only on small diameter pipes because of the high cost of flanges

Flexible Couplings, also known as Hydraulic Couplings: These comprise a coupling sleeve which fits over the pipe ends, together with clamps at each end and rubber sealing rings to make a watertight joint that will tolerate a certain amount of movement. Since the sleeve fits over the pipe, it is normally lined with the same material and to the same standard as the pipe. However, care must be taken when thick (1mm and over) pipe coatings or linings are used to ensure that the lining and coating combined does not exceed the clearance between sleeve inner diameter and the pipe exterior diameter

Proprietary couplings are those such as *Sintajoint*® and modified bell and spigot joint (Hall Longmore Ltd.)

29 CATHODIC PROTECTION

Cathodic protection is an electrical method of corrosion protection applied to prevent corrosion of underground or underwater structures to supplement the corrosion protection provided by the coating system (insulation against corrosion). The protection may be in the form of impressed current from a mains supply via a transformer rectifier or in the form of sacrificial anodes. Cathodic protection must be designed specifically for each location, depending on soil corrosivity, stray currents, etc. It is important to engage a cathodic protection specialist timeously since his recommendations can affect the construction of the pipes and ancillary components. Where there may be any break in continuity, bonding cables must be attached. Insulation joints must be installed where the cathodically protected structure requires to be insulated from the main structure, e.g. a pipeline entering a process plant.

30 SECURITY FENCE

30.1 FENCING POSTS

Fabricate all posts from mild steel with due attention to Clause 5. After fabrication, fencing posts shall be hot dip galvanized to comply with SANS 121 :2000/ISO 1461:1999. The bottom of fencing posts to be buried in soil shall be cleaned in accordance with Clause 10.4, then coated with bitumen to a dry film thickness not less than 30 or greater than 70 microns. Allow a minimum of 16 hours drying, then apply one coat Bituminous Aluminium Paint, complying with SABS 802, allowing a minimum of 3 days before burial

The coating shall cover the whole of the base plate and upwards to a height of not less than 500mm above ground. The total dry film thickness of primer and bituminous aluminium shall be not less than 50 microns

30.2 STRAINING WIRES, FENCING WIRE, TIE WIRES AND BARBED WIRE

Shall be hot dip galvanized to comply with SANS 675 Class A. galvanized wire complying with SANS 675:1997is not acceptable

30.3 CONCERTINA RAZOR/BARBED WIRE COILS

Shall be manufactured from stainless steel, type 304 or from 3CR12 or as recommended for specific conditions

APPENDICES

APPENDIX A - LIST OF STANDARDS AND CODES APPLICABLE

A1 NATIONAL STANDARDS AND CODES

Standards South Africa	**Previous SABS Number**	**DESCRIPTION**
SANS 10064 :2005	064 1979	The Preparation of Steel Surfaces for coating
SANS 10120 :1986	0120 1986	Code of Practice for use with standardized specification for Civil Engineering Construction - General
SANS 10129 :2006	0129 1977	Plastic tape wrapping of steel pipelines * (Project on Progress)
SANS 10140 :2003	0140 1992	Identification colour marking Part 3 - Contents of pipelines
SANS 10158 :1982	0158 1987	Code of Practice for Glossary of terms for Quality Assurance and Quality Control
SANS 1117	1117 1977	Plastic Wrappings for the protection of steel pipelines
SANS 1149	1149 1977	Flat and taper steel washers
SANS 1200 A 1986	1200A 1986	Standardized specification for Civil Engineering Construction Section A: General
SANS 1200 A 1986	1200AA 1986	Standardized specification for Civil Engineering Construction Section AA: General (small works)
SANS 1200 AH 1986	1200AH 1986	Standardized specification for Civil Engineering Construction Section AH: General (structural)
SANS 1200 H 1990	1200H 1990	Standardized specification for Civil Engineering Construction Section H: Structural steelwork
SANS 1200 HA 1990	1200HA 1985	Standardized specification for Structural Steelwork - General Section HA: Structural steelwork (sundry items)
SANS 1200 HB 1985	1200HB 1985	Standardized specification for Structural Steelwork - General Section HB: Cladding and Sheeting
SANS 1200 HC 1988	1200HC 1988	Standardized specification for Civil Engineering Construction - Corrosion Protection of Structural Steelwork

SANS 121 :2000 / ISO 1461:1999	SABS/ISO 1461:2000	Hot dip galvanized coatings on fabricated iron & steel articles – Specifications and Test Methods
SANS 1217 :1984	1217 1984	The Production of Painted and Powder-coated Steel Pipes
SANS 1274 :2005	SABS 1274 :2005	Coatings applied by the powder coating process
SANS 1391 SET : 1983	SABS 1391 SET:1983	Thermally sprayed metal coatings
SANS 14713 :1999 / ISO 14713:1999	SABS/ISO 14713:1999	Protection against corrosion of iron and steel structures. Zinc and Aluminium coatings - Guidelines
SANS 1578 :2003	1578:1993	Organic powder coating for external architectural aluminium
SANS 1586 :1995	1586 1995	Emulsion Paints
SANS 1796 :2001	1796 Edition 1 2001	Coatings of durable organic powder for external Aluminium
SANS 2063	1391 1998	Metallic and other inorganic coatings – Thermal spraying – Zinc, aluminium and other alloys
SANS 32 :1997 / EN10240:1997	SABS/EN 10240:1997	Internal and/or external protective coatings for steel tubes- specification for hot dip galvanizing coating applied in automatic plants
SANS 3575 :1996 / ISO 3575:1996	SABS/ISO 3575:1996	Continuous hot-dip (galvanized) zinc coated carbon steel sheet of commercial, lock forming and drawing qualities
SANS 4998 :1996 / ISO 4998:1996	SABS/ISO 4998:1996	Continuous hot dip (galvanized) zinc coated steel sheet of structural quality
SANS 630:2001	630 1972	Decorative High Gloss Enamel Paint for Interior and Exterior Use
SANS 675:1997	675 1997	Zinc coated Fencing Wire (Plain and barbed)
SANS 678:1973	678 1987	Primers for Wood for Interior and Exterior Use
SANS 679:1959	679 1972	Zinc Chromate Primer for Steel
SANS 680:1959	680 1979	Glazing putty for wooden and metal window frames
SANS 681 :1997	681 1997	Undercoats for Paints
SANS 684:1959	684 1972	Structural Steel Paint
SANS 716 :1962	716 1972	Mineral Turpentine (white spirit)
SANS 723	723 1973	Wash Primer (Metal etch primer)
SANS 802 :1966	802 1972	Bituminous Aluminium Paint

SANS 935 :1969	935 1993	Hot Dip (Galvanized) Zinc coatings on steel wire
SANS 975 :1970	975:1970	Pre-stressed concrete pipes
SANS 999 :1986	999 1998	Anodized Coatings on Aluminium (For architectural applications)

- New Specifications may be submitted in the future

A2 INTERNATIONAL STANDARDS

SPECIFICATION	Previous number	SPECIFICATION DESCRIPTION
	ASME	
ASME 1X 2004	1X 1983	Coded Welders
	ASTM	
ASTM G 8	G-8	Cathodic Disbonding of Pipeline Coatings
ASTM G 14	G-14	Impact Resistance of Pipeline Coatings (Falling weight test)
	AUSTRALIAN	
AS 2518	AS 2518	Fusion-bonded low density polyethylene coating for pipes and fittings
	BRITISH GAS	
BGC/S/CW 6	BGC/S/CW 6	British Gas Engineering Standard - Specification for the External Protection of Steel line Pipe and Fittings
	British Standard	
BS 6496:1984	6496	Powder organic coatings for application and stoving to aluminium alloy extrusions, sheet and preformed sections for external architectural purposes etc.
BS EN 10132 -	1449	Steel plate sheet and strip for automobile and general engineering purposes
BS EN ISO 15614-1:2004	4870-Part 1	Specification and qualification of welding procedures for metallic materials. Welding procedure test. Arc and gas welding of steels and arc welding of nickel and nickel alloys
	Canadian Standards Association	
CAN/CSA-Z245.20-M86	CAN/CSA-Z245.20-M86	External fusion bond epoxy coated steel pipe

ISO STANDARDS:

ISO Standards:	ISO Number	DESCRIPTION
ISO 2409	2409	Adhesion test method
ISO 3575	3575 1996	Continuous hot-dip (galvanized) zinc coated carbon steel sheet of commercial and drawing qualities
ISO 6272-1	6272	Impact test method
ISO 8501-1	8501-1	Preparation of Steel Substrates before application of paint and related products Visual assessment of surface cleanliness; part 1: rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings (pictorial surface preparation standards for painting steel surfaces)
ISO 8502.3	8502.3	Preparation of Steel Substrates before application of paint and related products. Tests for the assessment of surface cleanliness. Part 3 - Assessment of dust on steel surfaces prepared for painting (pressure sensitive tape method)
ISO 8503 Part 2	8503 Part 2	Preparation of Steel Substrates before application of paint and related products. Surface roughness characteristics of blast cleaned steel substrates. Part 2 - Method of grading of surface profile of abrasive blast cleaned steel - comparator procedure
ISO 9000	9000	Quality management systems-Fundamentals and vocabulary

APPENDIX B FORM STATING PROPOSED SUB-CONTRACTORS

This form to is be completed and signed by the tenderer, together with completed Form Appendix C

No change after acceptance is permitted without written approval by the Engineer

Contract Title		Number	

Main Contractor		Contact	
Address		Tel No Fax No Cell phone	

Fabrication Sub – Contractor		Contact	
Address		Tel No Fax No Cell phone	

Painting Sub – Contractor (Yard)		Contact	
Address		Tel No Fax No Cell phone	

Painting Sub – Contractor (Site)		Contact	
Address		Tel No Fax No Cell phone	

I certify that we will adhere to the above unless otherwise agreed in writing by the Engineer

Date: ……

NAME..... For Tenderer .....

Company Stamp

APPENDIX C FORM STATING MATERIALS TO BE USED

This form to be completed and signed by the material supplier and submitted by the tenderer with the completed Form Appendix B

Contract Title		Number	

Item	System No	Material Supplier	Product Name	Product Code No

I certify that I have read the requirements stated in 10.1 of the *GOLDER 2006 CORROSION SPECIFICATION* and the above materials comply with the specification for the above contract and that these materials are suitable for the purpose intended.

Date:…….

Name.....Signature……

ON BEHALF OF..... (Material Supplier)

Witness …….. Signature…….

COMPANY STAMP

Filename: Golder 2006 Corrosion Spec Rev 4-July06-Final.doc
Directory: G:\Company\Water Engineering\Corrosion
Template: Normal.dot
Title: grs amendments to Draft new Wates corr spec
Subject:
Author: Eric Duligal/Ludik
Keywords: SPECIFICATION
Comments: STANDARDIZED SPECIFICATION FOR CORROSION PROTECTION AND PAINTING
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