MOKOLO AND CROCODILE WATER AUGMENTATION PROJECT PHASE 2 (MCWAP-2)

TENDER NO 054/2024/PMID/MCWAP2/RFB

VOLUME 3
SPECIFICATION

SECTION 37

PAINTING AND CORROSION PROTECTION

Acknowledgement is given to the Department of Water and Sanitation (DWS) for the use of the corrosion specifications DWS 9900 C1 to C 8 in the compilation of this Section.

VOLUME 3
SPECIFICATION

SECTION 37
PAINTING AND CORROSION PROTECTION

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SECTION 37

PAINTING AND CORROSION PROTECTION

37.1 SCOPE

This Section covers the painting and corrosion protection of all steelwork, Plant, pipes and fixtures exposed to environments with variable corrosive tendencies.

Plant and pipes shall be manufactured and corrosion protected in accordance with the requirements specified in the Specification and Drawings. In the event that no corrosion protection is specified for any Plant or pipes within the design specifications or drawings, this Section shall be used to agree the specific application. No deviation from this Section of the Specification shall be allowed without the written approval of the Engineer.

This Section shall be interpreted as follows:

a) For corrosion protection of the Employer design components it shall be regarded as a Specification.

b) For corrosion protection of the Contractors design components it shall be regarded as an Employers requirement.

37.1.1 Coating of buried steel pipes, specials and fittings

The external coating of the MCWAP-2 pipelines shall be in accordance with the following requirements:

(a) Option 1:

i) All Pipes – Polymer Modified Bitumen (PMB)

ii) Joints: Primer and PMB “blankets/membranes”

iii) Specials: Primer and PMB “blankets/membranes”

(b) Option 2:

i) All Pipes – Three Layer High Density Polyethylene (3LPE)

ii) Joints: Epoxy coating and tape wrap

iii) Specials: Epoxy coating and tape wrap

(c) Option 3:

i) All Pipes – Rigid Polyurethane (RPU)

ii) Joints: RPU

iii) Specials: RPU

Other coating systems may be offered as alternative options subject to Approval by the Engineer.

37.1.2 Lining of steel pipes, specials and fittings

The internal lining system of the MCWAP-2 pipelines shall be solvent free epoxy in accordance with Clause 37.18 except for the Low Lift Rising Main, the section of the High Lift Rising Main between the Break Pressure Tank and Drop Chamber No 2 and at the Matlabas River crossing which shall be abrasion resistant epoxy applied directly to steel in accordance with Clause 37.18.

37.1.3 Corrosion protection of all other components

The selection of the corrosion protection system of all other components shall be as indicated on the Drawings.

37.2 APPROVAL PROCEDURE

The following Approvals shall be obtained for corrosion protection system application:

a) Qualification of personnel;
b) Type and Quality of application equipment;
c) Pre-preparation;
d) Surface preparation;
e) Application; and
f) Final acceptance.

37.3 DEFINITIONS AND REFERENCES

37.3.1 Definitions

In this Section the following shall have the meaning given:

a) **"Coating"** shall refer to the application of a uniform protective layer of material in the specified manner to the outside of Plant or piping.

b) **"Lining"** shall refer to the application of a uniform protective layer of material in the specified manner to the inside of Plant or piping.

c) **"Dis-bonded area"** shall refer to an area of coating that initially did adhere to the steel substrate after application, but which subsequently became loose from the substrate as a result of mechanical, chemical or other action.

d) **"Un-bonded area"** shall refer to an area of coating which at no stage adhered to the steel substrate.

e) **"Water path"** shall refer to the distance along the surface of a material embedded in concrete but exposed to water measured from the concrete surface.

f) **"Dry"** shall refer to atmospheric conditions only and includes periodic wetting by spray or rain.

g) **"Wet"** shall refer to permanently or usually "buried", "submerged", "submersed" or "immersed" conditions and shall include internal of valve chambers and other dry but normally very humid condition.

h) **"Wet/dry"** shall refer to conditions that are intermittently dry and wet as defined above.

i) **"Holiday"** shall refer to a discontinuity in a coating or lining which exhibits electrical conductivity when exposed to a specific voltage. This is also known as an "Electrical Insulation Defect".

37.3.2 References

When reference is made to a Code of Practice, Specification or Standard, the reference shall be taken to mean the latest edition or replacement at time of tender of the Code, Specification or Standard; including addenda, supplements, modifications and revisions thereto. Where a previous version is intentionally used, it will be indicated as such. Where reference is made to a Code, Specification or Standard that has subsequently been withdrawn and not replaced, the intended content will remain relevant unless confirmed otherwise in writing by the Engineer.

37.4 GENERAL REQUIREMENTS

37.4.1 Quality Assurance and Procedures

The coating operation shall be governed by a documented Quality System, which ensures that the requirements of this specification are met in every respect. Quality management shall comply with the requirements of Sections, 28, 38 and 40.

The Quality System shall be based upon recognised quality standards, of which ISO 9001 is a suitable example. Quality Assurance systems to other equivalent standards may be used, if approved by the Engineer.

The Contractor Quality Assurance Group shall have been established, which shall be responsible for reviewing the Quality System and ensuring that it is implemented.

The Quality System shall include control of material and equipment suppliers and sub-contractors and shall ensure that the requirements of this specification are satisfied by the suppliers and sub-contractors operating quality systems in their own organisations.

The Quality Plan and ITP shall include any sub-contracted work and the subcontractor's Quality Plans shall be submitted to the Engineer for Approval.

The following hold points will be required as a minimum. Further hold points may be agreed between the Engineer and the Contractor after acceptance of the contractor’s quality plan:

a) Fabrication quality and pre-cleaning;

b) Blast cleaning – profile and level of cleanliness;

c) DFT and cure of coatings; and

d) Holiday detection.

These hold points will be subject to inspection and release by the Engineer, and will apply to all coating application for the project, whether at suppliers works, contractors yards or *in situ* during pipe laying.

The Quality Plan shall be sufficiently detailed to indicate sequentially, and for each discipline, the requisite quality control, inspection, testing, and certification activities with reference to the relevant procedures and the acceptance standards.

The Quality System and associated procedures will be subject to formal audits by the Engineer, The application of quality control will be monitored by the Engineer's inspectors, who will witness and accept on behalf of the Engineer the inspection, testing, and associated work required by the specification.

The provision of inspection services reporting directly to the Engineer shall in no way relieve the Manufacturers and/or Contractors of the responsibility to ensure that the full scope of work is carried out entirely in accordance with the specification, the agreed Quality Plan and ITP.

37.4.2 Project Quality Plan

A detailed Project Quality Plan (PQP), based on the requirements of this Section, shall be submitted for approval to the Engineer before manufacture, lining and coating are initiated.

No manufacture, lining or coating shall be commenced before the Project Quality Plan (PQP) is approved by the Engineer all of which should be in accordance with the Specification.

37.4.3 Qualified Staff

Applicators, supervisors and inspectors shall be qualified in terms of SAQCC, SSPC or NACE certification as appropriate.

37.4.3.1 Application

A high standard of workmanship is required. Only experienced personnel shall be used to carry out corrosion protection work. All work shall be carried out under the constant supervision of a qualified supervisor. The Contractor shall submit proof to the Engineer that the applicators he intends to use for a specific application is competent to execute the work to the highest quality standards and methods as per product data sheets from the suppliers.

37.4.3.2 Repair Work at Site

Similarly all repair work at Site shall be done by competent personnel under the supervision of a qualified supervisor.

37.4.4 General Quality Control Requirements

37.4.4.1 Responsibility for Quality

The Contractor shall accept full responsibility for the quality of his workmanship and material used, irrespective of any quality surveillance that may be carried out by the Engineer or his assistants.

The Contractor and all approved Subcontractor(s) shall:

a) Be responsible for compliance with all the Clauses of this Section and shall carry out all inspections and tests called for in this Section in the presence of the Engineer or his assistant. The cost of these inspections and tests shall be included in the Rates; and

b) Abide by the approved Project Quality Plan (PQP) throughout all the intended stages of testing during manufacture, cleaning, preparation and application as well as hold points for independent quality surveillance.

37.4.4.2 Contractor Qualification

The Contractor and Subcontractor(s) shall satisfy the Engineer that they have the management, facilities and equipment, skilled staff, a quality control procedure and required test methods and

standards to carry out the quality control committed to in the approved PQP during manufacture and corrosion protection application.

In this regard, the Contractor and his Subcontractors shall be subject to quality audits.

37.4.4.3 Submission for approval

The Contractor shall submit the following to the Engineer, including data sheets where applicable, for approval:

(a) For Corrosion Protection

a) A programme;
b) The Quality Control Plan (QCP) for corrosion protection indicating hold points;
c) Process Method Statement;
d) Blast material;
e) Proposed Coating systems; and
f) Proposed pickling and passivating products.

(b) Manufacture and Corrosion Protection Programmes

The manufacture and corrosion protection programmes shall state the time and place when the following will be conducted:

a) Inspection of material;
b) Hydrostatic testing of uncoated castings, pipes and fittings;
c) Manufacture of components;
d) Fettling or dressing;
e) Degreasing;
f) Water soluble salts test;
g) Blast cleaning and application of the first coat;
h) Application of intermediate and final coats; and
i) The commencement of Site repairs.

37.4.4.4 Substandard Quality Control

All material, certification and records of the Contractor will be subject to examination by the Engineer. This shall include the checking and testing of the Plant. If any deviation to the approved QCP or product quality is found, additional testing and quality surveillance shall be carried out at no additional cost to the Employer.

If the additional testing confirms inaccurate quality control by the Contractor, all work on that particular Plant item shall be stopped and shall only proceed after remedial action has been implemented to the satisfaction of the Engineer.

37.4.4.5 Approval of Coating Systems for Field Coating Works

The compliance of the specific commercial products proposed by the Contractor for the selected field coating systems shall be identified at tender stage. The coating manufacturer name and product number, certified test reports and data sheets shall be provided. All repair coatings proposed shall have an established history of use on pipelines.

The Contractor shall also submit method statements, programme and a process flowchart detailing a trial application of the field coating systems.

(a) Field Coating Procedure Qualification Trial (PQT)

The Contractor shall undertake a procedure qualification test program at least one month prior to commencement of field coating work to satisfactorily demonstrate that the proposed repair procedures will meet the requirements of this Specification when applied to project-coated pipe.

Prior to commencement of the field coating operations the Contractor shall submit to the Engineer all necessary details of the proposed coating materials and procedures for approval and evidence of its experience of applying the selected field coating materials. The testing shall verify the properties of the applied coatings as detailed in the relevant sections of this specification.

The test program shall be proposed by the Contractor and witnessed by the Engineer. It shall be based on the consistent successful application of the coating to three or more repairs for each pipe diameter and coating type of each type to be used, to confirm the properties of the applied coatings. Approval of the material and procedures shall be based on the application procedure the Contractor proposes to use for the repairs. The results shall be recorded by the Contractor and submitted to the Engineer for approval.

(b) Pre-production Test (PPT)

The PPT shall be performed on site to demonstrate that the repair coatings can be correctly applied in accordance with the written procedures before production coating commences. The PPT shall be performed immediately prior to production using the same written procedures and personnel involved in the repair coating application during production. PPT shall repeat the test programme required by PQT.

Only individuals who have successfully completed the PQT and PPT shall be used during repair coating application. The minimum tests to be undertaken during PPT shall be as required in the relevant coating specifications.

A PPT plan detailing all aspects of the application and destructive testing shall be submitted to the Engineer 30 days before the test date for review and comments. A PPT report will be issued within 10 days of the testing providing numerical values of test results.

37.4.5 Inspection by the Engineer and Notice of Inspection

Inspection of Plant shall be carried out by the Engineer, his appointed representative or an Approved Inspection Authority (AIA) at manufacturer’s and corrosion applicator’s works.

The Engineer shall be notified at least seven days in advance, or as otherwise agreed, of the commencement of impending inspections or when cleaning and first coat application are to be carried out as well as for witnessing the points in terms of the agreed Quality Control Plans (QCP’s).

In the event of continuous production inspections as for the pipe manufacturing, the inspections will be aligned with the manufacturing program.

The Engineer's inspection shall in no way relieve the Contractor or his Subcontractors of any of their obligations with respect to design, manufacture and supply Plant of superior quality and workmanship in accordance with the Specification.

37.5 COMPATIBILITY OF MATERIALS

Where dissimilar materials are used together in an item of Plant, the Contractor shall ensure that these metals or alloys are compatible or are adequately protected if, in the galvanic series, there is more than 0.3 volt difference in their galvanic potential. See also Clause 37.5.2 below.

37.5.1 Design Precautions (Employers requirement)

All Plant shall be designed to suppress corrosion in a specific pre-defined environment.

37.5.1.1 Accessibility

Easy access for the initial application of corrosion protection materials and also for maintenance shall be provided. The use of back to back angles, partially open box sections or inaccessible stiffeners shall be avoided. Where this is not possible, corrosion protection of those areas that are unavoidably inaccessible shall be specifically specified and approved by the Engineer.

37.5.1.2 Water Retention Areas

Pockets, recesses and crevices in which water and dirt may collect shall be avoided. Water retention areas shall be properly drained by holes as large as possible i.e. in a recess of 150 mm diameter the drainage hole shall be minimum 50 mm diameter.

Surfaces of corrodible metals, such as the insides of tanks or hollow sections that cannot be protected by any method (e.g. painting or dipping), shall be avoided, or where unavoidable, be fully sealed against ingress of air and moisture.

37.5.2 Specific Corrosion Prevention Measures

The Contractor shall ensure that the following measures are taken to minimise corrosion if dissimilar metals are used:

a) Coat all surfaces of each part of the whole assembly;

b) If the nobler member of the assembly cannot be entirely covered:

   i) Keep the anode/cathode ratio as large as possible in the particular component; and

   ii) Use electrical insulators between the two metals. Insulation must be complete; a bolt requires a sleeve as well as washers made of an insulating material.

c) Joints and crevices between dissimilar metals shall be sealed; and

d) Where fastening is unavoidable, the fasteners shall be nobler (cathodic) than the base material. Fasteners shall be coated where possible and/or adequately electrically insulated between the fasteners and the material being joined.

37.6 EQUIPMENT

37.6.1 Measuring Equipment

a) The Contractor shall have the following measuring equipment at his paint shop or Site at all times:
   i) Ambient temperature gauge;
   ii) Blast profile gauge;
   iii) Dew point instrument;
   iv) Dry film thickness gauge;
   v) Electric insulation defect detector;
   vi) Surface temperature gauge;
   vii) Relative humidity instrument; and
   viii) Wet film comb.

b) All measuring equipment shall have current calibration certification.

c) All instruments shall be calibrated daily, except where otherwise specified by manufacturers, to achieve the required accuracy.

d) Dry film thickness gauges shall be calibrated on a flat surface, provided that the surface profile is in accordance with the relevant corrosion protection system Specification.

37.6.2 Spray Equipment

a) Spray equipment shall be suitable for the function for which it is used, capable of properly atomising the coating material and equipped with suitable pressure regulators and gauges. Air caps, needles and nozzles shall be of the type recommended by the coating manufacturer.

b) All spray equipment shall be fitted with suitable oil and moisture traps.

37.6.3 Mixer

Where mixing is required, allow speed mixer, which does not introduce air into the coating material being mixed, shall be utilised.

37.7 INSTALLATION REQUIREMENTS

37.7.1 Supports

When pipes are installed or mounted on concrete supports, rubber insertion shall be used to insulate the pipe from the support. The thickness of the rubber insertion shall not be less than 10 mm and protrude not less than 20 mm all round.

37.7.2 Anchors in Concrete

All permanent anchors in concrete shall be stainless steel to ASTM A240 grade 316L.

Special care shall be taken to ensure that anchors be installed to the correct level and depth.

Anchors shall not be cut after installation without prior inspection and approval of the Engineer.

To avoid a galvanic reaction (stainless steel / galvanizing) under wet conditions, the nut and washer shall be Fusion-bonded Epoxy (FBE) coated. Where necessary, caps may be specified by the Engineer.

37.7.3 Sealing

Where steelwork is installed in high corrosive or humidity areas, edges of the grouting shall be sealed with a continuous Polyurethane sealer, i.e. Polybron product or equal as approved by the Engineer.

37.7.4 Armouring

Armoured or special protection shall be applied to surfaces at all road and rail crossings, through sleeves and culverts, and as requested by the Engineer.

37.8 HEALTH AND SAFETY REQUIREMENTS

37.8.1 Control of Major Classes of Risk

a) Health risks, these include:
   i) Gases / vapours;
   ii) Volatile liquids in the paint; and
   iii) Powders / dust.

b) Fire or explosion risks, these include:
   i) Fire risk during storage / transport; and
   ii) Explosion hazard during application.

Regarding the management of these risks, the Contractor shall comply with the requirements of Section 2 - Occupational Health and Safety.

37.8.2 General Aspects of Explosion Hazards

The essential precaution to be taken is, inter alia that sufficient ventilation air shall be provided to maintain the ratio of vapour/air to no more than 10% of the lower explosive limit.

37.8.3 General Aspects of Toxic Hazard

Measures shall be taken by the Contractor to ensure that the following are prevented:

- Inhalation of dust / fumes;
- Skin contact with paint;
- Ingestion of paint; and
- Eye contact / penetration of paint.

Operators shall be provided with the necessary Personal Protective Equipment (PPE), such as masks / hoods, barrier creams and protective clothing to minimize the chances of the above occurring.

Emergency procedure shall be in place and First Aid kit provided to deal adequately with any of the above occurrences.

The Contractor shall ensure that the repairs of the epoxy lining inside the pipe shall be executed in compliance with the Construction Regulation's confined space entry and ventilation requirements.

37.9 STORAGE, HANDLING AND TRANSPORT

37.9.1 General

Storage, handling and transportation shall comply in accordance with Section 28 – Mechanical General. Adequate provision shall be made for the protection of Plant and pipe coatings between the completion of manufacture and installation. The coated items shall not be handled within the drying time recommended by the coating manufacturer, taking into account the ambient temperature.

37.9.2 End Covers

After inspection, testing and final acceptance, all ends (including branch ends) of Plant, pipes and pipe specials shall be sealed as follows:

- All plain ends shall be sealed with plastic or other approved sheeting secured with double flat steel binding strips and all flanged ends shall be closed off with sturdy timber flanges.
- All plastic covers and timber flanges to be clearly marked:

"NOT TO BE REMOVED BEFORE INSTALLATION"

- Plastic covers and timber flanges shall remain in place during, handling, transport, storage and installation or laying.

37.9.3 Lifting Pipes

All coated items shall only be lifted by means of broad band slings that will not damage the coating. Slings shall not be less than 500 mm wide for pipes up to 500 mm nominal bore, 1 000 mm wide for larger pipes or as approved by the Engineer.

37.9.4 Marking of Pipes and Specials

Each pipe and special shall be legibly, indelibly and durably marked, (in such a manner that the coating is not damaged), with the following information:

- Contract number;
- Scheme name;
- Serial number of the pipe or special;
- Nominal diameter;
- Grade and thickness of steel;

- Hydrostatic test pressure; and
- Item number.

The pipes and specials shall be consistently marked at the same position for ease of location when required in future.

37.9.5 Transport

Coated items shall be handled with due regard to the relatively soft nature of organic coatings and appropriate precautions shall be taken to protect all coatings.

The Contractor is responsible for the safe delivery of all items and small parts to Site without damage. All items shall be securely packed to prevent damage while in transit.

If transported by a third party, the Contractor is responsible for ensuring protection of items by that party as specified.

Precautions shall be taken to support and chock pipes and Plant on padded cradles and/or saw-dust filled bags to prevent movement when loading onto vehicles and transporting.

Where stacked pipes are transported, the packing shall be of a thickness and positioned to ensure that pipes do not touch when they flex.

Items shall be firmly lashed or chained with padded lashing. The area of padded surfaces shall be adequate to prevent damage to coatings.

Bolts and other small components shall be labelled and crated in strong hessian bags. The bags and crates shall be tagged using metallic tags and shall be marked in accordance with Clause 37.9.4 above.

The Contractor's Representative on Site shall be notified of the delivery date and of any requirements regarding off-loading and storage at Site.

37.9.6 Off-Loading at Site

The supplier shall be responsible for the transportation and supervision during off-loading of the Plant and other small components at the delivery Site.

Under no circumstances shall coated Plant be allowed to rest directly on the ground.

A final delivery inspection and acceptance of Plant supplied shall be undertaken on Site after off-loading has been completed.

37.9.7 Stacking and Storage

The Contractor shall provide all the necessary balks of timber and sawdust-filled bags necessary to support the items on soil, concrete or other hard surface and to separate them from each other both at his yards, on Site and when stringing along the trench.

Pipes shall be stacked to a safe height not exceeding two pipes high, on cradles and on level ground.

Grass or other vegetation shall not be allowed to grow in the storage area within five metres of the Plant or pipes.

37.9.8 Damage

Any damage that occurs during the handling and storage of items, including transportation to Site, shall be repaired by the manufacturer / Contractor at his own cost, in accordance with this Section and to the approval of the Engineer.

37.9.9 Rejection

The Engineer has the right to reject any damaged items and materials which have been delivered and off-loaded at Site.

37.10 COATING AND LINING SYSTEMS

37.10.1 Toxicity of Lining Material

Materials used for the lining of pumps, pipes and pipe work shall be non-toxic and shall not impart any odour, taste, or colour to the water. Certification that this has been complied with shall be submitted to the Engineer for his approval.

37.10.2 Proprietary Items

Unless an equivalent corrosion protection system has been specifically agreed prior to the award of the Contract, all components that are supplied painted or protected e.g. hoists, gearboxes, actuators, pipes etc., shall only be accepted provided that they meet the corrosion protection requirements of this Section.

37.10.3 Abbreviations

The following abbreviations shall have the meaning assigned to them:

µm	:	Micrometre
3Cr12	:	Corrosion Resistant Steel
3LPE	:	Three Layer High Density Polyethylene
ABS	:	Acrylnitrile-Butadiene-Styrene
Al	:	Aluminium
CI	:	Cast Iron - grade 220
CS	:	Cast Steel
DCA	:	Die Cast Aluminium
DFT	:	Dry Film Thickness
EID	:	Electrical Insulation Defect
FBE	:	Fusion-Bonded Epoxy
FBP	:	Fusion-Bonded Polyester
FBMDPE	:	Fusion-Bonded Medium Density Polyethylene
GRP	:	Glass Fibre Reinforced Polyester
HDG	:	Hot-Dip Galvanized
HDPE	:	High Density Polyethylene
MIO	:	Micaceous Iron Oxide
MS	:	Mild Steel – grade 300WA

PC : Polycarbonate
PMB : Polymer Modified Bitumen
PVC : Polyvinylchloride
RPU : Rigid Polyurethane
QCP : Quality Control Plan
SG : Spheroidal Graphite Cast Iron – grade 420
SS : Stainless Steel – grades 304L and 316L
UV : Ultra Violet

37.10.4 Coating Systems Reference

The final product specific selection of all corrosion protection systems shall be submitted to the Engineer for approval before application. The QCP shall refer to the relevant system number listed in the tables below.

The following tables are abbreviated guidelines and the systems are not listed in order of preference. Any item not listed below must be clarified in writing with the Engineer. See notes under Clause 37.10.25.

37.10.5 Pumps

ENVIRONMENT	MATERIAL	SURFACE	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Wet (See definitions Clauses 37.3.1 f), g) and h)	SG CI	Lining	1. Vinyl Ester Glass Flake	600	001
			2. Ceramic Epoxy	600	002
			3. Glass flake Epoxy	600	003
		Coating	1. Two pack Epoxy plus top coat of pure Aliphatic Polyurethane – where specified	400 25	004
			2. FBE	350	005
Dry (See definitions Clauses 37.3.1 f), g) and h)	SG CI	Coating	1. Two pack Epoxy plus top coat of pure Aliphatic Polyurethane – where specified	250 40	006
			2. FBE plus top coat of recoatable Polyurethane	250 40	007
Wet (See definitions Clauses 37.3.1 f), g) and h)	SG	Machined close tolerance	Long life Molybdenum Disulphide lubricant	10-15	008
Abrasive conditions	SG CS	Lining	Glass Flake or Ceramic Reinforced Two pack Epoxy	800	009
Submerged	SG	Coating	1. Two pack Epoxy	400	009.1
			2. FBE	350	009.2

37.10.6 Motors

ENVIRONMENT	MATERIAL	SURFACE	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Dry (See definitions Clauses 37.3.1 f), g) and h)	MS	Lining	1. Red Oxide	40	010
			2. Two pack Epoxy	250	011
		Coating	1. Two pack Epoxy plus top coat of recoatable Polyurethane	250 40	012
	SG CI	Coating	1. Two pack Epoxy plus top coat of recoatable Polyurethane	250 40	013
			2. FBE plus top coat of recoatable Polyurethane	250 40	014
	DCA	Coating	1. Two pack Epoxy plus top coat of recoatable Polyurethane	75 40	015
			2. FBE plus top coat of recoatable Polyurethane	250 40	016
Wet (See definitions Clauses 37.3.1 f), g) and h)	SG CI	Coating	1. Two pack Epoxy plus top coat of pure Aliphatic Polyurethane – where specified	400 25	017

37.10.7 Base Plates and Steelwork

ENVIRONMENT	MATERIAL	SURFACE	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Dry	MS		1. Two pack Epoxy plus top coat of recoatable Polyurethane	250 40	020
			2. Multi-purpose Epoxy plus top coat of recoatable Polyurethane if required	250 40	021
			3. HDG	105	022
Submerged	MS		1. Two pack Epoxy	400	023
			2. Multi-purpose Epoxy	400	024
	SS 316L		Pickle and passivate – See note 4		025
	MS	Machined close tolerance	Long life Molybdenum Disulphide lubricant	10-15	026

37.10.8 Valves and Flowmeters

37.10.8.1 Valves (Including Handwheels) and Flowmeters

ENVIRONMENT	MATERIAL	SURFACE	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Dry/Wet	MS SG	Lining	1. Two pack Epoxy	400 25	030
			2. FBE plus top coat of pure Aliphatic Polyurethane – where specified	350 25	031
	SS 316L	Lining	1. Two pack Epoxy plus top coat of pure Aliphatic Polyurethane – where specified	250 25	032
			2. FBE plus top coat of pure Aliphatic Polyurethane – where specified	250 25	033
			3. Pickle and passivate – See note 4		034
Dry (See definitions Clauses 37.3.1 f), g) and h)	MS SG	Coating	1. Two pack Epoxy plus top coat of recoatable Polyurethane	250 40	035
			2. Multi-purpose Epoxy plus top coat of recoatable Polyurethane if required	250 40	036
			3. FBE plus top coat of recoatable Polyurethane	250 40	037
Wet (See definitions Clauses 37.3.1 f), g) and h)	MS SG	Coating	1. Two pack Epoxy plus top coat of pure Aliphatic Polyurethane – where specified	400 25	038
			2. FBE plus top coat of pure Aliphatic Polyurethane	350 25	039
	SS 316L	Coating	1. Two pack Epoxy plus top coat of pure Aliphatic Polyurethane – where specified	150 25	040
			2. FBE plus top coat of pure Aliphatic Polyurethane – where specified	250 25	041
			3. Pickle and passivate – See note 4		042

37.10.8.2 Gearboxes

ENVIRONMENT	MATERIAL	SURFACE	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Dry/Wet (See definitions Clauses 37.3.1 f), g) and h)	CI SG	Lining	1. Two pack Epoxy	250	050
			2. FBE plus top coat of pure Aliphatic Polyurethane	250	051
		Coating	1. Two pack Epoxy plus top coat of pure Aliphatic Polyurethane – where specified	400 25	052
			2. FBE plus top coat of pure Aliphatic Polyurethane	350 25	053

37.10.9 Gates, Screens and Built-In Parts

37.10.9.1 Crest / Control Gates

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Wet	MS	Two pack Epoxy - plus top coat of pure Aliphatic Polyurethane	375 25	055
Dry	MS	Two pack Epoxy – plus top coat of: a) Recoatable Polyurethane or b) Multi-purpose Epoxy or c) MIO pigmented Polyurethane	275 40 125 50	056

37.10.9.2 Emergency / Service Gates and Stoplogs

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Wet	MS	Two pack Epoxy – plus top coat of recoatable Polyurethane	375 40	060
Dry	MS	Two pack Epoxy – plus top coat of Multi-purpose Epoxy	250 125	061

37.10.9.3 Wall / Channel Sluices / Scour Gates

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Wet-no maintenance	SS 316L	1. Pickle and passivate – See note 4		070
		2. Two pack Epoxy	125	071
		3. FBE	250	072
Wet/Dry	SS 304L or 3CR12	1. Two pack Epoxy – plus top coat of pure Aliphatic Polyurethane	250 25	073
		2. Multi-purpose Epoxy	300	074
		3. FBE – plus top coat of pure Aliphatic Polyurethane	250 25	075

37.10.9.4 Lashing Strips

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Wet	SS 304L or SS 316L	Two pack Epoxy – plus top coat of pure Aliphatic Polyurethane	125 25	080
	3CR12	Two pack Epoxy – plus top coat ofpure Aliphatic Polyurethane	250 25	081

37.10.9.5 Wheels

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Wet	MS + SS 316L tyre	Two pack Epoxy - on sides	400	090
		Two pack Epoxy - rolling surfaces	90-125	091
	SS 316L	Two pack Epoxy - on sides	125	092
		Two pack Epoxy - rolling surfaces	70-90	093
Dry	SG/CS	Two pack Epoxy - on sides	300	094
		Two pack Epoxy - rolling surfaces	90-125	095

37.10.9.6 Screens

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Wet	SS 316L	Pickle and passivate – See note 4		100
	SS 304L or 3CR12	Two pack Epoxy plus top coat of Multi-purpose Epoxy – See note 1	125 175	101

37.10.9.7 Guides and Built-in Parts

ENVIRONMENT WET		MATERIAL	SYSTEM	MINIMUM DFT (μm)	SYSTEM NUMBER
Water path	> 150 mm	MS 3Cr12 SS	Un-coated		110
	< 150 mm	MS	Two pack Epoxy plus Polyurethane sealant on edges – See notes 3 and 5	250	111
		SS	Pickle and passivate – See notes 3, 5 and 6		112
Concrete cover	> 75 mm	MS	Un-coated		113
	< 75 mm	SS	Pickle and passivate – See notes 3, 5 and 6		114
		MS	Two pack Epoxy – See note 5	250	115

37.10.10 Hydraulic Plant

37.10.10.1 Hydraulic Cylinders

ENVIRONMENT	MATERIAL	SURFACE	SYSTEM	MINIMUM DFT (μm)	SYSTEM NUMBER
Dry (See definitions Clauses 37.3.1 f), g) and h)	MS SS 304L SS 316L	Coating	1. Two pack Epoxy plus top coat of recoatable Polyurethane	250 40	120
			2. Multi-purpose Epoxy plus top coat of recoatable Polyurethane if required	250 40	121
			3. FBE plus top coat of recoatable Polyurethane	250 40	122
Wet (See definitions Clauses 37.3.1 f), g) and h)	MS SS 304L SS 316L	Coating	1. Two pack Epoxy plus top coat of pure Aliphatic Polyurethane – where specified	400 25	123
			2. FBE plus top coat of pure Aliphatic Polyurethane	250 25	124

37.10.10.2 Hydraulic Pipes

ENVIRONMENT	MATERIAL	SYSTEM	SYSTEM NUMBER
Dry/Wet (See definitions Clauses 37.3.1 f), g) and h)	SS 316L	Pickle and passivate (avoid MS contact and contamination)	130

37.10.10.3 Hydraulic Power Packs

ENVIRONMENT	MATERIAL	SURFACE	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Dry (See definitions Clauses 37.3.1 f), g) and h)	MS	Lining	1. Two pack Epoxy	200	140
			2. FBE	250	141
		Coating	1. Two pack Epoxy plus top coat of recoatable Polyurethane	250 40	142
			2. Multi-purpose Epoxy plus top coat of recoatable Polyurethane if required	250 40	143
			3. FBE plus top coat of recoatable Polyurethane	250 40	144
Wet (See definitions Clauses 37.3.1 f), g) and h)	MS	Coating	1. Two pack Epoxy plus top coat of pure Aliphatic Polyurethane	400 25	145
			2. FBE plus top coat of pure Aliphatic Polyurethane	250 25	146
	3CR12	Lining	1. Two pack Epoxy	150	147
			2. FBE	250	148
		Coating	1. Two pack Epoxy plus top coat of pure Aliphatic Polyurethane	250 25	149
			2. FBE plus top coat of pure Aliphatic Polyurethane	250 25	150
	SS 304L	Coating	Pickle and passivate - See note 4		

37.10.11 Electrical Plant

37.10.11.1 Actuators

ENVIRONMENT	MATERIAL	SURFACE	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Dry/Wet (See definitions Clauses 37.3.1 f), g) and h)	SG CI	Coating	1. Two pack Epoxy plus top coat of recoatable Polyurethane – where specified	250 (dry) 400 (wet) 40	160
			2. FBE plus top coat of recoatable Polyurethane – where specified	250 (dry) 350 (wet) 40	161
	DCA	Coating	1. Two pack Epoxy plus top coat of recoatable Polyurethane – where specified	200 40	162

ENVIRONMENT	MATERIAL	SURFACE	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
			2. FBE plus top coat of recoatable Polyurethane – where specified	250 40	163
			3. Powder Coating	200	164
	SG/CI gearbox	Lining	1. Two pack Epoxy	125	165
			2. FBE	250	166

37.10.12 Pipes and Specials

37.10.12.1 Above Ground

ENVIRONMENT	MATERIAL	SURFACE	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Above ground Dry/Wet (See definitions Clauses 37.3.1 f), g) and h)	MS 3CR12	Lining	1. Two pack Epoxy	400	170
			2. FBE	350	171
			3. HDG – See note 1	105	173
			1. Two pack Epoxy plus top coat of recoatable Polyurethane	250 (dry) 400 (wet) 40	174
		Coating	2. Multi-purpose Epoxy plus top coat of recoatable Polyurethane if required	250 (dry) 400 (wet) 40	175
			3. FBE plus top coat of recoatable Polyurethane	200250 (dry) 350 (wet) 40	176
			4. HDG – See note 1	105	177
			5. HDG – See note 1 If required: Epoxy primer for galvanised surfaces plus top coat of recoatable Polyurethane	40-80 40	178

37.10.12.2 Encased in Concrete

ENVIRONMENT	MATERIAL	SURFACE	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Encased in concrete	3CR12 (See note 9) MS (See note 10)	Epoxy lining plus Abrasion Resistant Overcoat	1. Two pack Epoxy plus Glass Flake or Ceramic Reinforced Two pack Epoxy (See Clause 37.16.5.3)	400 + 800	180

ENVIRONMENT	MATERIAL	SURFACE	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
		Factory lining	2. Glass Flake or Ceramic Reinforced Two pack Epoxy	800	181
	3CR12	Coating	1. Two pack Epoxy plus Glass Flake Reinforced Two pack Epoxy (see Clause 37.16.5.3)	250 + 600	182
	MS	Coating	1. Two pack Epoxy plus Glass Flake Reinforced Two pack Epoxy (see Clause 37.16.5.3)	300 + 600	184
	SS 304L or SS 316L See note 6	Lining	1. Two pack Epoxy	250	186
			2. FBE	250	187
		Coating	1. Two pack Epoxy plus sealant of Polyurethane or Polysulphide – See note 2	150	188
			2. FBE plus sealant of Polyurethane or Polysulphide - See note 2	250	189
			3. Pickle and passivate – See note 3		190
Buried in soil - chamber to coupling	All materials	Coating	Petrolatum or Visco-elastic encapsulation system – refer Clause 37.25		191
Anti-buoyancy encasement for river crossings	All materials	Coating	Armour tape wrap (see Clause 37.24.3.7)	1500	192

37.10.12.3 Within Chamber Walls

ENVIRONMENT	MATERIAL	SURFACE	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Within chamber walls	3CR12 (See note 9) MS (See note 10)	Lining	1. Two pack Epoxy	400	200
			2. FBE	350	201
		Coating See note 2	1. Two pack Epoxy plus top coat of pure Aliphatic Polyurethane plus sealant of Polyurethane or Polysulphide - See note 2	400 25	203
			2. FBE plus top coat of pure Aliphatic Polyurethane plus sealant of Polyurethane or Polysulphide -	350 25	204

ENVIRONMENT	MATERIAL	SURFACE	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
			See note 2		
	SS 304L or SS 316L	Lining	1. Two pack Epoxy	250	205
			2. FBE	250	206
		Coating	1. Two pack Epoxy plus top coat of pure Aliphatic Polyurethane plus sealant of Polyurethane or Polysulphide – See note 2	150 25	208
			2. FBE plus top coat of pure Aliphatic Polyurethane plus sealant of Polyurethane or Polysulphide - See note 2	250 25	209
Buried in soil – chamber to coupling	All materials	Coating	Petrolatum or Visco-elastic encapsulation system – Refer Clause 37.25		210

37.10.12.4 Buried in Soil

ENVIRONMENT	MATERIAL	SURFACE	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Buried in soil	MS	Lining	1. Two pack Epoxy	400	220
			2. FBE	350	221
		Coating Depth < 4 m	1. Reinforced bitumen – refer Clause 37.23		223
			2. FBMDPE	2300	224
			3. Tape wrapping – refer Clause 37.24.3.4		225
			4. Two pack Epoxy plus tape wrapping – refer Clause 37.24.3.4	400	226
			5. FBE plus tape wrapping – refer Clause 37.24.3.4	350	227
			6. 3LPE (Total system) FBE layer Adhesive layer	3500 250 Min 325 Avg 400 Max 200 ±50	228
			7. Polymer Modified Bitumen	5500	229A
			8 Rigid Polyurethane	1800	229B
			9 Visco-elastic coating	2000	229C
		Coating	1. Reinforced bitumen –		230

ENVIRONMENT	MATERIAL	SURFACE	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
		Depth > 4 m and proximity of other services	armour wrapping – refer Clause 37.23		
			2. FBMDPE	2300	231
			3. Armoured tape wrapping – refer Clause 37.24.3.5		232
			4. Two pack Epoxy plus tape wrapping – refer Clause 37.24.3.4	400	233
			5. FBE plus tape wrapping – refer Clause 37.24.3.4	350	234
			6. 3LPE (Total system) FBE layer Adhesive layer	3500 250 Min 325 Avg 400 Max 200 ±50	235
			7. Polymer Modified Bitumen	5500	236
			8 Rigid Polyurethane	1800	237
			9 Visco-elastic coating	2000	238

37.10.12.5 In Water

ENVIRONMENT	MATERIAL	SURFACE	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
In water and severe corrosion conditions	3CR12 MS	Lining	1. Two pack Epoxy	400	240
			2. FBE	350	241
		Coating	1. Two pack Epoxy plus pure Aliphatic Polyurethane	400 25	243
			2. FBE	350	244
			3. Rigid Polyurethane	1800	245
			4. FBMDPE	2300	246
	SS 304L See note 6	Lining	1. Two pack Epoxy	250	247
			2. FBE	250	248
		Coating	1. Two pack Epoxy	250	250
			2. FBE	250	251
			3. FBMDPE	2300	252
			4. 3LPE (Total system) FBE layer Adhesive layer	3500 250 Min 325 Avg 400 Max 200 ±50	253
			5. Polymer Modified	5500	254

ENVIRONMENT	MATERIAL	SURFACE	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
			Bitumen		
			6 Rigid Polyurethane	1800	255
			7 Visco-elastic coating	2000	256

37.10.12.6 Abrasion Resistant (AR) Lining Applications

ENVIRONMENT	MATERIAL	SURFACE	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
All external environments	3CR12 & MS specials, valve blades.	AR Lining overcoat	1. Two pack Epoxy plus Glass Flake or Ceramic Reinforced Two pack Epoxy (See Clause 37.16.5.3)	400 + 800	257
	Factory lined pipe	AR Lining	1. Glass Flake or Ceramic Reinforced Two pack Epoxy	800	258

37.10.13 Couplings, Flange Adaptors

MATERIAL	SURFACE	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
MS	Lining and Coating	1. Two pack Epoxy	400	260
		2. FBE	350	261
		3. HDG plus Epoxy primer plus Two pack Epoxy	105 40-80 250	262
		4. HDG plus FBE	105 250	263
SS 304L	Lining and coating	Pickle and passivate – See note 4		264
SS 304L buried	Lining and coating	1. Two pack Epoxy	150	265
		2. FBE	125	266

37.10.14 Joints

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Plain Ended Pipes where couplings or flange adaptors are to be fitted	MS	Same as lining material for 300 mm from end	400	270
		Two pack Epoxy for cement mortar lining with 100 mm overlap inside and outside	400	271

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Flanges of Bitumen wrapped pipes	MS	Same as lining material on top and back of flange with an overlap of 100 mm from the flange	400	272
		Two pack Epoxy for cement mortar lining with 100 mm overlap inside and outside	400	273
Flange faces	MS	Two pack Epoxy	60 - 90	274
Coupling or Flanged Joints Buried in Soil or in Wet Chambers	MS SS 304L SS 316L	Coating system plus petrolatum or visco-elastic encapsulation system - refer Clause 37.25		275
Welded Joints Buried in Soil or encased in concrete	MS SS 304L SS 316L	As specified for lining and coating		276
Welded joints, internal	MS	Epoxy system, same as lining	same as lining	279

37.10.15 Stainless Steel Items

SURFACES	COATING	MINIMUM DFT (µm)	SYSTEM NUMBER
Stainless steel components (Dissimilar materials in submerged conditions)	Two pack Epoxy or FBE to a smooth, glossy and uniform finish	250	280
Stainless steel components (Exposed to anaerobic conditions)	Two pack Epoxy or FBE to a smooth, glossy and uniform finish	250	281
3CR12 steel components (All submerged conditions)	Two pack Epoxy or FBE	400 / 350	282
Stainless steel components (Dry or compatible metal conditions)	Pickle and passivate – See note 4		283
3CR12 steel components (Dry conditions only)	Pickle and passivate – See note 4		284

37.10.16 Fasteners and Anchors

37.10.16.1 Fasteners

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Fasteners and washers - Dry (See definitions Clauses 37.3.1 f), g)	MS	HDG plus threads coated with Molybdenum Disulphide lubricant or wax	45	290
	SS 304L	Threads coated with Molybdenum Disulphide lubricant or Nickel Anti-seize compound	Uniform cover	291

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
and h)				
Fasteners and washers - Wet/Submerged (See definitions Clauses 37.3.1 f), g) and h)	SS 316L	1. Pickle and passivate - See note 4 plus threads coated with Molybdenum Disulphide lubricant or Nickel Anti-seize compound	Uniform cover	292
		2. FBE coated (thread surfaces excluded) plus threads coated with Molybdenum Disulphide lubricant or Nickel Anti-seize compound	50	293
Fasteners and washers – Buried in soil	MS	1. HDG plus threads coated with Molybdenum Disulphide lubricant plus encapsulation (system 275)	45	294
	SS 304L	2. Threads coated with Molybdenum Disulphide lubricant or Nickel Anti-seize compound plus encapsulation (system 275)	Uniform cover	295
Fasteners for flange adaptors – Drilled and tapped	MS	1. HDG plus wet assembly with Epoxy or threads coated with Molybdenum Disulphide lubricant	45	296
	SS 304L	2. Pickle and passivate - See note 4 plus wet assembly with Epoxy	Uniform cover	297
Fasteners for flange adaptors – Welded	SS 304L	Pickle and passivate - See note 4		298

37.10.17 Anchors

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Anchors in concrete –Dry (See definitions Clauses 37.3.1 f), g) and h) See Clause 37.7.2	SS 316L	Threads coated with Molybdenum Disulphide Lubricant or Nickel Anti-seize compound	Uniform cover	300
Anchors in concrete – Wet (See definitions Clauses 37.3.1 f), g) and h) See Clause 37.7.2	SS 316L	Threads coated with Molybdenum Disulphide Lubricant or Nickel Anti-seize compound plus nut and washer powder coated	Uniform cover 50	301

37.10.18 Cranes and Hoists

37.10.18.1 Crane Structures

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Indoor and outdoor	MS	1. Two pack Epoxy plus top coat of recoatable Polyurethane	250 40	305
		2. Multi-purpose Epoxy plus top coat of recoatable Polyurethane if required	250 40	306
		3. HDG - See note 1 if required: Epoxy primer for galvanised surfaces plus top coat of recoatable Polyurethane	85 40-80 40	307

37.10.19 Crane Structures Fixed to Concrete

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Indoor and outdoor	MS	1. Two pack Epoxy plus top coat of recoatable Polyurethane plus grout under base plus Polyurethane sealant	250 40	310
		2. Multi-purpose Epoxy plus top coat of recoatable Polyurethane if required plus grout under base plus Polyurethane sealant	300 40	311
		3. HDG - See note 1 if required: Epoxy primer for galvanised surfaces plus top coat of recoatable Polyurethane plus grout under base plus Polyurethane sealant	85 40-80 40	312

37.10.19.1 Crawl Beams

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Indoor – Dry (See definitions Clauses 37.3.1 f), g) and h)	MS	HDG - See note 1	85	320
Indoor – Wet (See definitions Clauses 37.3.1 f), g) and h)	MS	HDG - See note 1 Plus duplex system.	85	321
Outdoor	MS 3CR12	HDG - See note 1 Pickling & passivation	85	322

37.10.19.2 Rails Bolted to Concrete / Steel Runways

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Indoor – Dry (See definitions Clauses 37.3.1 f), g) and h)	MS	Multi-purpose Epoxy: Sides and bottom Rolling surface	 250 60-90	330
Indoor – Wet (See definitions Clauses 37.3.1 f), g) and h)	MS	Multi-purpose Epoxy: Sides and bottom Rolling surface	 250 60-90	331
Outdoor	MS	Multi-purpose Epoxy: Sides and bottom Rolling surface	 250 60-90	332

37.10.20 Platforms, Ladders, Handrails and Flooring

37.10.20.1 Platforms, Walkways and Flooring

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Indoor – Dry (See definitions Clauses 37.3.1 f), g) and h)	MS	HDG	85	340
	3Cr12	Pickle and passivate – See note 4		341
	SS 304L	Pickle and passivate		342
Indoor – Wet (See definitions Clauses 37.3.1 f), g) and h)	3Cr12	Pickle and passivate – See note 4		343
	SS 304L	Pickle and passivate		344
Outdoor	MS	HDG	85	345
	3Cr12	Pickle and passivate – See note 4		346
	SS 304L	Pickle and passivate		347
Immersed	SS 304L	Pickle and passivate – See note 4		348
	SS316	Pickle and passivate		349

37.10.20.2 Ladders

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Indoor – Dry (See definitions Clauses 37.3.1 f), g) and h)	MS	HDG	85	350
	SS 304L	Pickle and passivate – See note 4		351
Indoor – Wet (See definitions Clauses 37.3.1 f), g) and h)	SS 304L	Pickle and passivate – See note 4		352

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Outdoor	MS	HDG – See note 1	85	353
	SS 304L	Pickle and passivate – See note 4		354
	SS 316L	Pickle and passivate – See note 4		356

37.10.20.3 Handrails and Balustrades

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Indoor – Dry (See definitions Clauses 37.3.1 f), g) and h)	MS	1. Two pack Epoxy plus top coat of recoatable Polyurethane	250 40	360
		2. Multi-purpose Epoxy plus top coat of recoatable Polyurethane if required	250 40	361
		3. HDG - See note 1 if required: Epoxy primer for galvanised surfaces plus top coat of recoatable Polyurethane	85 40-80 40	362 363
	3Cr12	1. FBE	100	364
		2. Two pack Epoxy plus pure Aliphatic Polyurethane	125 25	365
		3. Pickle and passivate – See note 3		366
		4. FBP	100	367
	SS 304L	1. Pickle and passivate		368
	Al	1. Anodised	25	369
Indoor – Wet (See definitions Clauses 37.3.1 f), g) and h)	MS	1. Two pack Epoxy plus top coat of recoatable Polyurethane	250 40	370
		2. Multi-purpose Epoxy plus top coat of recoatable Polyurethane if required	250 40	371
		3. HDG - See note 1 if required: Epoxy primer for galvanised surfaces plus top coat of recoatable Polyurethane	85 40-80 40	372
	3CR12	1. FBE	100	373
		2. Two pack Epoxy plus pure Aliphatic Polyurethane	125 25	374
		3. Pickle and passivate – See note 3		375
		4. FBP	100	376
	SS 304L	1. Pickle and passivate		377
	Al	1. Anodised	25	378
Outdoor	MS	1. Two pack Epoxy plus top coat of recoatable Polyurethane	250 40	379
		2. Multi-purpose Epoxy plus top coat of recoatable Polyurethane if required	250 40	380

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
		3. HDG - See note 1if required: Epoxy primer for galvanised surfaces plus top coat of recoatable Polyurethane	85 40-80 40	381
	3CR12	Two pack Epoxy plus recoatable Polyurethane	125 50	382
		FBP	100	383
	SS 304L	Pickle and passivate		384
	Al	Anodised	25	385
		FBP	100	386

37.10.21 Electrical Plant

37.10.21.1 Electrical Panels and Enclosures

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Indoor – Dry (See definitions Clauses 37.3.1 f), g) and h)	MS	1. Multi-purpose Epoxy plus recoatable Polyurethane if required	250 40	400
		2. Two pack Epoxy plus recoatable Polyurethane	250 40	401
		3. Powder coating	70	402
	PC ABS DCA	Un-coated		403
	GRP	Polyester gelcoat	250	404
	3Cr12	1. Multi-purpose Epoxy plus recoatable Polyurethane if required	125 40	405
		2. Two pack Epoxy plus recoatable Polyurethane	125 40	406
		3. FBE	250	407
Indoor – Wet (See definitions Clauses 37.3.1 f), g) and h)	3Cr12 or SS 304L	1. Two pack Epoxy plus recoatable Polyurethane	250 40	408
		2. FBE	250	409
	DCA	FBE	250	410
	PC ABS	Un-coated		411
	GRP	Polyester gelcoat	250	412
Outdoor	3Cr12 or SS 304L	1. FBP	150	413
		2. Multi-purpose Epoxy plus recoatable Polyurethane if required	250 40	414

37.10.21.2 Transformers

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Indoor and Outdoor	MS	Multi-purpose Epoxy	300	420

37.10.21.3 Diesel Generator

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Indoor and outdoor	MS	Multi-purpose Epoxy – See note 11	300	430
	3Cr12	Multi-purpose Epoxy	150	431
	SS 304L	Multi-purpose Epoxy	150	432
Items subjected to high temperatures		See note 11		433

37.10.21.4 Industrial Switched Socket Outlets and Light Switch Housings

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Indoor – Dry (See definitions Clauses 37.3.1 f), g) and h)	PVC	Un-coated		440
	DCA	FBE	50	441
Indoor – Wet (See definitions Clauses 37.3.1 f), g) and h)	PVC	Un-coated		442
	DCA	FBE	75	443
Outdoor	DCA	FBP	75	444

37.10.21.5 Cable Support Systems

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Dry Not exposed to UV (See definitions Clauses 37.3.1 f), g) and h)	MS	1. Two pack Epoxy	250	450
		2. Multi-purpose Epoxy	250	451
		3. FBE	250	452
		4. HDG	85	453
	3Cr12	Pickle and passivate – See note 4		454
Dry Exposed to UV (See definitions Clauses 37.3.1 f), g) and h)	MS	1. Two pack Epoxy plus Recoatable Polyurethane	250 40	455
		2. Multi-purpose Epoxy	300	456
		3. FBP	150	457
		4. HDG	85	458
	3Cr12	Pickle and passivate – See note 4		459

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Wet (See definitions Clauses 37.3.1 f), g) and h)	3Cr12	FBE	250	460
	SS 304L or SS 316L	Pickle and passivate – See notes 3 and 4		461

37.10.21.6 Industrial Light Fittings

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Indoor – Dry (See definitions Clauses 37.3.1 f), g) and h)	MS	FBE	50	470
	DCA	FBE	50	471
Indoor – Wet (See definitions Clauses 37.3.1 f), g) and h)	DCA	FBE	75	472
	GRP	Polyester gelcoat	250	473
Outdoor	DCA	FBP	75	474
	GRP	Polyester gelcoat	250	475

37.10.21.7 Conduit

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Indoor – Dry (See definitions Clauses 37.3.1 f), g) and h)	MS	HDG	65	480
	PVC	Un-coated		481
Indoor – Wet (See definitions Clauses 37.3.1 f), g) and h)	SS 304L	Pickle and passivate – See notes 3 and 4		482
	PVC	Un-coated		483
Outdoor	MS	HDG	65	484
	SS 304L	Pickle and passivate – See notes 3 and 4		485
Underground	HDPE PVC	Un-coated		486
	SS 304L	Pickle and passivate – See notes 3 and 4		487

37.10.21.8 Junction Boxes

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Indoor – Dry (See definitions Clauses 37.3.1 f), g) and h)	DCA	FBP	50	490
	PVC	Un-coated		491
	GRP	Polyester gelcoat	250	492
Indoor – Wet (See definitions Clauses 37.3.1 f), g) and h)	DCA	FBE	250	493
	PVC	Un-coated		494
	GRP	Polyester gelcoat	250	495
Outdoor	DCA	FBP	125	496

37.10.21.9 Light Poles and Masts

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Indoor	GRP	Polyester gelcoat	250	500
	SS 304L	Pickle and passivate – See note 4		501
Outdoor	MS	HDG	105	502
	GRP	Polyester gelcoat	250	503
	3Cr12 SS 304L	Pickle and passivate – See note 4		504

37.10.21.10 Cable Mounting Straps and Clamps

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Indoor	MS	HDG	45	510
	PVC	Un-coated		511
	SS 304L	Un-coated		512
Outdoor	SS 304L	Un-coated		513

37.10.22 Service Gate

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Wet (See definitions Clauses 37.3.1 f), g) and h)	MS	Two-pack Epoxy – plus top coat of pure Polyurethane	400 25	520
Dry (See definitions Clauses 37.3.1 f), g) and h)	MS	Two-pack Epoxy – plus top coat of Multi-purpose Epoxy with Al flakes	250 125	521

37.10.22.1 Lashing Strips

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Wet (See definitions Clauses 37.3.1 f), g) and h)	SS304 or 316	Two-pack Epoxy – plus top coat of pure Polyurethane	125 25	530
	3Cr12	Two-pack Epoxy – plus top coat of pure Polyurethane	250 25	531

37.10.22.2 Wheels

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Wet (See definitions Clauses 37.3.1 f), g) and h)	MS+ SS316 tyre	Two-pack Epoxy – on sides Two-pack Epoxy – rolling surfaces	400 90	540
	SS316	Two pack Epoxy – on sides Two-pack Epoxy – rolling surfaces	125 90	541
Dry (See definitions Clauses 37.3.1 f), g) and h)	SG/CS	Two-pack Epoxy – on sides Two-pack Epoxy – rolling surfaces	300 90	542

37.10.23 Ropes

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Dry (See definitions Clauses 37.3.1 f), g) and h)	MS	Rope dressing-penetrating, water resistant & non-sticky surface	Cover all surface	550
Dry/Wet (See definitions Clauses 37.3.1 f), g) and h)	MS	HDG plus penetrating, water resistant & non-sticky dressing	85 all surface	551
	SS	Pickle and passivate		552

37.10.24 Chains

37.10.24.1 Load Chains

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Dry	MS	1. Rope dressing - water resistant with a non-sticky surface	Thin cover	560

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Dry/Wet	MS	1. Lubricating Rust Protector	Cover surface	561
	SS	2. Pickle and passivate		562

37.10.24.2 Operating Chains

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Dry/Wet	MS	1. Rope dressing - water resistant with a non-sticky surface	Thin cover	570
		2. Lubricating Rust Protector	Cover surface	571
		3. HDG	85	572
		4. HDG plus Rope dressing - water resistant with a non-sticky surface	85 Thin cover	573
		5. HDG plus Lubricating Rust Protector	85 Cover surface	574
	SS	1. Pickle and passivate		575

37.10.24.3 Plate Link Chains

ENVIRONMENT	MATERIAL	SYSTEM	MINIMUM DFT (µm)	SYSTEM NUMBER
Dry	MS	Multi-purpose Epoxy with dry lubricant on pins	150	580
		HDG with dry lubricant on pins	105	581

37.10.25 Notes

The following notes shall be read in conjunction with the above systems: In the event that the approved material application conditions have changed, the proposed revised application shall be approved by the Engineer prior to implementation:

1	Hot-dip galvanizing:	Only for pipes up to 200 mm diameter maximum and flow less than 2 m/s. Pipes shall not be embedded in concrete. Water analysis shall be provided.
2	Sealant:	Interfaces of different environments shall be sealed with a Polyurethane or Polysulphide flexible sealant to be applied in accordance with the manufacturer’s data sheets.

3	Un-coated stainless steel:	Only to be used if no galvanic reaction and no anaerobic conditions are present.
4	Pickle and passivated:	If not in contact with less noble material. If exposed to anaerobic conditions seal-coat all crevices with Elastoplastic Epoxy. Shall be done by the dipping process.
5	Galvanic cells:	Where a galvanic cell is situated within a water path < 150 mm and concrete cover < 75 mm, the MS, 3Cr12 or SS shall be coated.
6	Anaerobic conditions:	SS grade 316L shall be used under anaerobic and aggressive water conditions plus an additional coating application.
7	Polyurethane for colour coding:	Recoatable or pure Aliphatic Polyurethane where required for colour coding. Only UV resistant Polyurethane shall be used.
8	Primers:	Primers shall only be used in special cases i.e. over-coating of galvanized surfaces.
9	3Cr12:	Although coated 3Cr12 material has superior corrosion resistance imparted by the coating, special measures (e.g. insulation joints) are required to prevent galvanic corrosion due to dissimilar properties if connected to mild steel.
10	Mild steel:	Mild steel is the preferred material. No defects in lining and coating after installation and during casting of concrete encasement shall be allowed.
11	Items subjected to high temperatures:	Items to be manufactured out of stainless steel or coated with heat resistant paint.
12	Epoxy primer:	Epoxy primer may not be required if appropriate two Pack Epoxy / recoatable or pure Aliphatic Polyurethane is being used.
13	Rope dressing:	Shall be applied using a high pressure impregnation system. Minimum pressure of 5 MPa shall be used.
14	HDG chains:	Chains may only be hot dip galvanised if the strength is not affected, the load is reduced accordingly if it is used in a non-load bearing application.

37.11 FABRICATION MANAGEMENT

37.11.1 Responsibility

The Contractor shall be responsible for the integrated planning and coordination of the interactive processes required by the corrosion protection system application processes. The manufacturer's internal quality control process shall be reported in the approved QCP format.

37.11.2 Corrosion Specialist Personnel

The corrosion protection system application in the factories will be monitored by an Approved Inspection Authority. Refer to Section 1 - General.

37.11.3 Component Identification (Marking)

All components of Plant or pipe items shall be permanently and indelibly marked to identify each individual item.

37.12 FABRICATION REQUIREMENTS

37.12.1 Surface Defects

All extrusions, rolled steel and castings shall be clean and free of score marks, pits, protrusions, blisters, porosity, blowholes, cracks or any other flaws which may be detrimental to the relevant corrosion protection system used.

Laminations, scabs or occluded scale shall be ground out. The extent of grinding shall be subjected to a structural integrity analysis such as ASME B31 G. Ground areas may require caulking, welding or replacement.

37.12.2 Undercuts, Cavities and Pits

Weld undercuts and cavities as well as pits in metal surfaces are not permitted.

All undercuts, cavities and pits shall be ground out, re-welded and ground to a smooth contour.

37.12.3 Welds

All welds shall be continuous and shall have a smooth contour.

Staggered welds, where specified, shall only be permitted with prior approval of the Engineer on submission of appropriate remedial corrosion protection procedures.

Welding processes used shall limit heat input to a minimum to restrict the heat affected zone.

37.12.4 Lifting Lugs

Where required, lugs shall be fitted by the manufacturer to the requirements of the Contractor and the approval of the Engineer. Refer to Section 32.

37.12.4.1 Lugs to be Removed

All lugs shall be removed on components that will be buried. The damaged coating area shall be repaired in accordance with the original Specification.

37.12.4.2 Permanent Lugs

Lugs, not intended to be removed, shall be manufactured of equal or nobler grade than the base material in accordance with this Section.

37.13 PRE-PREPARATION

37.13.1 General Requirements

37.13.1.1 Protrusions

Protrusions shall be removed by grinding and dressing to a smooth contour.

37.13.1.2 Sharp Edges

Burrs and rough faces caused by guillotining, flame cutting, drilling, machining or punching shall be removed by grinding.

All sharp edges shall be radiused to a minimum of 2 mm.

37.13.1.3 Welds

Welds shall be free from slag, slag inclusions, cracks, surface cavities and under-cuts.

Irregular projections shall be ground to a smooth contour.

Areas adjacent to welds shall be free from weld spatter. Such spatter shall be removed by grinding or scraping.

37.13.2 Materials

37.13.2.1 Castings

Castings may require baking to render them suitable for blast cleaning and coating application.

Castings with defects exceeding the restrictions given in Table 37/1 below shall be rejected.

In the case of blowholes occurring opposite each other, the combined depth shall be taken into account.

Blowholes and cavities not exceeding 2 mm depth shall be smoothed out by grinding.

TABLE 37/1
ACCEPTANCE CRITERIA: REPAIR OF BLOWHOLES AND CAVITIES

SURFACE	DEPTH OF BLOWHOLES	DIAMETER OF BLOWHOLES	REPAIR
Internal	Maximum 20% of material thickness	40% maximum of material thickness	Welding only
External	Maximum 10% of material thickness	20% maximum of material thickness	Solvent free Epoxy or welding
External	10 to 20% maximum of material thickness	40% maximum of material thickness	Welding only

Castings shall, after inspection by the Engineer, be ground smooth.

Small and repaired blowholes shall be ground level and smooth.

37.13.2.2 Hot-Dip Galvanized Items

The design and manufacture of all items to be hot-dip galvanized shall conform to SANS 14713 as well as the Code of Practice for surface preparation and application of organic coatings as provided by the Hot Dip Galvanizers Association of Southern Africa.

The Silicon and Phosphorus contents of materials to be galvanized shall comply with the standard below. If no material certificates are available, samples of the materials shall be analysed for their Silicon and Phosphorus contents. Material certification shall be supplied in both cases.

The following materials shall be used:

a) For aesthetic appearance:
   - Aluminium-killed steel; or
   - Silicon-killed steel with a Silicon content not exceeding 0.04% and a Phosphorus content not exceeding 0.02%.

b) For general corrosion protection:
   - Aluminium killed steel; or
   - Silicon killed steel with a Silicon content not exceeding 0.25% and a Phosphorus content not exceeding 0.02%.

37.13.2.3 Corrosion Resistant Steels

Fabrication shall take place in dedicated areas separated from carbon steel.

All equipment used in the forming and manipulation of stainless steel items during fabrication shall be clean and free of materials that may contaminate the metal with carbon steel.

The manufacture of items from corrosion resistant steels shall be in accordance with the SASSDA's Information Series and the guidelines of the material supplier.

Discoloration caused by welding or cutting shall be mechanically cleaned by buffing followed by pickling and passivation in accordance with the SASSDA's Information Series and the guidelines of the material supplier.

Organic contamination shall be removed by degreasing.

Iron contamination shall be removed by pickling and passivation, by the dipping process, after degreasing.

All surfaces shall be tested for free iron contamination by using the ferroxyl test method.

37.14 PRIMARY CLEANING

The manufacturer shall remove all oil, grease or other surface contaminants with a water soluble solvent degreaser followed by rinsing with clean soft water before items are dispatched for corrosion protection.

37.15 SURFACE PREPARATION

37.15.1 Relevant Standards

SANS	10064	The preparation of steel surfaces for coating.
ISO	8501-1	Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after overall removal of previous coatings.
ISO	8504-2	Preparation of steel substrates before application of paints and related products – Surface preparation methods – Part 2: Abrasive blast cleaning.
ISO	8502-6	Preparation of steel substrates before application of paints and related products – tests for the assessment of surface cleanliness – Part 6: Extraction of soluble contaminants for analysis – The Bresle method.
ISO	8503-5	Preparation of steel substrates before application of paints and related products – Surface roughness characteristics of blast-cleaned steel substrates – Part 5: Replica tape method for the determination of the surface profile.
ISO	8502-3	Preparation of steel substrates before application of paints 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	11125	Preparation of steel substrates before application of paints – Metallic blast-cleaning abrasives.
ISO	11127	Preparation of steel substrates before application of paints – Non-metallic blast–cleaning abrasives.

37.15.1.1 Equipment

Equipment shall, to achieve the specified surface preparation, comply with the following:

a) Equipment and air supply free of oil and moisture;

b) Compressors shall have a capacity and pressure output to achieve the required nozzle pressures; and

c) Worn nozzles shall be replaced.

If the correct surface preparation is not achieved due to inadequate equipment, the Engineer may order the Contractor to obtain such equipment as may be necessary to achieve the specified results.

All equipment and temporary structures shall at all times be maintained in good and safe working order.

37.15.1.2 Working Conditions

Surface preparation shall not take place when conditions are likely to adversely affect the corrosion protection processes.

The Subcontractor shall provide screens, covers, trestles or any other equipment necessary to avoid contamination of surfaces and to minimise time delays caused by inclement weather.

37.15.1.3 Health and Safety

The Contractor's shall at all times enforce health and safety measures necessary to comply with the Occupational Health and Safety Act Regulations and the manufacturer's requirements. Refer to Section 2 – Occupational Health and Safety.

37.15.2 Procedure

37.15.2.1 Approval of Works and Programme

The Contractor programme, equipment and Works shall be approved by the Engineer prior to commencement of surface preparation.

37.15.2.2 Initial Inspection

Before accepting items from the Fabricator, the Contractor shall check the initial condition of the surface for:

a) Visible surface defects;

b) Corrosion or contamination;

c) Any required metal dressing;

d) Elimination of burrs and radiusing of edges;

e) Removing of weld spatter and weld imperfections such as blowholes; and

f) Suitable lifting lugs.

37.15.2.3 Degreasing

All surfaces to be coated shall be tested for oil and grease contamination by the water break free test.

Oil and grease contamination shall be removed using one or more of the following processes:

a) Steam-cleaning;

b) An emulsifiable or aqueous detergent; and

c) An alkaline cleaning solution:

- The alkaline solution shall be allowed to react, and then rinsed off with clean, potable water to remove all residues prior to surface preparation, all in accordance with the relevant section of SANS 10064;

The washed surfaces shall be tested after degreasing to show that no oil, grease and chemical contamination are present.

Care shall be taken to avoid entrapment of cleaning agents in recesses or other retention areas.

37.15.2.4 Rough-Blast

All rust, millscale, old coating or marking paint shall be removed by rough-blasting.

Laminations, scabs and occluded scale which becomes visible after cleaning shall be ground out and the area re-cleaned.

The Engineer shall be advised when blast-cleaning of the appropriate section will be completed so that an inspection can be carried out to determine if repairs are required.

Blast-cleaning shall be done in accordance with the code of practice SANS 10064 to achieve a cleanliness of Sa 2 (ISO 8501-1) for the rough-blast only.

37.15.2.5 Water Soluble Salts

The surfaces to be coated shall be tested for water soluble salts after blast-cleaning. The maximum level of salts allowable on the surfaces shall not exceed the values set by the coating manufacturer, or 50 mg/m^2 (ISO 8502-6) for wet conditions, whichever is the lesser value (refer to Clause 37.15.3.1).

Should these values be exceeded, the surfaces shall be cleaned by:

a) A liquid soluble salt remover approved by the Engineer;

b) Washing with a high pressure jet of clean potable water;

c) Water injected blast-cleaning; or

d) Flash blast-cleaning until the soluble salts are within the specified limits.

37.15.2.6 Final-Blast

(a) Humidity and Temperature

No final blasting or coating application shall be done if the relative humidity is more than 85%.

No coating shall be applied or cured at temperatures below 5°C.

All blast-cleaned surfaces shall be coated within:

- Four (4) hours when humidity is below 70%; or
- Two (2) hours when humidity is between 70% and 85%.

Final-blasting and coating shall not be carried out if the steel temperature is less than 3°C above dew point.

(b) Blast Cleaning Material

Final blast-cleaning shall be carried out using clean, uncontaminated blast-medium in accordance with Clause 37.15.3.2.

(c) Cleanliness

All surfaces for “wet / submerged conditions” and for “dry conditions” shall be blast-cleaned to Sa 3 and Sa 2½ respectively.

(d) Surface Profile

The required surface profile (refer to Clause 37.15.3.1) shall be achieved by final-blasting in accordance with SANS 10064 and ISO 8504-2.Residual Dust and Debris.

Prior to coating, dust and debris shall be removed by vacuum-cleaning in accordance with ISO 8502-3. Subject to the approval of the Engineer, dust and debris may alternatively be removed by blowing with clean uncontaminated compressed air.

(e) Contamination

After final blast-cleaning, un-coated steel shall not be touched with bare hands. All personnel shall wear white gloves and shoe covers where applicable.

37.15.2.7 Flash-Blast Cleaning

Flash blast-cleaning shall be carried out to reinstate the surfaces specified in Clause 37.15.3.1, in accordance with Clause 37.15.2.6.

37.15.2.8 Sweep-Blast Cleaning

Sweep blast-cleaning is used to create a fine, even profile on soft materials and to remove portions of a coating.

TABLE 37/2
THE PARAMETERS FOR SWEEP BLAST-CLEANING

Equipment and air supply	Free of oil and moisture
Nozzle pressure	Not greater than 300 kPa
Nozzle angle to the surface being cleaned	30 to 60°
Sweeping distance	450 to 600 mm
Abrasive – ultra fine non-metallic grit	Minimum 0.2 mm – maximum 0.8 mm
Grit	Only new grit shall be used

37.15.3 Requirements

37.15.3.1 Surface Conditions

Prepared surfaces shall conform to Table 37/3 below:

TABLE 37/3
SURFACE PREPARATION

PROPERTY	FOR DRY CONDITIONS	FOR WET/SUBMERGED CONDITIONS	TAPE WRAPPING
Cleanliness to ISO 8501-1 (min)	Sa 2½	Sa 3	Sa 2(Note b)
Residual dust and debris (ISO 8502-3)	Class 2	Class 1	Class 2
Oil, grease and perspiration	Nil	Nil	Nil

Note:

a) Surface profile and non-visible contaminants (soluble salts) shall be in accordance with the requirements of Clause 37.15.2.5.
b) Only applicable where the pipe has previously been blast cleaned, e.g. field joints.

37.15.3.2 Abrasive Material

(a) Material

The blast-cleaning abrasive material shall be composed of clean, non-recycled, sound hard particles free from foreign substances such as dirt, oil, grease, toxic substances, organic matter, water soluble salts and foreign metals.

(b) Certification

The abrasive material supplier shall certify that all products supplied conform to all the requirements specified.

(c) Shape and Size

The individual abrasive particles shall be angular in shape and within the following sizes:

- Non-metallic material – 0.2 to 0.8 mm; or 0.4 to 1.4 mm
- Metallic material – 0.3 to 0.9 mm

(d) Hardness

The minimum hardness of abrasive material particles shall be as follows:

- For non-metallic abrasive material – 6 on the Moh's scale
- For metallic abrasive material – 390 HV

(e) pH

The pH of the prepared slurry mixture shall not be below 6.2.

(f) Water Soluble Salts

The conductivity of slurry shall be less than 25 mS/m in accordance with ISO 11127.

(g) Moisture Content

The moisture content for abrasive material shall not exceed 0.2%.

(h) Re-cycling

Re-cycled blasting-material shall only be used if:

- The blasting-material was only used on degreased surfaces;

- Dust and debris is removed from the blasting-material; and
- Particles have retained their angularity and remain within specified sizes.

37.15.4 Air Supply

The air pressure at the nozzle shall be a minimum of 600 to 700 kPa.

Air supply equipment shall be fitted with efficient oil and water traps to avoid contamination of the surface.

37.16 SURFACE PREPARATION OF OTHER MATERIALS

37.16.1 Galvanized Surfaces to be Coated

37.16.1.1 Passivation

Galvanized surfaces to be coated shall **not** be passivated.

37.16.1.2 Degreasing

Galvanized steel surfaces shall be degreased prior to coating, using either a water soluble solvent degreaser in accordance with SANS 1344 and the manufacturer's instructions, or a mild acid-detergent degreasing solution to be approved by the Engineer.

37.16.1.3 Surface Profile

(a) Sweep-Blasting

Large areas shall be prepared by sweep-blasting with non-metallic abrasive in accordance with Clause 37.15.2.8. 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 10 µm.

(b) Mechanical

Surfaces that cannot be sweep-blasted shall be abraded manually or mechanically with abrasive paper grade 220 or by using non-metallic abrasive pads.

37.16.1.4 Dust and Debris

All dust and debris shall be removed by vacuum-cleaning immediately prior to the application of the required primer.

37.16.1.5 Primer

Primer for galvanised surfaces shall be applied immediately after surface preparation, not exceeding the time limits specified in Clause 37.15.2.6.

37.16.2 Aluminium Surfaces to be Coated

Aluminium surfaces to be coated shall be treated as follows:

37.16.2.1 Degreasing

Surfaces shall be degreased in accordance with Clause 37.15.2.3.

To preserve an acceptable profile, sweep-blasting shall be used with non-metallic abrasive in accordance with Clause 37.15.2.8.

37.16.2.2 Dust and Debris

All dust and debris shall be removed by vacuum-cleaning immediately prior to the application of the required primer.

37.16.2.3 Primer

Primer for aluminium surfaces shall be applied immediately after surface cleaning, not exceeding the time limits specified in Clause 37.15.2.6.

37.16.3 Corrosion Resistant Steel and Stainless Steel

Components fabricated from stainless steel shall not be contaminated with iron or mild steel.

37.16.3.1 Un-Coated Surfaces

Stainless steel surfaces shall not be contaminated with carbon steel, scratched or stressed.

The following areas shall be pickled and passivated:

- All un-coated areas;
- Ground and sheared edges; and
- Heat affected zones caused by welding or cutting.

Where possible, pickling and passivation shall be done by the dipping process.

Proprietary pickling and passivation chemicals (as supplied by approved suppliers) shall only be used in accordance with the manufacturer's recommendations. Care shall be taken not to exceed the maximum contact time recommended.

After pickling and passivation, surfaces shall be very thoroughly washed with clean potable water to remove all traces of acid. Surfaces shall be allowed to dry, then polished where necessary, using polishing compounds recommended by the stainless steel manufacturer.

37.16.3.2 Surfaces to be Coated

(a) Degreasing

Surfaces shall be degreased in accordance with Clause 37.15.2.3.

(b) Profile

Corrosion resistant steel surfaces shall be blast-cleaned with stainless steel, aluminium oxide or other approved non-ferrous grit or non-metallic abrasive material to create a profile in accordance with the table in Clause 37.15.3.1. The use of steel shot and steel or cast iron grit is strictly prohibited.

Where blast cleaning is impossible, the surface shall be roughened manually with abrasive paper grade 220, disc grinders or flapper wheel abrasive pads. In all instances, clean, uncontaminated equipment shall be used.

(c) Dust and Debris

Dust and debris shall be removed by vacuum-cleaning.

37.16.4 Synthetic Materials to be Coated

37.16.4.1 Degreasing

Surfaces shall be degreased in accordance with Clause 37.15.2.3.

37.16.4.2 Profile

Abrade the surface with abrasive paper grade 220 to achieve a uniform matt finish.

37.16.4.3 Dust and Debris

Dust and debris shall be removed by vacuum-cleaning.

37.16.5 Coated Surfaces

37.16.5.1 Primed Surfaces to be Over-coated

(a) Degreasing

Surfaces shall be degreased in accordance with Clause 37.15.2.3.

(b) Profile

Primers to be over coated outside the over-coating period shall be abraded with abrasive paper grade 220 to a uniform matt finish.

All un-coated areas and all areas with micro rust shall be re-blasted to the original surface finish as specified.

(c) Dust and Debris

Dust and debris shall be removed by vacuum-cleaning.

37.16.5.2 Coated Surfaces to be Repaired

Spot repairs shall be carried out in accordance with the relevant corrosion protection system Specification or as specified by the Engineer. Repairs shall overlap the undamaged area by a minimum of 25 mm. Repairs shall be built up to the original undamaged coating thickness.

(a) Preparation of Bare Areas

Bare areas shall be prepared by spot-blasting to Sa 3 in accordance with Clause 37.15.3.1. If spot-blasting is not possible, the area shall be cleaned with abrasive paper grade 220 to a bright metal surface.

(b) Soluble Salts

The surfaces shall be tested for water soluble salts in accordance with Clause 37.17.2.

(c) Feathering of Coated Surfaces

The surrounding paint, which must be intact, shall be feathered for a minimum distance of 25 mm beyond the damaged areas.

(d) Dust and Debris

Dust and debris shall be removed by vacuum-cleaning.

37.16.5.3 Coated Surfaces to be over Coated

(a) Degreasing

Surfaces shall be cleared of all contamination and degreased in accordance with Clause 37.15.2.3.

(b) Profile

Coated surfaces to be over-coated outside the over-coating period shall be abraded with abrasive paper grade 220 to a uniform matt finish.

(c) Dust and Debris

Dust and debris shall be removed by vacuum-cleaning.

(d) Solvent-wiping

The surfaces to be coated shall be wiped with the solvent specified by the coating manufacturer and approved by the Engineer.

Further coats shall then be applied as specified in the relevant Specification.

37.17 TEST METHODS

Tests, instruments, methods and criteria shall be as specified below or in the relevant Specification.

37.17.1 Free of Oil and Grease

37.17.1.1 Wetting with Water

All surfaces cleaned of oil and grease shall be tested using the “water-break-free” method. The surface shall be wetted with water and the entire surface shall be covered by an unbroken film.

37.17.1.2 Solvent-wiping

Where water soluble lubricants may be present the surface shall be further tested by wiping with a clean cotton wool swab soaked in solvent. No stain shall be evident on the swab after solvent-wiping.

37.17.2 Water Soluble Salt Contaminants

Substrate surfaces shall be tested for the presence of water soluble salt contaminants in accordance with SANS 5770 or by means of the Weber Reilly Test.

37.17.3 Standard of Mechanical Surface Preparation

Mechanical surface preparation shall be visually compared to the standard shown in ISO 8501-1.

37.17.4 Blast Profile

The blast profile of the substrate surfaces shall be determined in accordance with ISO 8503-5 part 5 (replica tape).

37.17.5 Residual Dust and Debris

Substrate surfaces shall be tested for the presence of residual dust and debris in accordance with ISO 8502-3.

37.17.6 Blasting Material

All blasting-materials shall be approved by the Engineer.

37.17.6.1 Metallic Abrasive

Abrasive shall be tested in accordance with ISO 11125 for particle size, hardness, density, foreign matter and moisture.

37.17.6.2 Non-Metallic Abrasive

Non-metallic abrasive material shall be tested in accordance with ISO 11127 for particle size, hardness, density, moisture and water soluble contaminants.

37.17.7 Protection of Works during Painting Operations

The Contractor shall protect all parts of the Works against disfigurement by spatters, splashes and smirches of paint or of paint materials. The Contractor shall be responsible for any damage, paint or dirt caused by his operations to vehicles, persons or property, including plants and animals, and he will be required to provide protective measures at his expense to prevent such damage.

Any paint stains which may result in any unsightly appearance shall be removed or obliterated by the Contractor at his expense.

If passing traffic creates so much dust that it will harm or spoil the appearance of painted surfaces, the Contractor shall, at his expense, sprinkle the adjacent roads and shoulders with water for a sufficient distance, in order to keep dust away from freshly painted surfaces. The Contractor shall also furnish and post "DRIVE SLOWLY" signs at his own expense and take other necessary precautions to prevent dust and dirt from adhering to freshly painted surfaces.

37.18 EPOXY LINING / COATING SYSTEM

The use of the word coating shall denote a coating applied as an external coating or internal lining to any item of plant.

37.18.1 Standards

Equipment, materials and operational methods shall comply with the relevant SANS, ISO, BS, DIN or equivalent American Standard.

The Contractor shall ensure that he is in possession of the latest editions of all the relevant National Specifications, Codes of Practice or Standards referred to in this Specification.

Reference is made to the latest issues of the following Standard Specifications:

SANS	1091	National colour standards for paint.
SANS	1217	The production of painted and powder coated steel pipes.
SANS	5768	Preparation of steel substrates before the application of paints and related products - Test for the assessment of cleanliness of blast-cleaned steel surfaces - Photo-electric reflectance measurement.
SANS	5770	Preparation of steel substrates before the application of paints and related products - Test for the assessment of cleanliness of blast-cleaned steel surfaces - Freedom from certain soluble salts.
SANS	5771	Preparation of steel substrates before the application of paints and related products - Test for the assessment of cleanliness of blast-cleaned steel surfaces - Detection of residual millscale.
SANS	5772	Preparation of steel substrates before the application of paints and related products - Surface roughness characteristics of blast-cleaned steel surfaces - Profile of blast-cleaned surfaces determined by a micrometre profile gauge.
SANS	5775	Preparation of steel substrates before the application of paints and related products - Surface roughness characteristics of blast-cleaned steel surfaces - Profile of blast-cleaned surfaces determined by metallographic section.

SANS	2808	Determination of film thickness.
ISO	8501-1	Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after removal of previous coatings.
BSS	5493	Protective coating of iron and steel structures against corrosion.
SANS	9000	Model for quality assurance in production and installation.

37.18.2 Material

The Contractor shall have the Manufacturer's data sheets of materials to be used available.

Two Pack Epoxies shall be in accordance with SANS 1217. Solvent free Epoxies shall be used unless otherwise approved by the Engineer for specific application conditions.

Special epoxies for abrasion resistant applications shall be reinforced with glass flake or ceramic pigments as appropriate.

Multi-purpose Epoxy shall be surface tolerant, self-priming aluminium pigmented epoxy mastic.

Materials and procedures shall comply with the relevant SANS Specifications and Codes of Practice.

All materials in a coating system shall be purchased from the same manufacturer unless approved by the Engineer. Details of coating materials shall be supplied for approval by the Engineer.

Details of coating materials shall be supplied for approval by the Engineer before use.

The Contractor shall only proceed with the purchase of coating materials upon receipt of written approval from the Engineer.

Materials offered and subsequently approved shall not be changed without written approval of the Engineer.

Coating material selection shall also be approved by the material manufacturer / supplier. The Contractor shall obtain a written assurance from the chosen material supplier that the proposed materials comply with the specified requirements and are suitable for the intended application.

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

- Manufacturer's name;
- Product Brand and Reference Number;
- Batch Number which may incorporate the date of manufacture;
- Abbreviated instructions for storage and use of material, which shall include mixing ratios of the components of multi-component materials, minimum and maximum temperature of application and the method of application; and
- The SANS mark where applicable.

All coating materials shall be kept in an approved dry and enclosed store. The temperature shall not drop below 0°C nor exceed 40°C.

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

37.18.3 Special Coating Areas

Areas that are inaccessible after assembly shall be prepared and fully coated with the specified system to the specified requirements before assembly. The coating shall be fully cured before assembly.

Mating surfaces of joints shall be coated with primer (where specified) or first coat only. The coating shall be uniform in thickness and shall not interfere with the mechanical tolerances. After assembly the outside surface of the joints shall be fully coated.

Steel edges to be welded after coating shall not be coated for a distance of 50 mm from the welding edge for structures and 100 mm from the welding edge for pipes. The unlined strip of grit blasted surface shall be temporarily protected with a coat of (red or a different colour to the lining/coating) weldable primer between coating application and installation.

Friction grip areas shall be left un-coated unless otherwise specified.

Specials (e.g. thrust flanges, bellmouths) which are cast into concrete walls/floors of chambers, pump stations and reservoirs, and pipes which are encased (e.g. anchor blocks) shall be externally overcoated with glass flake reinforced epoxy.

Localised internal surfaces of pipes, valves and specials subject to accelerated abrasion/erosion conditions shall be overcoated with glass flake or ceramic reinforced epoxy after application of the standard epoxy lining as indicated on drawings.

Factory lined pipes shall be lined with glass flake or ceramic reinforced epoxy applied directly to the steel surface at the pipe mill. Field joint linings shall be of a similar material.

Where indicated on drawings, pumps for abrasive conditions shall be lined with glass flake or ceramic reinforced epoxy applied directly to the surface of the impeller / casing.

37.18.4 Acceptability of Items to be Coated

Items to be coated shall be assessed in accordance with ISO 12944-3.

37.18.5 Surface Preparation

The Contractor shall satisfy himself that the condition of each item to be coated is such that it is fit for coating or lining, or both, as relevant. Immediately after surface preparation each item or special shall be examined, including the inside surface, where possible, for compliance with the relevant requirements of this Sub-clause.

Pre- and surface preparation shall conform to Clauses 37.13 and 37.15 respectively.

For pipes and specials intended for butt welding the prepared surfaces shall extend to the pipe ends.

37.18.6 Coating Thicknesses

Coating thicknesses shall conform to Clause 37.10.

37.18.7 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 by the Contractor unless otherwise specified in the Specifications or instructed by the Engineer.

The following details shall be made available to the applicator:

- Brand and type of epoxy resin;
- Mixing and thinning instructions;
- Recommended type and quantity of solvent required for thinning during application;
- Pot life of mixed product;
- Minimum and maximum recommended dry film thickness per coat;
- Recommended time intervals between coats;
- Recommended minimum and maximum steel surface temperatures during application;
- Time for complete drying and curing on steel surfaces;
- All relevant information the Supplier wishes to submit on his product; and
- Recommended method of coating application.

Verbal information by the manufacturer's representative will not be accepted unless confirmed in writing.

37.18.8 Coating Application

37.18.8.1 Environmental Conditions

(a) Dusty Conditions

Coatings shall not be applied in dusty or contaminated conditions.

(b) Surface Temperature

Coatings shall not be applied if the surface temperature of the base metal is less than 3°C above dew point or outside the range 5 - 40°C, unless otherwise specified by the coating manufacturer.

(c) Relative Humidity and Time of Application

Refer to Clause 37.15.2.6.

(d) Ambient Temperature

Coatings shall not be applied when the ambient temperature is less than the minimum or greater than the maximum specified by the manufacturer of the coating material.

37.18.8.2 Mixing

The Contractor shall ensure that all paints are mixed in accordance with the requirements of BS 5493.

All coating components, particularly two- or multi-component materials, shall be thoroughly mixed until a homogeneous mixture is achieved.

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

In the case of solvent based Epoxy materials, it is recommended that the mixed material be allowed to stand for an induction period, as recommended by the manufacturer, before use.

During application, coating materials shall be agitated regularly to keep the solids in suspension.

The preparation time, induction time and pot life of these materials shall be closely adhered to.

37.18.8.3 Application Requirements

(a) Equipment

Application equipment shall be maintained in a clean condition and in good working order.

The use of equipment not maintained in good condition may lead to rejection of the coating.

(b) Compatibility of Coats

All primer, intermediate and finishing coats shall be mutually compatible.

(c) Surface Restoration

Should immediate lining/coating not be possible, or should any atmospheric oxidisation take place between the completion of blast cleaning and commencement of lining / coating, such oxidisation shall be removed by flash blasting to restore the specified surface finish. Removal of dust and debris shall be in accordance with Clause 37.15.

(d) Supports

During coating application, the items shall be so supported to prevent damage to the wet coatings until the coatings have hardened adequately. Items shall remain supported during curing, storing and handling.

37.18.8.4 Method of Application

(a) Application

Epoxy coatings shall be applied by any appropriate method recommended by the manufacturer thereof, and approved by the Engineer.

(b) First Coat

The first coat shall be applied to a minimum dry film thickness of 40 µm above the peaks of the blast profile.

(c) Cleanliness

During application and curing of the layers, the items shall be protected against contamination by dust or other foreign matter and shall be kept dry and shaded from direct sunlight.

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

Operators handling blast-cleaned or partially painted surfaces shall wear clean gloves to avoid contamination of the surface.

(d) Stripe Coat and Crevices

All metal edges, up stands, welds, bolts and nuts shall be adequately coated. Additional stripe coatings shall be applied after initial priming, if ordered by the Engineer.

Special attention shall be given to crevices and edges to ensure complete coverage and uniform paint thickness.

(e) Second and Subsequent Coats

The second and subsequent layers shall then be applied within the recommended over-coating periods.

(f) Coat Colours

The colour of each subsequent coat shall be different from that of the previous coat except where two finishing coats of the same colour are necessary to achieve colour uniformity.

(g) Over-coating Times

Over-coating times shall be not less than the minimum nor greater than the maximum specified by the manufacturer relevant to the ambient temperature.

Strict adherence to over-coating times is particularly important for coatings which are subsequently immersed.

37.18.8.5 Pipe Ends

(a) Extension of Lining

For flanged pipes or specials and pipes or specials intended for joining with flexible couplings or for Site welding by means of double sleeve weld-on couplings, the lining shall extend to the ends of pipes and specials including edges and shall overlap by at least 300 mm on the outside of the pipe. Coatings shall overlap epoxy surfaces on the outside by at least 25 mm.

(b) Butt Weld Edges

For pipes and specials intended for Site butt-welding, lining and coating shall extend up to a distance of 50 mm from pipe ends. The unlined circumferential strip of grit blasted surface shall be temporarily protected between the Works and Site with a coat of weldable primer (of a different colour to the lining / coating).

37.18.8.6 In-situ Applied Epoxy Lining

In-situ application shall only be used to make good defects that occurred during handling and transportation. No welding whatsoever shall be performed on any pipe or special on which the lining or coating has been completed, without the approval in writing of the Engineer. The temporary protected surfaces shall be blast cleaned before coating with the specified system. The approval shall only be considered by the Engineer after submission by the Contractor of acceptable proposals/method statements for making good un-coated and damaged areas.

37.18.8.7 Protection with Tape Wrap

Pipes to be tape wrapped before being buried in soil, shall be wrapped in accordance with Clause 37.24.3.4.

37.18.9 Over-Coating with Polyurethane

37.18.9.1 Wet, Submerged or High Humidity Conditions

(a) Pure Aliphatic Polyurethane

- The area to be over-coated shall be abraded with abrasive paper grade 220 to a uniform matt finish;
- The surface shall be vacuum-cleaned to remove dust and debris – refer to Clause 37.15.2.6;
- Contaminants shall be removed and surfaces prepared by wiping with an organic solvent; and
- Over-coat with a layer of pure Aliphatic Polyurethane in accordance with the Colour Code, Annexure 37/1.

37.18.9.2 Dry or UV Conditions

(a) Recoatable Polyurethane

The area to be over-coated shall be abraded with abrasive paper grade 220 to a uniform matt finish.

The surface shall be vacuum-cleaned to remove dust and debris – refer Clause 37.15.2.6; and over-coat with a layer of recoatable Polyurethane in accordance with the colour code, Annexure 37/1.

37.18.10 Quality of Coating

37.18.10.1 Finish

The fully cured coating shall have a uniform, smooth, gloss finish.

37.18.10.2 Dry Film Thickness (DFT)

The Epoxy coating shall be evenly applied to the minimum final film thickness as specified in Clause 37.10 and shall be tested in accordance with Clause 37.18.11.

37.18.10.3 Electrical Insulation Defects

All coated surfaces subjected to wet environments under normal service conditions shall show no electrical insulation defects when tested in accordance with Clause 37.18.11.

37.18.10.4 Finishing Coat Colours

The finishing coat colours shall be as specified in the Colour Code, Annexure 37/1.

Where not specified, the selection of final colours shall be approved by the Engineer.

37.18.10.5 Solvent Entrapment

Coatings showing evidence of entrapped solvents after full cure will be rejected. No inter-coat de-lamination shall be allowed.

The Contractor shall be held responsible for blistering of coatings, when shown to be caused by solvent retention.

37.18.11 Testing

To be read in conjunction with Clause 37.4.1.

37.18.11.1 Contractor's and Engineer's Inspections

Clauses 37.4.4 and 37.4.5 shall apply.

37.18.11.2 Visual Inspection

All surfaces shall be inspected visually and shall be free from tears, runs, sags, wrinkles, blisters, change in colour or gloss, orange peel, dirt, visible pinholes, dust or fluff occlusions or any other visible defects.

37.18.11.3 Holiday Inspection (Electrical Insulation Defects Inspection)

100% of the lining and coating of all pipes and pipe specials shall be tested and there shall be no electrical insulation defects on any area inspected.

Except on coating containing conductive pigment (Zn, Al), low-voltage wet sponge electrical insulation defects inspection shall be carried out in accordance with SANS 1217 for coatings and linings of thickness not exceeding 500 µm.

For coatings exceeding 500 µm thickness, the high voltage, sparking electrical insulation defects detector shall be used in accordance with SANS 1217.

37.18.11.4 Dry Film Thickness (DFT)

Measurements shall be taken in accordance with SANS 2808.

100% of all coating thicknesses measured shall comply with the minimum thicknesses set out in Clause 37.10.

In the case of coats applied after the erection of plant on Site, the frequency at which measurements of the DFT are taken shall be at the discretion of the Engineer, and may be dictated by accessibility.

DFT in excess of the prescribed maxima shall not necessarily constitute reason for rejection if the paint film is demonstrated to be sound in all respects and subject to the approval of the Engineer.

The method used to measure DFT, and the significance of the readings for each particular item, shall be subject to the approval by the Engineer prior to commencement of the coating work.

37.18.11.5 Automated Shop Applied Lining and Coating

The film thickness on the first pipe of a production run and thereafter on at least one pipe selected at random from every day's production, but not less than one pipe out of every ten pipes, shall be measured non-destructively by an approved eddy current instrument. At least four readings at equally spaced intervals around the circumference, approximately 300 mm from each end of the pipe, shall be taken. The first reading shall be over the weld bead. When practicable an additional four readings at equally spaced intervals around the circumference in the centre of the pipe shall be taken. The thickness shall not be less than the minimum specified over 100% of the area including weld beads. The Engineer may at his discretion supplement the above test by checking wet film thickness on any or all pipes during application of the coating.

37.18.11.6 Hand and In-situ Applied Lining and Coating

All the hand applied lining and coating thicknesses shall be tested by means of an approved eddy current or magnetic instrument. At least four readings shall be taken at equally spaced intervals around the pipe circumference at any test point. The first reading shall be over the weld bead. The thickness shall not be less than the minimum specified over 100% of the area including weld beads.

37.18.11.7 Degree of Cure of Two-Component Materials

The degree of cure of a two-component material will vary with time, temperature and ventilation and shall be assessed by solvent wiping in accordance with the method given in SANS 1217 (Methyl Ethyl Ketone Resistance Test).

37.18.12 Damaged Coatings

Repair procedures shall be approved by the Engineer and repairs will be subject to inspections as set out in Clause 37.18.11. Where the damage is extensive the particular remedial procedures for each such instance shall be agreed with the Engineer in writing.

All repairs shall comply with the requirements of the repair-product manufacturer’s data sheet. The Engineer may at his discretion request that repaired coating areas undergo adhesion tests.

Any damage occurring during transit from the Contractor’s premises to the Site shall be the responsibility of the Contractor. The Contractor shall repair any damage occurring on Site during handling, assembly, storage, transport and erection.

A repaired area shall be tested in accordance with Clause 37.18.11 for compliance with the relevant requirements for thickness and electrical insulation defects respectively.

Any item showing electrical insulation defects exceeding an average of five per square metre (a cluster of pinholes within a radius of 25 mm being regarded as a single defective area), or flaking or other signs of loss of adhesion, shall not be repaired. The item shall be blast cleaned and re-coated in accordance with the relevant requirements of this Section.

37.18.12.1 Repair Methods for Minor Defects

The repair of areas showing electrical insulation defects or low film thickness shall, if approved by the Engineer, be carried out as follows:

- Degrease in accordance with Clause 37.15.2.3;
- Thoroughly abrade the damaged area, including an adjacent surrounding area of at least 25 mm wide, with a medium grade 220 abrasive paper;
- Vacuum-clean the surface to remove dust and debris in accordance with ISO 8502-3 and Clause 37.15.2.6;
- Wipe the abraded paint surface with methyl ethyl ketone and allow to dry; and
- Apply as many coats of repair material as necessary to achieve the specified electrical insulation thickness and finish.

NOTE:

- When solvent borne materials are used, curing time between coats, as specified by the coating material manufacturer, shall be adhered to.
- Apply a final top coat over the repaired area to achieve a pleasing, uniform finish of the item.

37.18.12.2 Repair Methods for Major Defects

The repair of areas showing damage down to the steel surface shall, if approved by the Engineer, be carried out as follows:

- Degrease in accordance with Clause 37.15.2.3;
- Blast-clean all damaged areas to Sa 3 (ISO 8501-1);
- Feather the surrounding paint for a distance of 25 mm beyond the damaged areas with a medium grade 220 abrasive paper;
- Vacuum-clean the surface to remove dust and debris in accordance with ISO 8502-3 and Clause 37.15.2.6;
- Wipe only the abraded paint surface with methyl ethyl ketone and allow to dry; and
- Apply as many coats of repair material as necessary to achieve the specified thickness and finish.

NOTE:

- When solvent borne materials are used, curing time between coats, as specified by the coating material manufacturer, shall be adhered to.
- Apply a final top coat over the repaired area to achieve a pleasing, uniform finish of the item.

37.18.12.3 Pipe Field Joints for Epoxy Linings

Internal corrosion protection of welded field joints for pipes with epoxy linings shall be provided by the installation of an epoxy paint system the same as that of the epoxy lining system applied for the pipe. Installation of the epoxy system for the corrosion protection of the welded field joint shall comply in full with Clause 37.18.

The surface preparation of the field joint area shall be as specified in Clause 37.18.12.2.

The epoxy system shall be applied as specified in Clause 37.18.12.2.

37.19 FUSION BONDED EPOXY COATING SYSTEM (HEAVY DUTY)

37.19.1 Standards

Equipment, materials and operational methods shall comply with the relevant SANS, ISO, BS, DIN or equivalent American Standard.

The Contractor shall ensure that he is in possession of the latest editions of all the relevant National Specifications, Codes of Practice or Standards referred to in this Section.

Reference is made to the latest issues of the following Standards:

SANS	1217	The production of painted and powder coated steel pipes.
SANS	8502-3	Cleanliness of blast-cleaned steel surfaces for painting (dust and debris).
SANS	5772	Profile of blast-cleaned steel surfaces for painting.
SANS	2808	Determination of film thickness.
ISO	8501-1	Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after removal of previous coatings.
BSS	5493	Protective coating of iron and steel structures against corrosion.
SANS	9000	Model for quality assurance in production and installation.

37.19.2 Material

Material used shall conform to SA*N*S 1217, Type 2, powder coating.

37.19.3 Application

37.19.3.1 Surface Preparation

Pre- and surface preparation shall conform to Clauses 37.13 and 37.15 respectively.

37.19.3.2 Coating Thicknesses

Coating thicknesses shall conform to Clause 37.10.

37.19.3.3 Coating Application

Items shall be heated to a temperature of 200°C (only applicable to heavy items) and coated with Fusion-bonded Epoxy by means of an electrostatic powder gun.

The normal procedures pertaining to powder application shall apply.

On completion of the coating, items shall be cured for 60 minutes at 200°C (mean temperature).

37.19.4 Quality of Coating

Refer to Clause 37.18.10.1.

37.19.5 Testing

To be read in conjunction with Clause 37.4.1 and SANS 1217.

37.19.5.1 Contractor's and Engineer's Inspections

Clauses 37.4.4 and 37.4.5 shall apply.

37.19.5.2 Visual Inspection

All surfaces shall be inspected visually and shall be free from tears, runs, sags, wrinkles, blisters, change in colour or gloss, orange peel, dirt, visible pinholes, dust or fluff occlusions or any other visible defects.

37.19.5.3 Holiday Inspection (Electrical Insulation Defects Inspection)

100% of all coated surfaces shall be tested and there shall be no electrical insulation defects on any area inspected.

For films exceeding 500 µm thickness, a high voltage, electrical insulation defects detector shall be used in accordance with SANS 1217.

37.19.5.4 Film Thickness

Measurements shall be taken in accordance with SANS 2808.

100% of all coating thicknesses measured shall comply with the minimum requirements of Clause 37.10.

Film thickness in excess of the prescribed maxima shall not necessarily constitute reason for rejection if the coating is demonstrated to be sound in all respects, subject to the approval of the Engineer.

The method used to measure film thickness, and the significance of the readings for each particular item, shall be subject to approval by the Engineer prior to commencement of the coating work.

37.19.5.5 Degree of Cure of Fusion-Bonded Materials

The degree of cure of fusion-bonded material shall be assessed by solvent wiping in accordance with the method given in SANS 1217 (Methyl Ethyl Ketone Resistance Test).

37.19.6 Damaged Coatings

Repair procedures shall be subject to approval by the Engineer and repairs will be subject to inspection as set out in Clause 37.18.11.

Where the damage is extensive the particular remedial procedure for that instance shall be agreed in writing with the Engineer.

All repairs shall comply with the requirements of the repair-product manufacturer's data sheet. The Engineer may at his discretion request that repaired coating areas undergo adhesion tests.

Any damage occurring during handling and transit from the Contractor's premises to Site shall be the responsibility of the Contractor. The Contractor shall also repair any damage occurring on Site during handling, assembly, storage, transport and erection.

A repaired area shall be tested in accordance with Clause 37.18.11 for compliance with the relevant requirements for thickness and electrical insulation defects respectively.

Any item showing electrical insulation defects exceeding an average of five per square metre (a cluster of pinholes within a radius of 25 mm being regarded as a single defective area), or flaking or other signs of loss of adhesion, shall not be repaired. The item shall be blast cleaned and re-coated in accordance with the relevant requirements of the Specification.

37.19.7 Repair Methods for Minor Defects

The repair of areas showing electrical insulation defects or low film thickness shall, if approved by the Engineer, be carried out as follows:

- Degrease in accordance with Clause 37.15.2.3;
- Thoroughly abrade the damaged area, including an adjacent surrounding area of at least 25 mm wide, with a medium grade 220 abrasive paper;
- Vacuum-clean the surface to remove dust and debris in accordance with Clause 37.15.2.6;
- Wipe the abraded paint surface with methyl ethyl ketone and allow to dry; and
- Apply as many coats of one of the following repair materials as necessary to achieve the specified electrical insulation, film thickness and finish:
  - Solvent free Epoxy, or
  - Fusion-bonded Epoxy powder repair kit.

NOTE:

- Apply a final top coat over the repaired area to achieve a pleasing, uniform finish of the item.

37.19.8 Repair Methods for Major Defects

The total un-coated areas for renovation by the applicator shall not exceed 0.5 percent of the total surface area of a component. Each un-coated area for renovation shall not exceed 2 500 mm². If damaged areas are larger, the items containing such areas shall be re-coated.

The repair of areas showing damage down to the steel surface shall, if approved by the Engineer, be carried out as follows:

- Degrease in accordance with Clause 37.15.2.3;
- Blast-clean all damaged areas to Sa 3 (ISO 8501-1);
- Feather the surrounding paint for a distance of 25 mm beyond the damaged areas with a medium grade 220 abrasive paper;
- Vacuum-clean the surface to remove dust and debris in accordance with SANS 8502-3 and Clause 37.15.2.6;
- Wipe only the abraded paint surface with methyl ethyl ketone and allow to dry; and
- Apply as many coats of the following repair material as necessary to achieve the specified thickness and finish:
  - Solvent free Epoxy; or
  - Fusion-bonded Epoxy powder repair kit.

NOTE:

- Apply a final top coat over the repaired area to achieve a pleasing, uniform finish of the item.

37.20 POWDER COATINGS AS SPECIFIED IN SANS 1274

37.20.1 Standards

Equipment, materials and operational methods shall comply with the relevant SANS, ISO, BS, DIN or equivalent American Standards.

The Contractor shall ensure that he is in possession of the latest editions of all the relevant National Specifications, Codes of Practice or Standards referred to in this Section.

Reference is made to the latest issues of the following Standards:

SANS	10064	The preparation of steel surfaces for coating
SANS	1217	The production of painted and powder coated steel pipes.
SANS	1274	Coatings applied by the powder-coating process.
SANS	8502-3	Cleanliness of blast-cleaned steel surfaces for painting (dust and debris).
SANS	5772	Profile of blast-cleaned steel surfaces for painting.
ISO	2808	Determination of film thickness.
ISO	8501-1	Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after removal of previous coatings.
BSS	5493	Protective coating of iron and steel structures against corrosion.
ISO	9000	Model for quality assurance in production and installation.

37.20.2 Material

Material shall conform to SANS 1274. Type powder coating shall be as specified in this Section.

37.20.3 Application

37.20.3.1 Surface Preparation

Pre- and surface preparation shall conform to Clauses 37.13 and 37.15 respectively.

If abrasive blast-cleaning is not practical, a surface conversion hot applied coating in accordance with SANS 10064, Section 5 shall be applied.

37.20.3.2 Coating Thicknesses

Coating thicknesses shall conform to Clause 37.10.

37.20.3.3 Coating Application

The coating shall be applied by means of an electrostatic powder gun and the application of heat treatment to initiate fusion of the powder.

37.20.4 Quality of Coating

37.20.4.1 Finish

The fully cured coating shall have a uniform, smooth, gloss finish.

37.20.4.2 Film Thickness

The coating shall be evenly applied to the minimum final film thickness as specified Clause 37.10 and shall be tested in accordance with Clause 37.20.5.4.

37.20.4.3 Electrical Insulation Defects

All coated surfaces exposed to wet environments under normal service conditions shall show no electrical insulation defects when tested in accordance with Clause 37.19.5.3.

37.20.4.4 Finishing Coat Colours

The finishing coat colours shall be as specified in Annexure 37/1.

Where not specified, the selection of final colours shall be made by the Engineer.

37.20.5 Testing

To be read in conjunction with Clause 37.4.1.

37.20.5.1 Contractor's and Engineer's Inspections

Clauses 37.4.4 and 37.4.5 shall apply.

37.20.5.2 Visual Inspection

All surfaces shall be inspected visually and shall be free from tears, runs, sags, wrinkles, blisters, change in colour or gloss, orange peel, dirt, visible pinholes, dust or fluff occlusions or any other visible defects.

37.20.5.3 Holiday Inspection (Electrical Insulation Defects Inspection)

All coated surfaces exposed to wet environments under normal service conditions shall show no electrical insulation defects when tested in accordance with Clause 37.19.5.

For films exceeding 500 µm thickness, a high voltage, electrical insulation defects detector shall be used in accordance with SANS 1217.

37.20.5.4 Film Thickness

Measurements shall be taken in accordance with ISO 2808.

100% of all coating thicknesses measured shall comply with the minimum requirements of Clause 37.10.

DFT in excess of the prescribed maxima shall not necessarily constitute reason for rejection if the paint film is demonstrated to be sound in all respects subject to the approval of the Engineer.

The method used to measure DFT, and the significance of the readings for each particular project, shall be subject to the approval of the Engineer prior to commencement of the coating work.

37.20.5.5 Degree of Cure of Fusion-Bonded Materials

The degree of cure of fusion-bonded material shall be assessed by solvent wiping in accordance with the method given in SANS 1217 (Methyl Ethyl Ketone Resistance Test for Epoxy materials).

37.20.6 Damaged Coatings

No repairs of damaged coatings will be accepted.

37.21 GALVANIZING (HEAVY DUTY)

37.21.1 Standards

Reference is made to the latest issues of the following Standards:

SANS	14713	Protection against corrosion of iron and steel in structures - guidelines.
SANS	32	Internal/external protective coatings for steel tubes.
SANS	121	Hot-dip galvanized coatings on fabricated iron and steel articles.
SANS	5772	Profile of blast-cleaned steel surfaces for painting.
SANS	2063	Metallic and other inorganic coatings – Thermal spraying.
SANS	2808	Determination of film thickness.

ISO	8501-1	Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after removal of previous coatings.
SANS	10374-1	The suitability of hot-dip galvanized steel piping for the transportation of water.
SANS	1344	Medium duty solvent detergent.
ISO	752	Zinc ingots.
EN	1179	Zinc and zinc alloys – primary zinc.
SANS	9000	Model for quality assurance in production and installation.

37.21.2 Material

Impurities in the molten zinc, as defined in ISO 752 and EN 1179, shall not exceed a total of 1.5%.

Steel to be hot-dip galvanized shall be as listed below. In both cases material certification shall be supplied:

a) For aesthetic appearance:
- Aluminium killed steel; or
- Silicon-killed steel with a Silicon content not exceeding 0.04% and a Phosphorus content not exceeding 0.02%.

b) For general corrosion protection:
- Aluminium killed steel; or
- Silicon killed steel with a Silicon content not exceeding 0.25% and a Phosphorus content not exceeding 0.02%.

The condition of articles to be hot-dip galvanized shall comply with “Annexure C” of SANS 121.

The condition of tubes to be hot-dip galvanized on a continuous line shall comply with “Annexure A” of SANS 32.

37.21.3 Application

Galvanizing shall only be done by members of the Hot Dip Galvanizers Association of Southern Africa (HDGASA) in accordance with SANS 9000 and for tubes shall be in accordance with SANS 121 and SANS 32.

37.21.4 Requirements

37.21.4.1 Steel Specials

Steel Specials shall be in accordance with Clause 6 of SANS 121.

(a) Surface

Surfaces shall be free from nodules, blisters, roughness and sharp points. Un-coated areas, flux residues, lumps and zinc ash will not be permitted.

Notwithstanding Clause 6.1 of SANS 121, in the case of handrails etc. a high quality surface finish is required and a bright smooth surface shall be achieved. Double dipping shall not be allowed.

(b) Thickness

The thickness of hot-dip galvanizing shall comply with the requirements of Clause 37.10.

Heavy duty coatings are required except in the following cases:

- Where a high surface finish is required; and
- Where otherwise specified in this Section.

37.21.4.2 Steel Tubes (where not covered under Clause 37.10)

Steel tubes shall be in accordance with Clause 7 of SANS 32.

(a) Surface

The surface of the coating shall be continuous, smooth and free from flux residues.

(b) Thickness

The thickness shall comply with the requirements of the coating quality A1, in accordance with Clause 8, Table 1 of SANS 32, as specified below.

TABLE 37/4
MINIMUM LOCAL COATING THICKNESS REQUIREMENTS

REQUIREMENTS	COATING QUALITY A1
Minimum local coating thickness on the inside surface except at the weld bead	55 µm
Minimum local coating thickness on the inside surface at the weld bead	28 µm
Minimum local coating thickness on the outside surface	55 µm

(c) Adhesion

The coating shall show no evidence of flaking or cracking when tested in accordance with Clause 11.4 of SANS 32.

(d) Coating Qualities

Coating qualities shall be A1 for water installations – see Sub-Clause 8.2 of SANS 32.

The surface of the coating on the inside shall be as smooth as can be achieved by steam blowing.

37.21.5 Testing

37.21.5.1 Steel Items

To be read in conjunction with Clause 37.4.1.

(a) Visual Examination

Where a superior aesthetic appearance of hot-dip galvanizing is requested, a bright mirror surface finish shall be achieved by the galvanizer.

(b) Thickness

Thicknesses shall be in accordance with Clause 37.10 and shall be tested in accordance with SANS 121.

37.21.5.2 Steel Tubes

To be read in conjunction with Clause 37.4.1.

(a) Visual Examination

Where a superior aesthetic appearance of hot-dip galvanizing is requested, a bright mirror surface finish shall be achieved by the galvanizer.

(b) Thickness

Shall be tested in accordance with SANS EN 10240.

(c) Adhesion

Shall be tested in accordance with SANS EN 10240.

(d) Chemical Analysis

Shall be tested in accordance with SANS EN 10240.

37.21.6 Repair Methods

37.21.6.1 Steel Items

The total un-coated areas for renovation by the galvanizer shall not exceed 0.5% of the total surface area of a component. Each un-coated area for renovation shall not exceed 400 mm². If un-coated areas are larger, the item containing such areas shall be re-galvanized.

The repair method shall be approved by the Engineer before repairs are initiated.

Repairs shall be by zinc thermal spray in accordance with SANS 2063 or three component zinc solvent free Epoxy repair system. The repair shall include removal of any scale, cleaning and any necessary pre-treatment to ensure adhesion – refer to Clause 37.15.

The coating thickness on the renovated areas shall be a minimum of 30 µm more than the local coating thickness specified in Clause 37.21.4.1 for the relevant hot-dip galvanized coating unless otherwise specified by the Engineer. The coating on the renovated areas shall be capable of giving sacrificial protection to the steel to which it is applied.

37.21.6.2 Steel Tubes

Repairs shall not be allowed on internal surfaces of tubes. Where repairs are required, tubes shall be re-galvanized. Repairs on external surfaces shall be in accordance with Clause 37.21.6.1.

37.22 DUPLEX SYSTEM (HOT-DIP GALVANIZING + ORGANIC COATING)

37.22.1 Surface Preparation

37.22.1.1 Surface Passivation

Items to be over-coated shall not be passivated.

37.22.1.2 Contaminants and Physical Factors

The following contaminants shall be removed:

- Galvanizing residues and passivation products;
- Oil and grease;
- Perspiration and oil contamination from contact with hands; and
- Dust and chemical contamination.

37.22.1.3 Degreasing

Galvanized steel surfaces shall be degreased prior to coating, using either a water soluble solvent degreaser in accordance with SANS 1344 and the manufacturer's instructions, or a mild acid-detergent degreasing solution to be approved by the Engineer.

37.22.1.4 Sweep Blast-cleaning

Large areas shall be prepared by sweep-blasting with non-metallic abrasive in accordance with Clause 37.15.2.8. Cracking, flaking, or any form of de-lamination of the zinc coating due to

excessive blast-cleaning will not be permitted. Amount of zinc removed by blast-cleaning shall not exceed 10 µm.

37.22.1.5 Mechanical Cleaning

Surfaces that cannot be sweep-blasted shall be abraded manually or mechanically with abrasive paper grade 220 or non-metallic abrasive pads.

37.22.2 Application

Coatings shall be applied immediately after surface preparation in accordance with Clause 37.15. All coating materials shall be applied strictly in accordance with the manufacturer's instructions.

In the case of nuts, bolts and other fasteners, care shall be taken to ensure that all edges are over-coated to the minimum specified thickness.

Only coatings approved by the Engineer for application on hot-dip galvanized surfaces shall be used.

For additional protection under high humidity conditions and for colour coding Epoxy and Polyurethane coatings shall be applied to thicknesses specified in Clause 37.10.

Epoxy primer may not be required if appropriate two pack Epoxy / recoatable or pure Aliphatic Polyurethane is being used.

37.22.3 Repairs of Duplex System

To repair coatings damaged during transportation, handling or erection, the following procedures shall be followed:

37.22.3.1 Damage Down to Bare Steel

Degrease in accordance with Clause 37.15.2.3.

Thoroughly abrade the damaged area, including an adjacent surrounding area of at least 25 mm wide, with grade 80 abrasive paper.

Vacuum-clean the surface to remove dust and debris in accordance with SANS 8502-3 and Clause 37.15.2.6.

Where originally over-coated with two component Epoxies, wipe the surface with methyl ethyl ketone and allow to dry.

Apply sufficient coats of three component zinc solvent free Epoxy to a dry film thickness of 30 µm more than the original thickness of the zinc.

When dry, apply the same system as originally applied so as to cover the damaged area extending for 25 mm over the surrounding area.

NOTE:

- When solvent borne materials are used, curing time between coats, as specified by the coating material manufacturer, shall be adhered to.
- Apply a final top coat over the repaired area to achieve a pleasing, uniform finish of the item being repaired.

37.22.3.2 Damage Down to Zinc Surface

Prepare the surface as described in Clause 37.22.3.1.

Apply coating as described in Clause 37.22.3.1.

NOTE:

- When solvent borne materials are used, curing time between coats, as specified by the coating material manufacturer, shall be adhered to.
- Apply a final top coat over the repaired area to achieve a pleasing, uniform finish of the item being repaired.

37.23 BITUMEN COATING SYSTEMS

Traditional (oxidised, blown) hot applied bitumen/fibreglass systems are no longer available in South Africa. Repair and/or modifications to existing pipelines which may have this coating system will be handled using Polymer Modified Bitumen. Refer to Clause 37.30 of this specification.

37.24 TAPE WRAPPING SYSTEM

37.24.1 Standards

Reference is made to the latest issues of the following Standards:

SANS	1117	Plastic wrappings for the protection of steel pipelines.
SANS	10129	Plastics tape wrapping of steel pipelines.
ISO	8501-1	Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after removal of previous coatings.
SANS	9000	Model for quality assurance in production and installation.

37.24.2 Material

Polyethylene pressure-sensitive tape or polyethylene laminated to an elastomeric layer of butyl rubber tapes shall conform to SANS 1117, types A, B or C.

37.24.3 Application

37.24.3.1 General

Steel pipes, fittings and specials, protected by means of tapes, shall be wrapped in accordance with SANS 10129 as amended and supplemented by this Section. All pipes shall be wrapped outside the trench in accordance with acceptable factory applications. Tape wrapping may be carried out in an "over the trench" operation for pipe diameters up to 450 mm.

If in the opinion of the Engineer adverse weather conditions are such as to interfere with the successful application of an efficient corrosion protective wrapping, he shall order a stoppage of work. The Contractor will be deemed to have accepted this risk and made provision for it in his rates.

37.24.3.2 Surface Preparation

Steel pipe surface preparation shall conform to Clause 37.15.

37.24.3.3 Priming

The appropriate primer shall be applied immediately after surface preparation but not later than 4 hours after cleaning, provided the pipe surfaces are kept dry and free from dust.

37.24.3.4 Normal Wrapping

Tape wrapping shall be applied with sufficient pre-tensioning immediately after priming, and shall ensure a smooth wrap free from wrinkles, blisters, frayed or torn edges, cracks or other defects at temperatures up to 65°C.

For normal wrapping, tape shall be applied in two layers with a minimum overlap of 50 mm on both the inner and outer wraps.

Tape joints and repairs shall be done in accordance with SANS 10129.

Hand wrapping shall only be allowed for short lengths that are inaccessible to a wrapping machine, specials, joints, small diameter pipes and small repairs – refer to Clause 37.24.6.

37.24.3.5 Armouring

Where armour wrapping is specified, two layers of tape wrapping shall first be applied with sufficient pre-tensioning immediately after priming, and shall ensure a smooth wrap free from wrinkles, blisters, frayed or torn edges, cracks or other defects even at temperatures up to 65°C.

The first layer of wrap shall overlap by half the tape width plus 25 mm and the second wrap shall overlap by not less than 50 mm.

The above-mentioned layers of tape shall be armoured by the application of a third layer of pressure-sensitive polyethylene tape with a carrier thickness of 750 micrometres and a minimum overlap of 50%.

Armoured wrappings shall generally be applied at the following positions:

- All road crossings through sleeves and culverts;
- All railway crossings through sleeves or culverts; and
- Wherever the Engineer may consider that special conditions warrant such measures.

37.24.3.6 Wrapping of Specials

In the case of specials or pipe lengths where length and/or shape preclude the application of a protective wrapping system by any means, the protection shall be carried out either by polymer modified bitumen or epoxy coating in accordance with Clauses 37.30.7 or 37.18.8 respectively. In the case of access, scour, air valve and farmers off-take tees the special shall be deemed to incorporate at least two (2) diameter lengths either side of the main tee barrel.

37.24.3.7 Armour Wrapping of Pipes Coated with Other Systems

Where armour wrapping of coated pipes is specified, a single layer of pressure-sensitive polyethylene tape with a carrier thickness of 750 micrometres and a minimum overlap of 50% shall be applied.

37.24.3.8 Application of cold tape wrapping on site

This applies to field joints and any other pipe sections requiring supplementary wrapping. The Cold Tape Wrapping system shall consist of a primer, an inner wrapping tape and an outer wrapping tape, as described below.

(a) Primer Application

Once the Liquid Applied Field Joint Coating has reached full cure and has been inspected, the cold tape wrapping procedure shall be as follows:

- The factory applied coated pipe surface to which the cold tape wrapping is to be applied shall be abraded with 40 grit abrasive paper or sweep blasted for 100 mm;
- The entire joint surface to be wrapped shall be primed with a suitable primer (e.g. Denso Primer D);
- Priming shall not be carried out further ahead of physical tape wrapping than a maximum of 4 hours;
- Ensure the primer is dust free prior to application of a tape wrap system. If the primer has become severely contaminated with dust, a re-prime shall be carried out. Heavy contamination with sand or dirt shall require cleaning of the surface with a manufacturer recommended cleaning solvent (e.g. Denso Cleaning Solvent) and re-application of the primer; and
- Allow approximately 30 minutes drying time or until the primer is tacky to the touch.

(b) Inner Wrap

The inner wrap shall consist of a 100 mm wide conformable polyethylene or PVC backed modified bitumen mastic tape, compliant with the requirements of SANS 1117 type C (e.g. DENSO ULTRAFLEX 1250/300 or similar product approved by the Engineer).

Peel back approx. 0,5 m of interleaving. Align the edge of the 100 mm wide tape 50 mm beyond the exposed FBE toe onto the primed, factory applied, polyethylene pipe coating. Press down firmly.

Before spiral wrapping commences, a full circumferential wrap of tape is applied by hand with sufficient tension to narrow the width of tape between 1 and 2 m.

Whilst maintaining tape tension as described above, the tape shall be applied spirally. Remove interleaving as wrapping proceeds.

The tape shall be applied to ensure that a minimum 25 mm overlap shall be achieved.

(c) Outer Wrap

The outer wrap shall consist of a 100 mm wide medium density adhesive polyethylene compliant with the requirements of SANS 1117 Type B&D (e.g. DENSO MDP 030 (B) or similar product approved by the Engineer).

Centre 100 mm wide outer-wrap tape on the edge of the applied inner wrap tape on the factory applied coating. Press down firmly.

Before spiral wrapping commences, a full circumferential wrap of tape is applied by hand with sufficient tension to narrow the width of tape between 1 and 2 mm.

Whilst maintaining tape tension as described above, the tape shall be applied spirally.

The tape shall be applied to ensure that a minimum 55% overlap shall be achieved.

The tape shall be applied to a minimum width of 50 mm beyond the applied inner tape-wrapped area onto the primed shop applied coating.

(d) Finished Cold Tape Wrapping

Ensure that the tape is in full contact with the underlying surface with no wrinkles, fish-mouths or bubbles.

Holiday detection shall be carried out in accordance with NACE RP0188.

The cold Tape Wrapping System will be subject to PQT and PPT and production Quality Control as per ISO/DIS 21809-3 Annex O.

37.24.4 Tolerances

37.24.4.1 Pressure Sensitive Tape Wrapping

The minimum thickness of the inner low-density polyethylene tape carrier component shall be 300 µm and the maximum thickness of the outer high-density tape carrier shall be 1000 µm. Total minimum polyethylene thickness of 1450 µm.

The adhesive part of the inner layer shall be a minimum thickness of 1.5 times the polyethylene tape carrier thickness. For the outer layer the adhesive layer shall be at least equal to the thickness of the polyethylene tape carrier thickness.

The minimum thickness of the completed wrapping shall be 750 µm. The inner layer shall be a butyl rubber laminate of 450 µm minimum thickness of which the butyl rubber film shall not be less than 200 µm thick and the polyethylene film shall not be less than 200 µm thick.

The outer layer shall be high density pressure tape of 300 µm minimum thickness.

37.24.5 Testing

To be read in conjunction with Clause 37.4.1.

37.24.5.1 Visual Inspection

The wrapping shall have a smooth appearance, free from wrinkles, blisters, bridging across weld beads, frayed edges, cracks, dis-bonding and any signs of physical damage.

37.24.5.2 Electrical Insulation Defect (Holiday) Testing

The entire wrapping of the pipeline shall be tested to ASTM G62with an approved Holiday Detector equipped with a rolling ring detector around the pipe by the Contractor to the Engineer's satisfaction. The ring shall be in close contact with the surface of the wrapping along the pipe circumference. The test shall be carried out immediately prior to lowering the pipe into the trench. The wrapping on specials or short pipe lengths shall be tested with an approved Holiday Detector fitted with a copper bristle brush detector of suitable form. The wrapping shall exhibit no Holidays when tested with an effective voltage of 12 kV at a nominal pulse frequency of not less than 30 Hz.

The Engineer may instruct any length of pipe or any number of specials to be re-tested using a Holiday Detector with a copper bristle brush detector.

37.24.5.3 Destructive Testing

The Engineer may from time to time collect samples of 10 m of each type of tape and one litre of primer for testing, for compliance with the Specification, by any independent laboratory appointed by the Engineer. The supply of samples shall be for the Contractor's account. The Engineer reserves the right to reject the whole batch of materials from which unsatisfactory samples were obtained.

37.24.5.4 Repairs

The Contractor shall be required to locate areas of faulty protection on all sections on which unsatisfactory results are obtained and to affect the necessary repairs. The cost of this work and all additional materials provided or supplied, including the reinstatement of the trench and the retest shall be for the Contractor's account.

37.24.6 Repair Methods

Where damage to the wrapping on a pipeline has occurred and where there are creases, wrinkles and folds in the wrapping, proceed as follows:

37.24.6.1 Small Damaged Areas

If the width of the tape being used exceeds by at least 100 mm the length of the section affected, cut the area of damaged wrapping away to bare metal leaving no raised edges or protrusions.

Clean and prime the exposed area in accordance with Clauses 37.24.3.2 and 37.24.3.3 and apply a patch of tape, ensuring an overlap of not less than 50 mm on all sides onto the surrounding wrap.

Apply by hand-wrapping with a 55% overlap, a further layer of tape commencing two turns before and continuing for two turns beyond the patch.

37.24.6.2 Large Damaged Areas

Where the extent of damaged or faulty wrapping is such that the tape cannot span the affected area and provide a 50 mm overlap on all sides it must be completely removed from the pipe over the affected section. The area shall be cleaned and primed in accordance with Clauses 37.24.3.2 and 37.24.3.3. The pipe must be re-wrapped with a 55% overlap, commencing two turns before and finishing two turns beyond the bared section.

37.24.6.3 Damage on Double Wrap

Where damage or a defect has occurred in a section that has been double wrapped and in the case of small Holidays, the outer wrap shall be removed for a distance equal to three (3) times the width of the inner wrap tape on each side of the damaged area.

The appropriate procedure given in Clauses 37.24.6.1 or 37.24.6.2 shall be used to affect the repair of the inner wrap.

The outer wrap shall be re-instated in accordance with Clause 37.24.3.5.

37.24.6.4 Outer Wrap Damage

Where damage extends through an outer wrap / rockshield (see Section 6 of SANS 10129), this shall be carefully removed for a distance equal to three (3) times the width of the inner wrap tape on each side of the damaged area without damaging the inner wrapping.

The repair shall be carried out by the appropriate method given in Clauses 37.24.6.1 and 37.24.6.2 and the outer wrap / rockshield re-instated in accordance with Clause 37.24.3.5.

37.25 PETROLATUM WRAPPING SYSTEM

Profiling mastic and mastic blankets are used for corrosion protection of couplings and flanges in chambers with high humidity and buried in soil.

37.25.1 Standards

Reference is made to the latest issues of the following Standards:

SANS ISO	8501-1	Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after removal of previous coatings.
SANS	0129	Plastics tape wrapping of steel pipelines.
SANS ISO	9000	Model for quality assurance in production and installation.

37.25.2 Surface Preparation

Mechanically clean and wire brush the joint to remove all loose rust, scale, old coating and foreign matter to St 2 (ISO 8501-1).

Areas subjected to chemical attack, salt spray, fungus or bacteria shall be neutralized, rinsed with clean potable water and mechanically cleaned as specified above.

37.25.3 Priming

Brush priming solution well over the entire joint area, leaving a thin film (at a nominal coverage rate of 0.8 m²/litre). Apply a liberal amount around the bolt threads, narrow cavities and crevices.

Paste shall be used where excessive surface corrosion has occurred and under high humidity or submerged conditions.

37.25.4 Application of Mastic and Tape

Use profiling mastic and/or strips to fill all voids, crevices and sharp or irregular contours.

Apply petrolatum tape circumferentially over the area to be coated with a minimum 25 mm overlap and a 75 mm overlap on the adjacent coating.

Eliminate all air pockets, wrinkles and creases.

37.25.5 Top Coat

37.25.6 Buried Conditions (lay-flat sheeting)

Two complete turns of the polyethylene sheeting shall be applied circumferentially. The ends are secured to the pipe barrels with 48 mm wide bands of PVC adhesive tape, which is also applied to the outside diameter of the bolted joint.

37.25.7 High Humidity Conditions

Overcoat with a synthetic coating mixed with a cementitious filler to give a tough, flexible coating. The base coat may be over-coated with water based Acrylics or Epoxies.

NOTE:

- Detail of application shall be in accordance with the manufacturer's data sheets and subject to approval by the Engineer.

37.26 POLYOLEFIN-BITUMEN WRAPPING SYSTEM

This system is normally used for additional corrosion protection of galvanised pipes up to 200 mm diameter. Other applications may also be instructed subject to the approval of the Engineer.

The system comprises an inner layer and outer coating whereby the inner layer is made up of a self-adhesive rubber bitumen compound reinforced with a fully impregnated heat set polyester mat. The outer layer is a tough medium density cross-linked Polyolefin heat shrinkable sleeve.

37.26.1 Standards

Reference is made to the latest issues of the following Standards:

SANS ISO 1461 Hot-dip galvanized coatings on fabricated iron and steel articles.

SANS ISO	8501-1	Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after removal of previous coatings.
SANS	1117	Plastic wrappings for the protection of steel pipelines.
SANS	0129	Plastics tape wrapping of steel pipelines.
SANS ISO	9000	Model for quality assurance in production and installation.

37.26.2 Material

Tapes shall conform to SANS 1117, Type C.

37.26.3 Application

37.26.3.1 Surface Preparation

Surfaces, hot-dip galvanised in accordance with SANS ISO 1461, shall be degreased as per Sections 6 and 7 of this standard.

37.26.3.2 Application

The wrapping shall be applied as follows:

- Apply an adhesive bitumen layer at 130°C;
- Allow the compound to cure for thirty (30) minutes and cool to room temperature;
- Fit the oversized sleeve onto the pipe protruding 75 mm beyond the pipe ends;
- Shrink the sleeve with a yellow LPG or propane flame; and
- Trim the sleeve edges.

37.26.4 Tolerances

- Prime coat 20 µm DFT
- Inner layer 900 µm nominal
- Outer layer 600 µm nominal
- Overall thickness 1.5 mm nominal
- Colour Black

37.26.5 Testing

To be read in conjunction with Clause 37.4.1.

37.26.5.1 Visual Inspection

The wrapping shall have a smooth appearance, free from wrinkles, blisters, bridging across weld beads, frayed edges, cracks, dis-bonding and any signs of physical damage.

37.26.5.2 Electrical Insulation Defect (Holiday) Testing

The entire wrapping of the pipeline shall be tested with an approved Holiday Detector equipped with a rolling ring detector around the pipe by the Contractor to the Engineer's satisfaction. The ring shall be in close contact with the surface of the wrapping along the pipe circumference. The test shall be carried out immediately prior to lowering the pipe into the trench. The wrapping on specials or short pipe lengths shall be tested with an approved Holiday Detector fitted with a copper bristle brush detector of suitable form. The wrapping shall exhibit no Holidays when tested with an effective voltage of 12 kV at a nominal pulse frequency of not less than 30 Hz.

The Engineer may instruct any length of pipe or any number of specials to be re-tested using a Holiday Detector with a copper bristle brush detector.

37.26.5.3 Adhesion

Shall be tested in accordance with SANS 1117 (Type C).

37.26.6 Repairs

37.26.6.1 Small Repairs (Less Than 10 mm)

Remove any contaminants from the damaged area.

Cut away any protrusions.

Use a weld stick and seal the damaged area by gently heating the point of the weld stick until it begins to flow. Press the weld stick firmly over the damaged area.

37.26.6.2 Large Repairs

Remove any contaminants from the damaged area.

Cut away any protrusions.

Using a 100 mm wide bitumen tape and beginning 100 mm from the affected area, spirally wrap the tape utilizing a 55 percent overlap. Continue to apply the tape until the repair is 100 mm beyond the affected area.

Alternatively, if the pipe has not yet been installed, a section of sleeve may be placed over the defect and shrunk to at least 100 mm beyond each side of the defect.

37.27 FUSION BONDED MEDIUM DENSITY POLYETHYLENE PIPE COATING SYSTEM

37.27.1 Standards

Reference is made to the latest issues of the following Standards:

AS4321	Fusion bonded medium-density polyethylene – coating and lining for pipes and fittings.
AS3894	Method 3: Determination of dry film thickness.
ASTMD1693	Environmental stress cracking.

SANS ISO 1183	Plastics – Methods for determining the density and relative density of non-cellular plastics.
SANS ISO 8501-1	Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after removal of previous coatings.
SANS Method 1264	Cathodic dis-bonding test for pipeline coatings.
SANS ISO 2808	Paints and varnishes – Determination of film thickness.
SANS ISO 3270	Paints and varnishes and their raw materials – Temperatures and humidity for conditioning and testing.
SANS 1217	The production of painted and powder coated steel pipes.
SANS Method 767	Cleanliness of blast-cleaned steel surfaces for painting (pictorial standards).
SANS Method 769	Cleanliness of blast-cleaned steel surfaces for painting (dust and debris).
SANS Method 772	Profile of blast-cleaned steel surfaces for painting.
SANS ISO 9000	Model for quality assurance in production and installation.

37.27.2 Material

Shall conform to AS 4321.

37.27.3 Application

37.27.3.1 Surface Preparation

All surfaces to be coated shall be abrasive blast-cleaned in accordance with Clause 37.15.

37.27.3.2 Polyethylene Application

The pipes and specials shall be heated in such a way as not to produce any deleterious contaminants on the surface to be coated.

The polyethylene compound shall be applied to obtain a smooth finished surface.

The coating shall not be post-heated by use of a torch or other flame treatment being applied directly to the coating.

37.27.3.3 Treatment

Where the coating is terminated externally it shall be set back a nominal distance of 100 mm from the closest assembly weld point and sealed with a primer.

Where the coating in the joint region terminates internally and the pipe is cement mortar lined, the mortar shall overlap the coating by a minimum of 25 mm.

The end coating to be tapered over a distance not less than the coating thickness.

37.27.4 Tolerances

37.27.4.1 Coating Thickness

When determined with a magnetic thickness gauge in accordance with Method 5 of SANS ISO 2808, the minimum coating thickness of the fusion bonded polyethylene applied to pipes and specials shall be as tabled below.

TABLE 37/5
COATING THICKNESS

PIPE OD IN MM	MINIMUM COATING THICKNESS IN MM	
	COATING	AREA AT COUPLING
OD≤ 273	1.6	0.8
273 < OD ≤ 508	1.8	0.8
508 < OD ≤ 762	2.0	1.0
762 > OD	2.3	1.0

37.27.5 Testing

To be read in conjunction with Section 28 - Mechanical General for Mechanical and Electrical work.

37.27.5.1 Visual Inspection

The coating shall be smooth, glossy, free from pinholes, excessive orange peel, bubbling or excessive runs or sags.

37.27.5.2 Thickness

When tested using a thickness gauge complying with AS 3894 Method 3, the minimum coating thickness of the FBMDPE shall be as specified in the above-mentioned table. On any pipe the minimum thickness may be up to 0.2 mm less than that specified in the table provided that the area of coating or lining with reduced thickness does not cover more than five (5) percent of the total pipe coating or lining area. Pipes with reduced thickness shall comprise not more than five (5) percent of the pipe coating order.

37.27.5.3 Electrical Insulation Defects

The total coated and lined surfaces of every pipe and fitting shall be tested in accordance with Annexure L of AS 4321. All Holidays detected shall be repaired in accordance with Clause 8 of AS 4321.

37.27.6 Test Requirements

37.27.6.1 General

Type tests shall be carried out at intervals of no greater than three (3) years and at any change in formulation or source of polyethylene compounds and at any change in application process.

37.27.6.2 Polyethylene Compound

The polyethylene compound to be used for coating, lining and repairs shall be type tested for thermal stability, water absorption, penetration resistance, tensile stress at yield, environmental stress-cracking resistance, density and impact resistance as specified in Clauses 6.1.2.2 to 6.1.2.8 of AS 4321.

Test samples may be prepared in the laboratory or in the coating Plant.

If the same formulation and source of polyethylene is used for both the coating and lining, then tests on the coating shall also qualify the lining. The impact resistance test is not required for the lining.

37.27.6.3 Production Tests

The coating and lining shall comply with the production test requirements specified in Clauses 6.3.2 to 6.3.4 of AS 4321.

37.27.7 Repair Methods

37.27.7.1 General

Where a Holiday is located it shall be repaired to produce a continuous coating and lining. Damaged areas that pass the continuity test need not be repaired provided the coating or lining thickness remains greater than or equal to 1.0 mm.

The bare steel surface shall be prepared in such a way to produce a rust-free, clean, abraded surface.

Where practicable the following coating repair methods shall be used:

- Fusion-bonded repairs as specified in Clause 7.2 of AS 4321.
- Circumferential tape wrapping compatible with FBMDPE coating and subject to the approval of the Engineer.
- Hot gas welding repair (for the joint region shown in Figure 1 of AS 4321).

NOTES:

- The repair methods outlined apply to repairs at the application Plant only.
- The Engineer may specify a particular repair method (see Annexure A of AS 4321).

37.27.7.2 Repair Limits

The number of coating repairs (this includes repairs to the joint region, see Figure 1 of AS 4321) shall not exceed three per pipe or fitting. An allowance is made for up to six repairs per pipe or fitting provided that the number of pipes or fittings with this larger number of repairs does not exceed five (5) percent of a pipe coating order.

The area of any single coating repair shall not exceed 0.1 m², and the length of such repair shall not exceed 2 m in the longitudinal direction.

37.27.7.3 Repair Test Methods

All repairs shall comply with the continuity test requirements of Clause 6.3.3 of AS 4321.

37.27.8 Field Joint Repairs

Field joints shall be repaired using Polyethylene laminated to an elastomeric layer of self-amalgamating butyl rubber tapes and the product shall be subject to the approval of the Engineer. The surface preparation, the coating material and the application shall comply with the following:

37.27.8.1 Surface Preparation

a) The surface preparation of the field joint area for the self-amalgamating butyl rubber tapes application shall be as follows:
   i) The edges of the MDPE coating shall be cut back to a distance of 100 mm from the weld joint. The coating edges shall be bevelled / chamfered to make a 10 mm minimum tapered transition between the full thickness coating and the exposed steel.
   ii) All corrosion products and/or contaminants on the exposed steel substrate shall be removed.
   iii) The steel substrate shall be blast-cleaned to Sa 3 (ISO 8501-1).
   iv) The MDPE coating shall be roughened to a distance of 100 mm from the weld joint with 120 grit emery or sand paper.
   v) The joint area shall be vacuum-cleaned to remove all dust and debris in accordance with SANS 8502-3. With prior approval of the Engineer, dust and debris may be removed by blowing with clean uncontaminated compressed air.
   vi) The steel surface temperature shall always be 3°C above the dew point to remove any moisture prior to application of a primer.
   vii) Apply a tape supplier approved Xylene solvent degreaser to the roughened MDPE.
   viii) A tape supplier approved butyl primer shall be applied immediately following the completion of the surface cleaning. The compatible primer shall be applied at an average rate of 5m^2/l and allowed to tack dry. The Contractor shall provide dust protective shields where Site conditions require such measures. The Contractor shall not execute surface preparation in an unprotected dusty environment.

b) The Contractor shall introduce hold points in the Quality Control Plan for sign off by his corrosion protection inspector. The surface preparation and the primer application shall be signed off. The Contractor shall also introduce an ad hoc inspection points for the Approved Inspection Authority or the Engineer who will do sample inspections of the joint repairs throughout the duration of the Contract. The number of ad hoc sample inspections will be determined by the Engineer.

37.27.8.2 Coating Repair Material

The use of HSS requires specific motivation by the Contractor and approval by the Engineer for special repair conditions only.

The Heat Shrink Sleeve (HSS) material shall comply with the following:

a) The HSS shall be suitable to be applied on Site to steel pipes with welded joints without requiring pre-heating of the steel to ensure bonding. The sleeve shall be able to provide effective corrosion protection of the welded field joint over the full 45 year design lifespan of the pipeline and shall be fully compatible with the coating of the pipeline. The HSS shall have a minimum width of 450 mm.

b) The Contractor shall submit the detail product specification of the proposed heat shrink sleeve for the approval of the Engineer. This specification shall at minimum comply with the following application conditions:

   i) Shall be compatible with Fusion Bonded Medium Density Polyethylene (MDPE).
   ii) Pipe Material: Steel (Grade X42 or X52).
   iii) Pipe Operating Temperature: -0 -65°C.
   iv) Pipe Diameter: DN 900 mm – DN 1600 mm.
   v) Adverse Soil Conditions: stable: low soil stresses.
   vi) Mechanical Resistance: high impact and penetration resistance.
   vii) Pipe Laying Method: Open Trench.
   viii) Climate conditions (Ambient Temperature during Sleeve Application): Land climate: cold – very warm. (0°C - 45°C).

c) The HSS product to be submitted for approval by the Engineer shall at minimum comply with the following material requirements:

   i) Generic Type: Irradiation cross-linked HDPE.
   ii) Sleeve System: 3 Layers.
   iii) Minimum Thickness: Adhesive ≥ 1.3 mm.
   iv) Backing ≥ 0.9 mm.
   v) Sleeve ≥ 2.4 mm.
   vi) Adhesive: Softening point 94°C.
   vii) Backing: Tensile strength ≥ 24MPa.
   viii) Backing: Elongation ≥ 700%.
   ix) Backing: SG ≥ 0.93.
   x) Sleeve: Peel adhesion > 100N/cm.
   xi) Sleeve: Impact Resistance > 15J.
   xii) Sleeve: Low temp flexibility > -32°C.
   xiii) Sleeve: Water Absorption < 0.05%.
   xiv) Cathodic Disbondment = 3 mm rad.

The self-amalgamating butyl rubber tape (BRT) material shall comply with the following:

a) The self-amalgamating butyl rubber tape shall be suitable to be applied on Site to steel pipes with welded joints without requiring pre heating of the steel to ensure bonding. The tape system shall be able to provide effective corrosion protection of the welded field joint over the full 45 year design lifespan of the pipeline and shall be fully compatible with the coating of the pipeline.

b) The Contractor shall submit the detail product specification of the proposed butyl rubber tape for the approval of the Engineer. This specification shall at minimum comply with the following application conditions:

i) Shall be compatible with Fusion Bonded Medium Density Polyethylene (MDPE).

ii) Pipe Material: Steel (Grade X42 or X52).

iii) Pipe Operating Temperature: 0 - 65°C.

iv) Pipe Diameter: ND 900 mm – 1600 mm.

v) Adverse Soil Conditions: stable / low soil stresses.

vi) Mechanical Resistance: high impact and penetration resistance.

vii) Pipe Laying Method: Open Trench.

viii) Climate conditions (Ambient Temperature during Sleeve Application): Land climate - cold to very warm. (0°C - 45°C).

c) The Butyl Rubber Tape (BRT) product to be submitted for approval by the Engineer shall at minimum comply with the following material requirements:

i) Tape System: 2 Layers.

ii) Inner Tape:

- Minimum Total Thickness: ≥ 0.75 mm.
- Adhesive: Thickness: 0.5 mm.
- Tensile strength: ≥ 50N/cm (DIN 30672).
- Elongation ≥ 300%.
- Peel adhesion > 25N/cm.
- Impact Resistance > 15J (DIN 30672).
- Water Absorption < 0.1%.
- Cathodic Disbondment = 3 mm rad.

iii) Outer Tape:

- Minimum Total Thickness: ≥ 0.500 mm.
- Adhesive: Thickness: 0.2 mm.
- Tensile strength: ≥ 50N/cm (DIN 30672).
- Elongation ≥ 400%.
- Peel Adhesion > 25N/cm.
- Impact Resistance > 15J (DIN 30672).
- Water Absorption < 0.1%.

Further to the above, the inner layer shall be a butyl rubber laminate as specified in Clause 37.24. The outer layer shall be a high density pressure tape as specified in Clause 37.24. The inner layer shall be compatible with the MDPE coating.

Application of the BRT system shall be in accordance with Clause 37.24.

37.27.8.3 HSS Installation

The use of HSS requires specific motivation by the Contractor and approval by the Engineer for special repair conditions only.

(a) Installation Method

The Contractor shall submit an HSS application Method Statement that will be technically reviewed in terms of the following application guideline (the requirements of the guideline may be adjusted by the Engineer after consultation with the design team corrosion specialist to accommodate product specific requirements):

i) The wraparound heat shrink sleeve shall be moved into position, centred over the field joint cutback area with the overlap located at either the 10 o'clock or 2 o'clock position. The sleeve shall be overlapped by minimum 50 mm to ensure the correct 'sag' is allowed for correct shrinking of HSS and to maintain residual circumferential (hoop) stress once installed onto the pipe.

ii) Two operators (one on each side of the field joint) shall begin by heating the centre of the sleeve around its circumference using propane torches. The torches shall be angled towards the centre of the field joint at all times during the initial shrinking phase. The operators will continue heating the sleeve from the centre towards the outer edges. If the sleeve backing becomes shiny or gives off smoke at any time during shrinking, the torch should be temporarily moved away from the subject area.

iii) The initial shrinking will be complete when the sleeve fully conforms to the entire underlying joint profile. Additional post heating shall then be applied to the outer ends of the sleeve at the overlap with the factory coating. The shrinking procedure shall be completed using long circumferential strokes over the entire sleeve surface area to ensure that a uniform bond is achieved.

iv) After the HSS has been installed, a soft J-Roller shall be used to promote contact between the sleeve and the field joint, focusing on the overlap area between the sleeve and the factory coating. The roller shall not be used over the circumferential weld seam area which is a region of critical importance due to thickness requirements. Otherwise, rolling shall be conducted per standard heat shrink sleeve installation procedures.

v) The operators shall then check the sleeve adhesion by pressing on the sleeve edges with a gloved finger at each of 4 locations on the outer edges of the installed sleeve and a probe shall be used to pull at the sleeve edges to ensure that full adhesion has been achieved. The sleeve shall be considered well bonded to the adjacent factory coating when the adhesive and coating remain fused and adhesive begins to flow out of the sleeve edges, all around the circumference of the joint. If necessary, additional heating shall be applied to the required areas.

(b) Visual Inspection

After application of the heat shrink sleeve, a visual inspection shall be performed in order to verify the following:

- There shall be no significant wrinkles, voids, cracks, or burn marks on the applied sleeve.
- The adhesive shall protrude all around the outer circumference at the ends of the applied sleeve.
- The overlap between the sleeve and the factory applied coating on both sides of the field joint shall be a minimum of 50 mm after shrinking.
- The installed heat shrink sleeve shall be inspected over 100% of its surface area using a calibrated Holiday Detector. Each coated field joint shall be inspected using a voltage of maximum 15kV at a travelling speed not to exceed 200 - 300 mm/s. As a result of the Holiday Inspection, there shall be no Holidays detected on any part of the field joint coating area. In case any single Holiday is detected, the application of the heat shrink sleeve shall be rejected.

(c) Performance Testing

The Contractor shall allow for the following performance testing at 5% of the joints:

a) Prior to measuring the thickness of the installed heat shrink sleeve, the sleeve shall be allowed to cool to < 40°C. The thickness of the applied heat shrink sleeve shall be checked using a calibrated thickness measuring gauge. Thickness checks shall be performed at one location for the 12 o'clock, 3 o'clock, 6 o'clock, and 9 o'clock positions on the sleeve body. At no time shall the total thickness be less than the required minimum average value of 2.2 mm on the sleeve body and 75% of this minimum average value across the circumferential weld bead.

b) Following completion of the installed thickness test, the HSS shall be subjected to peel testing at ambient temperatures (23ºC, +/- 5ºC) and an elevated temperature of 50ºC (-2ºC / +5ºC) to validate the adhesion between the HSS and the steel pipe surface/factor applied MDPE (In accordance with DNV-RP-F102; Data sheet 2A).

c) For both adhesion tests, two parallel incisions shall be made with a sharp blade perpendicular to the pipe axis, spaced 20 mm apart, each incision at least 100 mm long and then, a transverse incision at right angle intersecting previous incisions shall be made. Using the blade and starting from the transverse incision, the end of the strip thus formed shall be lifted. The peel test shall be performed using a hand dynamometer device fixed and pulled at 90° angle trying to maintain the constant speed of 100 mm/min according to the supplier recommended Field Peel Test Procedure.

   The adhesion test shall be considered as passed if the following occurred:

   - Minimum peel adhesion strength to the steel shall be 3N per centimetre of strip peeled at 50 ± 2°C, and 50 N per centimetre width at 23 ± 2°C.
   - Minimum adhesion strength to the MDPE shall be 3N per centimetre of strip peeled at 50 ± 2°C, and 50 N per centimetre width at 23 ± 2°C.
   - Cohesive failure shall be observed, meaning the primer shall remain on steel surface and the adhesive shall not be completely removed from the testing area after the test.

d) Cathodic Disbondment testing shall be performed in accordance with DNV-RP-F102 (Data Sheet 2A) for 28 days in a 3% sodium chloride solution at temperatures of 23±2°C and in addition to this, tested for 48 hours @ 65±2°C. The test location shall be near the centre of the joint.

37.28 ELASTOPLASTIC POLYURETHANE COATING SYSTEM

This coating system is no longer considered for pipeline coating applications and has been removed from the specification for current projects.

37.29 CEMENT MORTAR LINING SYSTEM

37.29.1 Standards

Reference is made to the latest issues of the following Standards:

SANS ENV 197-1	Cement composition, specification and conformity criteria.
SANS 1024	Welded steel fabric for concrete reinforcement.
SANS 1083	Aggregates from natural sources.
SANS 1200	Standardised specifications for civil engineering construction.

SANS 0100	Structural use of concrete.
SANS Method 551	Sodium and potassium contents of Portland cement.
SANS Method 769	Cleanliness of blast-cleaned steel surfaces for painting (dust and debris).
SANS Method 830	Chloride content of aggregates.
SANS Method 863	Compressive strength of concrete (including making and curing of the test cubes).
SANS Method1245	Potential reactivity of aggregates with alkalis (accelerated mortar prism method).
SANS ISO 8501-1	Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after removal of previous coatings.
SANS ISO 9000	Model for quality assurance in production and installation.
AWWA C602	Cement-mortar lining of water pipelines - 4 inches (100 mm) and larger - in place.
BS 3148	Methods of test for water for making concrete (including notes on the suitability of the water).
SIS05 59 00	Pictorial surface preparation standards for painting steel surfaces. (Swedish).

37.29.2 Material

37.29.2.1 Cement

Cement shall be of Type I with class strength of 42.5 and shall be identified by CEM I : 42.5.

The cement shall conform to SANS ENV 197-1.

The alkali content of the cement, when expressed as sodium oxide (Na2O) equivalent, shall not be greater than 0.6 percent by mass of cement determined in accordance with SANS Method 551 or any other reduced value as determined by the Engineer, where:

- % Na_2O equivalent = % Na2O + (0.658 x % K2O).

Cement shall be from the same source and shall be fresh. Cement shall be used strictly in the order of delivery. All cement in storage for longer than eight weeks and all cement in unsealed pockets shall be removed from storage and discarded.

Cement shall be stored in weather-proof bulk silos, or if in pockets, shall be stored in weather-proof sheds provided with damp proof floors at least 300 mm above ground level, stacked on pallets and covered with a waterproof membrane.

37.29.2.2 Aggregates

Both, the coarse aggregate (stone) and fine aggregate (sand) used in the manufacture of concrete or mortar shall conform to SANS 1083.

The aggregates shall be evaluated for potential alkali reactivity using SANS Method 1245.

The chloride content of the sand determined by SANS Method 830 shall not exceed 0,01 percent per mass.

Coarse aggregate shall be suitable for concrete subject to surface abrasion, and of the largest possible size that would allow placement of concrete without difficulty.

Within eight (8) weeks of award of Contract, the Contractor shall submit to the Engineer the results of tests carried out on aggregates from the Contractor's proposed source by an independent and competent body. The Engineer reserves the right to take further samples of aggregates at any time from the Contractor's source or from his stockpiles and have same tested for compliance with the Specification.

37.29.2.3 Water

Water used for concrete, mortar or cement slurry shall be clean i.e. free from oil, acid, alkalis, vegetable and mineral matter.

The water shall generally conform to the recommendations in the Annexure to BS 3148.

37.29.2.4 Concrete and Mortar

Concrete and mortar ingredients shall be batched by mass and shall be well mixed in mechanical mixers of good condition for a duration of not less than two (2) minutes.

There shall be no re-tempering of the mix after discharge from the mixer. Only fresh concrete and mortar shall be used and all concrete, mortar or cement slurries in a mixed state for longer than thirty (30) minutes shall be discarded.

No additives shall be used, except where approved by the Engineer in writing.

The minimum cement content per cubic metre of concrete shall be 400 kg.

Mortar shall be a mixture of one (1) part cement to two (2) parts fine aggregate, for linings of up to 15 mm thickness and one (1) part cement to three (3) parts fine aggregate for thicker linings.

Mortar shall not be used for coatings.

Total water content shall be the minimum required to produce suitable consistency and shall not exceed fifty (50) percent by mass of cement content, allowance being made for the moisture content of aggregates.

150 mm cubes of concrete or mortar made and cured in accordance with SANS Method 863 shall have a minimum compressive strength of 30 MPa after twenty eight (28) days.

37.29.2.5 Welded Steel Fabric

Welded steel fabric shall conform to SANS 1024, except that wire diameter and mesh sizes shall conform to this Section.

37.29.3 Application

37.29.3.1 Lining

(a) Thickness

The thickness of linings on pipes shall generally be as tabled below, except where specified to the contrary in the Schedule of Quantities or on the Drawings.

TABLE 37/6
CEMENT MORTAR LINING THICKNESS

PIPE OD IN MM	THICKNESS OF LINING IN MM		
	NOMINAL	MAXIMUM	MINIMUM
273.0 to 609.6	10	13	8
Above 609.6 to 1 016	14	16	12
Above1 016.0 to 1 220	16	20	14
Above 1 22.0 to 1 620	20	24	16

The thickness of lining on specials shall generally comply with the above, provided the minimum cover of mortar over reinforcement mesh shall not be less than 10 mm.

(b) Surface Preparation

After bare pipes and specials have been tested and inspected for compliance with the applicable Specification and after application of coating, if applicable, surface shall be prepared as follows:

- Weld spatter, loose rust and loose mill scale shall be removed by chipping and/or scraping.
- Deposits of grease, oil, bitumen or other contaminants shall be removed by scraping and wiping with rag soaked in white spirit or similar toxic free solvent.
- Other contaminants shall be removed by manual-, mechanical- or abrasive blast cleaning. The standard of cleaning shall not be less than grade St 2 or grade Sa 1 of ISO 8501-1, as appropriate.
- Residual dust and debris on the pipe surface shall be 0.5percent maximum when tested in accordance with SANS Method 769.

(c) Shop Applied Linings - Centrifugal Spun

Within twenty four hours of having been grit blasted and provided the pipe surfaces are kept dry, free of dust, oil and other deleterious contaminants and provided ambient temperatures are above 20°C the pipe shall be transported to a suitable spinning machine. The coating, if applicable, shall be suitably protected against mechanical damage during the handling and spinning operation. Before being placed in the spinning machine, the pipe shall be suitably braced with external stiffening rings, which shall not be removed until the appropriate one of the following periods has elapsed from the time of placing of the lining:

- Seventy two (72) hours when water curing is used; and
- Thirty six (36) hours when steam curing is used.

End gauge rings shall be securely attached to the pipe ends to control the lining thickness, to act as stop end to prevent mortar leakage and to stiffen and hold the pipe ends round.

Each pipe shall be rotated in a spinning machine with its axis horizontal during and for a suitable period after the placing of the lining. The speed of rotation shall be such as to produce a uniform distribution of the cement mortar over the interior surfaces of the pipe.

Sufficient mortar to line completely one pipe to the appropriate nominal thickness specified in Clause 37.29.3.1 (a) shall be mixed in one batch, and it shall be of such consistency as to minimise segregation during spinning. The mortar shall be placed in the pipe immediately after mixing and before initial set has taken place, and in a manner providing uniform longitudinal distribution of the batch from end to end of the pipe.

As soon as the mortar lining has achieved a uniform thickness over the whole interior surface of the pipe, the speed of rotation shall be increased to a speed that will compact the mortar and is not less than 1 peripheral speed of 17 metres per second. The required speed shall be maintained for such a period as will give the maximum density of mortar and smoothness of surface, and sufficient bonding to permit removal of the pipe from the machine without injury to the lining.

The ends of the lining shall be finished uniform and square or slightly bevelled as required in paragraph (h).

All water and laitance expelled during spinning shall be removed in such a manner that the surface of the lining is smooth, level and true.

After the lapse of a suitable period after spinning (as determined by experiment), the spun lining shall be given a steel trowelled or smoothing bar finish. A second trowelling may be necessary to remove all laitance and produce a smooth and hard finished surface. The Colebrook-White (k) friction value shall be not more than 0.13 mm.

(d) In-Situ Applied Linings

(i) Standard

Shall be carried out generally in accordance with the provisions of the latest issue of AWWA C602 for “Cement-Mortar Lining of Water Pipeline - 4 in (100 mm) and larger - In Place”, subject to the modifications, amendments and amplifications in this Section.

(ii) Curing

The contents of Clauses 4.7.2, 4.7.3, 8.7.2 and 8.7.3 of AWWA C602 shall be deleted and shall be replaced by: “Curing by Contractor”. The Contractor shall be responsible for careful curing of the mortar lining until the pipeline has been handed over to the Department.

(iii) Length of Uninterrupted Lining

Tenderers shall state in Tenders the maximum length of lining which they are prepared to undertake between any two consecutive points of access and under what circumstances they would require this length modified.

This factor will be taken into account when assessing the comparative economic merits of Tenders.

(iv) Methods of Lining

For pipe sizes up to 500 mm nominal bore, the “Tate System” of lining is permissible. The “Perkins System” of lining by means of a suitable machine that travels through the pipe and distributes mortar by high velocity centrifugal spraying, followed by a trowelling device, shall be permissible for all pipe sizes.

Tenderers shall submit full details of the system to be employed with special reference to methods of pre-cleaning of surfaces and delivery of mortar to the spraying head.

(e) Lining of Specials

Bends, tees and other specials that cannot be lined by machine shall be manually lined. In case where the nominal diameter exceeds 600 mm the lining shall be reinforced by steel mesh tack-welded to the inside of the pipe in such a way that it is not in contact with the pipe except where welded. The steel mesh shall be of 2.5 mm diameter steel wire at 100 mm by 50 mm, or equivalent spacing. The minimum cover over the mesh shall be 10 mm.

(f) Finish

The lining shall be well finished with a smooth surface free from excessive laitance and surface irregularities. Projections exceeding a height of 1.5 mm shall be removed by trowelling before the concrete has set, or by grinding after the lining has cured.

The thickness of the laitance, if any, shall not exceed ten (10) percent of the thickness of the lining, or 1.25 mm, whichever is less.

The effective surface roughness of the lining when measured in terms of the Colebrook-White “K” friction coefficient for lining surface effective roughness shall be guaranteed by the Contractor and shall not be more than 0.13 mm when actually measured in the field after completion of the pipeline. No rougher surface will be acceptable.

(g) Curing

(i) Water curing

Immediately after the placing of the concrete, the pipe shall be so sealed as to prevent loss of contained water, and the concrete shall be kept continuously moist for a period of at least seven (7) days or, in the case of an in-situ applied lining, until the pipe has been handed over to the Purchaser. During this period steps shall be taken, when necessary, to prevent the temperature of the steel shell falling below 2°C.

(ii) Steam curing

Pipes that have shop applied linings, and that have not been coated with bitumen or coal tar may be steam cured.

Immediately after application of the concrete lining, the ends of the pipe shall be completely sealed. After the lined pipe has been standing for not less than two (2) hours, steam shall be injected into it so as to raise the temperature at a rate not exceeding 28°C per hour until the temperature of the lining is within the range 55-70°C.

Steaming shall continue for a further six (6) hours, the temperature of the lining being maintained within the range specified. Steaming shall be discontinued and the pipes shall remain sealed for a further two (2) days from the time that the temperature of the pipe has fallen to ambient. During this period precautions shall be taken to prevent the temperature of the steel falling below 2°C.

During the curing cycle, excluding the two (2) day holding period, the temperature of at least one pipe out of that day's production, shall be recorded by a suitable automatic recording instrument. If the temperature record reveals that the requirements set out above have not been achieved, then the pipes shall be subjected to the full period of water curing as specified above.

(iii) General

Concrete lined pipes shall not be moved or transported for a period of twenty one (21) days after the date of lining.

(h) Pipe Ends

Where lining takes place before welding, i.e. not in-situ but on Site or in the shop, the following shall apply:

- For flanged pipes and specials and pipes intended for jointing by couplings, concrete lining shall be ended flush with pipe ends with a 6 mm bullnosing of edges by means of a nosing tool.
- For pipes to be butt welded the lining shall terminate 100 mm from the internal end of each pipe and the end of the lining shall be bevelled to form an angle of approximately 85 degrees between the clear end of the pipe barrel and the lining end.
- The unlined circumferential strip of grit blasted surface shall be temporarily protected between the Works and the Site with a coat of (red or a different colour to the lining/coating) weldable primer.

37.29.3.2 Coating

(a) Thickness

The thickness of coatings on pipes and specials shall generally be as in Table 37/7 below, except where specified to the contrary elsewhere in these documents.

TABLE 37/7
CEMENT MORTAR COATING THICKNESS

PIPE OD IN MM	THICKNESS OF COATING IN MM		
	NOMINAL	MAXIMUM	MINIMUM
273.0 to 609.6	16	18	14
Above 609.6 to 1 016	20	22	18
Above1 016.0 to 1 220	25	25	22
Above 1 220.0 to 1 620	30	30	25

(b) Cover to Reinforcement

The cover to reinforcement of cement mortar coatings on pipes and specials shall generally be as tabled below, except where specified to the contrary elsewhere in these documents.

TABLE 37/8
COVER TO REINFORCEMENT

NOMINAL COATING THICKNESS IN MM	MINIMUM COVER TO REINFORCEMENT IN MM
16	10
20	14
25	18
30	20

(c) Surface Preparation

Clause 37.15 shall apply.

(d) Application

(i) Stiffening Rings

End gauge rings shall be securely attached to the pipe ends to control the coating thickness, to act as stop end to prevent mortar spillage at pipe ends and to stiffen and hold pipe ends round.

(ii) Reinforcement

The coating shall be bonded to the pipe surface and shall be reinforced by 2.5 mm diameter round steel wire wound spirally around the total length of the pipe and tack-welded to the pipe surface. The pitch between windings shall not exceed 40 mm. Alternatively, the reinforcement shall consist of 2.5 mm thick, 100 mm by 100 mm steel mesh wrapped around the pipe and tack-welded to the surface.

Except where welded, the reinforcement shall not be in contact with the pipe surface.

(iii) Cement Slurry

Within twenty four (24) hours of having been grit blasted and provided the pipe surfaces are kept dry, free from dust, oil and other deleterious contaminants and provided ambient temperatures are above 2°C on a rising thermometer, the pipe surfaces and reinforcement shall be coated with a slurry consisting of approximately ten (10) litres of water to twenty (20) kilograms of cement. No more of the pipe surface shall be coated at any time than what can be covered with cement mortar immediately without the cement slurry drying out.

(iv) Concrete Application

Immediately after application of the cement slurry and while the cement slurry is still wet, concrete shall be applied by impact, or under vibration, or by hand plastering where mechanical means of application are not possible.

(v) Finish

The finished coating shall be firm and dense, shall adhere rigidly to the outside of the pipe and the thickness of laitance shall not exceed 1.25 mm. The coating shall furthermore be free from pinholes, craters, cracks, laminations and other imperfections.

(vi) Curing

Upon completion of the coating operation and until the coating has set sufficiently to allow the pipe to be handled and transported to the curing Site without damage to the coating, the coated pipe shall be fully protected from wind, rain, direct sunlight and against loss of moisture from the coating.

- Water curing: As soon as the coating has set sufficiently for the pipe to be handled, the coating shall be kept continuously moist by continuous water spraying for a period of at least 7 days. During this period steps shall be taken to prevent the temperature of the steel shell from dropping below 2°C.
- Steam curing: Clause 37.29.3.1(g) shall apply, except that steam curing shall continue for 6 hours before end stiffeners and gauging rings are removed. Steam curing shall thereafter continue for a further twelve (12) hours or alternatively, after six (6) hours of steam curing, the coatings may be water cured by continuous water spraying for at last five (5) days.

(e) Pipe Ends

For pipes and specials intended for jointing by flexible couplings, the coating shall be terminated 250 mm from pipe ends with a 6 mm radius bull-nosed outer edge.

For pipes to be butt welded, the coating shall terminate 100 mm from pipe ends and the ends of coatings shall be bevelled to form an angle of approximately 85 degrees between the clear end of the pipe barrel and the end face of the coating.

The unlined circumferential strip of grit blasted surface shall be temporarily protected between the Works and the Site with a coat of (red or a different colour to the lining/coating) weldable primer.

(f) Repair of Defects

Clause 37.29.6 shall apply.

37.29.4 Tolerances

The thickness of linings and coatings shall be as given by Clauses 37.29.3.1(a) and 37.29.3.2(a) respectively.

37.29.5 Testing

To be read in conjunction with Section 28 - Mechanical General for Mechanical and Electrical Work.

37.29.5.1 Lining

(a) Visual Inspection

(i) Shop Applied Lining

The cured lining in every pipe and special shall be inspected visually for defects before the pipe leaves the factory, but not sooner than twenty one (21) days after application of the lining.

The lining shall have a smooth, steel floated appearance and shall have no projections exceeding a height of 1.5 mm above immediate lining surface.

Slight surface crazing and hair cracks shall be permissible. All cracks into which a suitable metal depth gauge with a probe of 1.5 mm diameter can be inserted to a depth of half the minimum specified thickness of the lining shall be considered a defect and shall be repaired as described in Clause 37.29.6.1 of this Section.

(b) In-situ Lining

Visual inspection of the finished lining shall include the provision of a camera mounted on a suitable trolley which shall be so arranged as to make exposures at intervals of approximately twenty (20) metres throughout the lined pipe.

Accurate records including exposure serial numbers and the relative pipe chainages shall be kept by the Contractor. All records and exposures shall become the property of the Employer.

The Contractor shall supply all equipment, facilities and chemicals required for the processing of films. A full description of the equipment and method proposed shall be submitted with Tenders.

Exposures of any completed section of lining shall be processed and be made available immediately after processing. The Engineer may order repeat exposures at any point in the line due to the lack of good definition, lighting, focus or because a defect in the lining is suspected. Repeat exposures shall be to the account of the Contractor. Repeat exposures to clarify suspected defects however, shall, if the suspected defects prove acceptable or non-existent, be to the account of the Department.

(c) Destructive Testing

(i) Thickness of Lining and Cover to Reinforcement

On the first pipe lined and thereafter on one pipe selected at random out of every day's production and after completion of curing, chisel down to bare steel base a representative section of area at least 0.25 square metres of the lining. The area shall contain the weld bead.

Measure distance between steel base and surface of concrete, top of weld bead and surface, and reinforcement mesh to surface of concrete, with a suitable dial gauge or micrometre to accuracy of 0.1 mm. Take not less than five (5) readings for each pipe and record all readings, the mean of readings, the maximum and the minimum readings.

Repair lining as described in Clause 37.29.6.1. Should thickness not fall within the specified ranges, a further two pipes out of the day's production shall be tested. If thickness of any of the two pipes or specials tested shall fail the requirements, the lining of all pipes and specials in that day's production may be rejected.

(ii) Water Absorption

On first pipe and thereafter on one pipe selected at random out of every day's production, chisel out approximately 0.2 cubic metres of cured lining in as large chunks as possible. Dry sample in oven at 100°C to constant mass. Allow to cool to room temperature and determine dry mass to the nearest gram. Immerse sample in clean water for twenty four (24) hours. Withdraw sample, remove excess surface water and determine saturated mass to the nearest gram.

$$\text{Water absorption \%} = \frac{\text{Saturated mass - Oven dry mass x 100}}{\text{Oven dry mass}}$$

Water absorption shall not exceed 6 percent.

(iii) Concrete Strength

Prepare, cure and test in accordance with SANS method 863, three 150 mm cubes daily of mortar sampled out of a single batch of mortar selected at random from batches mixed for every day's production. Standard of acceptance shall be in accordance with Clause 5.8 of SANS 0100, Part II.

(d) Contractor's and Engineer's Inspections

Clauses 37.4.4 and 37.4.5 shall apply.

37.29.5.2 Coating

(a) Visual Inspection

The cured coating in every pipe and special shall be inspected visually for defects before leaving the factory, but not sooner than twenty one (21) days after application.

The finished coating shall be firm and dense, shall adhere rigidly to the outside of the pipe and the thickness of laitance shall not exceed 1.25 mm.

The coating shall be free from pinholes, craters, cracks, and laminations, although slight surface crazing and hair cracks shall be permissible.

All cracks into which a suitable depth gauge with a probe of 1.5 mm diameter can be inserted to a depth of half the minimum specified thickness, shall be considered a defect and repaired as described in Clause 37.29.6.1.

(b) Destructive Testing

Clause 37.29.5.1(c) shall apply, except that lining shall be read as coating.

(c) Contractor's and Engineer's Inspections

Clauses 37.4.4 and 37.4.5 shall apply.

37.29.6 Repair Methods

37.29.6.1 Repair of Defects

All defective concrete shall be removed and the surrounding area of concrete chipped back to a position where the concrete is firmly bonded to the steel.

The edges of the firm surrounding concrete shall be bevelled to form an angle of 85 degrees with the portion of pipe barrel under repair.

The pipe surface shall be cleared from all signs of concrete and dust.

The pipe surface and surrounding concrete shall then be given one coat of cement/water grout and the fresh mortar applied by hand while the grout coat is still wet. The mortar shall be of the same mix and consistency as the lining.

The repair area shall be built up to the full thickness of the lining, care being taken to ensure complete filling of the bevelled edges with the mortar.

The repaired areas shall be covered by damp hessian, which shall be kept continuously wet for seven (7) days after completion of repair.

37.30 POLYMER MODIFIED BITUMEN PIPE COATING SYSTEM

This specification relates to factory applied pipe coating operations based on hot applied polymer modified bitumen. It is also applicable to modification, refurbishment and repairs on pipes coated with standard (oxidised or blown) bitumen fiberglass coatings.

37.30.1 Applicable Standards

This part of the Specification makes reference to the standards listed below. Unless otherwise specified the latest editions of these documents, including all addenda and revisions, shall apply.

British Standards

BS 410	Specification for test sieves.
BS 1796	Methods using test sieves of woven wire cloth and perforated metal plate.
BS 2000	Methods of test for petroleum and its products.
BS 3900	Methods of test for paints:
	Part A 6 (replaced by EN 535) – Determination of flow time of paints.
	Part B 2 (replaced by ISO/DR 1515) – Determination of volatile matter and non-volatile matter.
BS 4147	Bitumen-based hot-applied coating materials for protecting iron and steel, including suitable primers where required.
BS 7079	(Replaced by ISO 8501-8504) – Preparation of steel substrates before application of paints and related products.
BS EN 10300	Steel tubes and fittings for onshore and offshore pipelines – Bituminous hot applied materials for external coating.

Swedish Standard

SIS OS 5900	Pictorial surface preparation standards for painting steel surfaces.

American Standard

ASTM D 113-86	Ductility of bituminous materials.
ANSII AWWA C203-91	Coal-tar Protective Coatings and linings for steel water pipelines – enamel and tape-hot applied.

37.30.2 Materials

37.30.2.1 Primer

The primer shall be of synthetic composition, designed to be used with a specific polymer modified bitumen. The drying rate of the primer shall be suited to the application conditions. The primer shall be supplied in new sealed steel drums.

The primer shall have the characteristics shown in Table 37/9. In addition, when stored in original sealed containers at ambient temperature, the primer shall retain the properties as set out in Table 37/10 for not less than 6 months from the date of delivery.

TABLE 37/9
CHARACTERISTICS OF PRIMER

CHARACTERISTIC	REQUIREMENTS	METHOD OF TEST
Viscosity at 23°C	35-60 seconds	Flow cup No 4 BS3900: Part A6 = EN 535
Volatile matter (max. % loss by mass)	75	BS3900: Part B2 = ISO/DR 1515 (105^0C for 3 hours)

37.30.2.2 Polymer Modified Bitumen

(a) Composition

The polymer modified bitumen shall consist of a uniform mixture of the following:

- A formulated blend of polymer modified bitumen, as specified in (c) and (d) below.
- A proportion of approved filler (limestone or asbestos shall not be used).
- Characteristics of the filler shall be as specified in (b) below.

(b) Filler Grading

Method of test to BS 1796 modified to use the metric sieves specified in BS 410.

Passing 90 microns – not less than 93%.

Passing 250 microns – not less than 99%.

(c) Characteristics of the Polymer Modified Bitumen

The material shall conform to the requirements given in Table 37/11 when tested in accordance with the methods specified.

(d) Performance Tests of the Polymer Modified Bitumen System

The polymer modified bitumen shall be of thermoplastic rubber / bitumen modification.

The polymer modified bitumen containing mineral filler with the characteristics detailed in Clause 37.30.2.2 shall pass the performance test specified in Table 37/10.

TABLE 37/10
CHARACTERISTICS AND PERFORMANCE TEST: PMB

PROPERTIES	METHOD	UNIT	REQUIREMENTS
Softening Point	ASTM D36	°C	115-130
Penetration @ 25°C	ASTM D5	1/10 mm	15-30
Density @ 25°C	BS 4147	g/cm^3	1.1-1.4
Viscosity @ 170°C	Brookfield	Cp	7000-12000
Viscosity @ 190°C	Brookfield	Cp	3000-6000
Filler Content	BS 4147	%	20-30
Impact @ -10°C	BS 4147	mm^2	Max. 6500
Peel Initial / Delayed	BS 4147	mm	Max:
Sag @ 25°C	BS 4147	mm	3,0/3,0
Sag @ 40°C	BS 4147	mm	3,0/3,0
Sag @ 50°C	BS 4147	mm	3,0/3,0
Sag @ 60°C	BS 4147	mm	3,0/3,0
Sag @ 80°C	BS 4147	mm	Max. 1.5
Aging Test @ 190°C	Phoenix	hours	Min. 72
Bend	BS 4147	mm	Min. 15

NOTES:

- The test plates shall be cleaned by abrasive blasting to grade Sa 3 of SIS OS 5900 (BS 7079 and ISO 8501 – 8504) and with a profile of 50 – 75 microns (SANS Method 772). They shall be coated with primer at a rate of 100g per m^2.
- For the impact test a plate 12.7 mm thick shall be used and a single impact made in each quarter of the plate. The average of the four areas disbanded shall not exceed the permitted value.
- The peel test at 25°C is equivalent to / replaces the preliminary adhesion test in the original Specification.

37.30.2.3 Outerwrap

a) The outerwrap consists of a combination of polyester and glass fibres to ensure the required strength and elasticity. This is combined with a glass fabric of uniform quality and amount to control the best application and the required amount of bleed through, in order for the outerwrap to provide maximum protection.

b) The outerwrap shall be impregnated with the polymer modified bitumen compatible material to fulfil the characteristics shown in Table 37/11.

c) The characteristics of the outerwrap shall comply with the requirements of Table 37/12 and shall be determined in accordance with the test procedure.

TABLE 37/11
CHARACTERISTICS OF OUTERWRAP SATURANT

CHARACTERISTIC	REQUIREMENT	METHOD OF TEST
Softening Point	Min 100°C	BS 2000
Penetration @ 25°C	60-85 1/10 mm	BS 2000
Saturant	Polymer Modified Bitumen	

TABLE 37/12
PHYSICAL CHARACTERISTICS OF OUTERWRAP

CHARACTERISTIC	TYPE A	TYPE B	METHOD OF TEST
Minimum Thickness (mm)	0.6	0.6	AWWA C203-91
Weight (g) per m^2	500 – 700	500 – 700	AWWA C203-91
Tensile strength (N/50 mm)			
Longitudinal	> 800	> 400	AWWA C203-91
Transverse	> 800	> 200	AWWA C203-91

37.30.3 Application

37.30.3.1 Care of Wrapping Materials

All wrapping materials consigned to the coating yard or factory shall be properly stored to prevent damage or deterioration.

37.30.3.2 Care of Pipe

Throughout the wrapping process pipe and coating materials shall be kept clean and away from all foreign matter.

37.30.3.3 Marking

Any pipe manufacturer's identifying marks shall be removed before the start of the wrapping process and shall be permanently marked on the side of each pipe at both ends with a weatherproof paint. Metallic dye stamping shall only be permitted using approved stamps and only on the pipe bevel.

37.30.3.4 Blast Cleaning

In preparation for the application of primer all grease or heavy soil shall be removed without spreading over the surface with a volatile solvent, e.g. xylene (or approved equivalent) and thereafter the external surface of the pipes shall be cleaned by abrasive blasting to Sa 3 grade SIS O5 009 (BS 7079 and ISO 8501-8504) and surface profile amplitude 75 µm. Refer to 37.15 for detailed description of surface preparation process.

37.30.3.5 Priming

a) Following blast cleaning and within 2 hours, the pipe exterior shall be coated with the primer applied at a controlled rate to the manufacturer's recommendations. Pipes shall be coated within 24 hours of being primed.

b) The primer shall be applied to a dry, clean and dust free pipe and thereafter the primed pipe shall be kept free from moisture, dust or any other contaminant. The primed pipe shall be uniform and free from runs, drips, flooded or bare areas. Particular care shall be taken to ensure complete coverage of weld areas.

c) The primer should be applied at a pipe temperature of 10^{o}C (or above) or 3^{o}C above the dew point. If the pipe temperature is lower than this level or if moisture is present on the pipe, heating of the pipe may be required.

d) Deteriorated or contaminated primer shall not be applied to the pipe. Primer that has deteriorated or become contaminated after its application shall be removed to the satisfaction of the Employer or his representative, at the Contractor's expense. The cleaned area shall then be re-primed.

37.30.3.6 External Coating and Wrapping Application

a) The pipe, after priming and when the primer is no longer tacky, shall be passed through coating facilities of a type approved by the Engineer. The machine shall coat the pipe weld (longitudinal or spiral) with a 50 mm wide strip of extruded polymer modified bitumen and thereafter the entire pipe with an extruded coating of polymer modified bitumen and shall simultaneously apply the outerwrap.

b) All primed surfaces shall be clean and dust free immediately prior to coating.

c) The coating (including the outerwrap) shall have a minimum average thickness as specified in Clause 37.10. The coating shall be reinforced by a spirally-wound layer of outerwrap pulled into the polymer modified bitumen with an overlap of 20 mm, such that the outerwrap is wetted by the polymer modified bitumen. Particular attention shall be paid to the location of the reinforcement and thickness of the wrapping over the weld. The average thickness shall be determined in the following manner: At least four thickness measurements at approximately the pipe quarter points per lineal metre of pipe length shall be taken. At least 25% of the measurements shall be taken at the weld bead. The average thickness shall be the arithmetic average of all measurements.

d) The completed coating shall be well bonded to the pipe metal; uniform, smooth and free from Holidays, laminations, voids or other defects.

e) The wrapping shall be carefully trimmed off 100 mm from the ends of each pipe and bevelled throughout its thickness over a minimum length of ±5 mm, unless otherwise specified by the Employer or his representative.

f) Solar protection paint shall be applied to the coated pipe while the coating is still warm. It shall be white in colour, water resistant, continuous and shall cover the wrapping sufficiently to form an effective barrier to solar radiation. The solar protection shall be terminated approximately 100 mm from each end of the wrapping (i.e. 200 mm from each end of the pipe).

37.30.4 Inspection and Testing

The Contractor shall be responsible for, and shall bear the cost of a system of inspection and repair of the wrapped pipe approved by the Engineer. The system shall meet all relevant requirements in this Section and in addition the following requirements:

a) Monitoring of grit size and the finish of blast cleaned pipe.

b) Viscosity measurement and control of film thickness of external primer at least once for every batch of primer, in addition to visual checks of the applied prime coating.

c) Adequate temperature control of the polymer modified bitumen at the application head. In order to ensure that the polymer modified bitumen applied to the pipe has the characteristics specified, samples of the polymer modified bitumen shall then be taken from the application head and subjected to the following test and frequency of testing shown in Table 37/13.

d) Visual checks on the outer wrap and the appearance of the final wrap.

e) Holiday detection of 100% of the surface area of every wrapped pipe with approved equipment operating at a minimum 15 kV, maximum 25 kV with regular calibration of the equipment to the satisfaction of Quality Assurance.

f) Test of bond strength and thickness of the wrapping including removal of samples of the wrapping for inspection.

g) Adequate and proper repair of any defects to ensure compliance with this Section. A need to repair more than 1 defect per m^2 of pipe coating shall be sufficient grounds to reject the pipe and cause the Contractor to adjust his process to reduce the number of defects to an acceptable level.

Any necessary repairs of tested pipes shall be carried out by the Contractor at no additional cost to the Employer.

One pipe from every day's production shall be held back for examination on the following day. This examination shall include bond testing, thickness testing and examination for laminations, voids or any other defects.

If, in the opinion of the Engineer, there are a signification number of defects on the test pipe, then a back check procedure will be invoked. This will involve checking the ten pipes immediately preceding and the ten pipes immediately following the faulty test pipe (the pipe numbers shall be available from the final inspection). These twenty pipes shall be subjected to an examination similar to that carried out on the test pipe. Should the number of defects detected be, in the opinion of the Engineer, significant, then the entire production for that week shall be quarantined and jointly investigated by the Contractor and the Engineer.

Should tests in any production batch show a defect rate of more than 10%, the Engineer may reject the whole batch. In such cases the Contractor shall conduct an investigation to establish the cause of the defects.

TABLE 37/13
'IN PLANT TESTING'

TEST	FREQUENCY OF TESTING
1. Softening Point	Twice per working shift
2. Penetration at 25°C	Twice per working shift
3. Bond test for coated pipes	One pipe per working shift

These tests should be conducted at the coating Plant by the Contractor and monitored by the Approved Inspection Authority (AIA), who must be trained in the procedures by the coating material supplier.

At least once during the Contract or when the method of surface preparation is changed, a sample wrapped pipe shall be tested for resistance to cathodic disbonding.

When tested, the wrapping shall not be disbonded from the pre-damaged area by more than a 5 mm radius after exposure for 28 days at the specified potential, i.e. -1500 mV (BS 3900:F1 1).

The inspection activities shall be coordinated with the Contractor's operations so as to delay or interfere with the operations as little as possible. The Contractor's methods shall, nevertheless, always permit inspection to be made and allow adequate repair of imperfections.

Prior to dispatch from his Plant, the Contractor shall ensure that the wrapped pipe is correctly marked on the internal painted surface of the pipe at each end with approved paint, with sufficient information to enable subsequent identification of the pipe to be made. Documentation shall be supplied to the Engineer to enable the history of the processing of each pipe to be traced.

37.30.5 Methods of Testing

37.30.5.1 Testing of Wrap Characteristics

(a) General

The procedures given below are reference methods of test, which shall be used to establish conformity to the Specification in cases of dispute. Other similar methods, however, may be used by manufacturers for routine quality control purposes with the approval of the Engineer.

(b) Thickness

The thickness shall be determined by means of a suitable instrument fitted with a micrometre dial gauge, a cylindrical brass block 57 mm in diameter and giving a nominal loading of 3.45kN/m^2 and a surface plate.

The thickness shall be measured by interposing the outer wrap between the cylinder and the surface plate. Measurements shall be made by marking 75 mm square across the effective width of the mat and making a measurement within each square. No single reading across the width of the mat shall be less than the specified minimum thickness.

(c) Weight per m^2

The weight per square metre shall be determined by cutting representative samples from the effective width of the outer wrap. The samples shall be of such a size, that the weight per square metre may be determined to an accuracy of ±2%.

(d) Tensile Strength

The tensile strength shall be measured with approved equipment. The size of the samples cut from the roll shall be 520 mm long and shall have the required width. (See Table 37/12 for the minimum tensile strength).

When mounted in the equipment, the distance between the jaws shall be 320 mm. The constant rate of separation of the jaws shall be in the range of 100 mm to 610 mm/minute and the tensile strength at breaking point shall be determined. For reference purposes the rate of separation of the jaws shall be 200 mm/minute. At least four samples shall be tested and an average figure obtained. The test may be carried out on narrower samples if required, provided that at least two of the reinforcing strands are included in the specimen. Sealing of the ends is recommended.

The value for tensile strength obtained from a narrower sample shall be extrapolated to 150 mm width.

37.30.5.2 Bond Test for Coated Pipes

a) Measure the temperature of the coating with a surface thermometer.

b) If the temperature of the coating is not between 10°C and 25°C, cool or warm the pipe in the test area to bring the temperature within this range.

c) Using a knife, heated if necessary, make two parallel cuts, through the coating down to the pipe surface. The cuts shall be 100 mm long and 30 mm apart.

d) With a stiff flat blade, loosen the coating the full width between the two cuts and lift the wrap upward in a direction at right angles to the pipe surface.

e) The bond shall be considered satisfactory if the coating does not peel cleanly from the primer or the pipe surface but is removed with difficulty.

f) This bond test should be carried out at the start of each shift or change in production and thereafter at a frequency approved by the Engineer.

37.30.6 Handling

At all times the pipe, unwrapped as well as wrapped, shall be handled with the aid of slings, lifting yokes and protected hooks to the approval of the Engineer.

At all times the coated pipe shall be handled and stacked in such a manner as to prevent damage to the coating. Particular care shall be taken immediately after coating to avoid damage while the enamel is above ambient temperature. No stacking or loading shall be undertaken until the coating has cooled sufficiently to avoid marking.

The coated pipe shall be stored at all times clear of the ground and in such a way that either water or mud cannot accumulate on the inside or outside of the pipe. Storage shall be effected by the use of wooden bearers, suitably covered, or mounds of gravel-free sand, covered with polyethylene sheets.

The pipe shall only be stacked to a height such that no flattening of the wrapping occurs.

The pipes shall be separated from each other with approved polyethylene covered pads.

37.30.7 Repairs

Although the polymer modified bitumen has excellent self-healing properties, damage caused by transportation or laying of the coated pipe may occur. This shall be quickly repaired using torch-on membrane.

Damage shall be repaired by removing the existing coating to at least 10 mm beyond the area of damage. The repair area shall then be cleaned of all deleterious matter to 100 mm beyond the proposed repair area. Exposed metal shall be re-primed in accordance with this Section. The repair patch, which shall lap at least 50 mm onto sound coating, shall be applied by gently heating with a gas torch and applying it to the pipe in a manner, which prevents the entrapment of air bubbles. All air bubbles shall be removed using a wooden roller or by other means and the perimeter of the repair patch shall be neatly finished off. The patched area shall then be Holiday tested in accordance with the Specification.

37.30.8 Field Joint Coating, Bends and Specials

Where applicable, remove the whitewash for a distance of 150 mm from the edge of the factory applied coating. Ensure the end of the factory coating is firmly adhered. Cut back any areas of loose or damaged coating to 10mm beyond the area of damage. Ensure the edge of the factory applied coating is bevelled at 30°or less.

Prepare the exposed steel surface of the joint in accordance with Clause 37.15 and apply the bitumen primer.

Using hot air or gas torches, apply the custom sized rolls of membrane material to achieve the same minimum thickness as the factory applied coating. The membrane shall overlap onto itself or the factory coating by a minimum of 50 or 100 mm respectively.

Ensure a liquid bead of coating is maintained in contact with the steel at all times to prevent air entrapment. The perimeter of the field joint shall be neatly finished off and blended into the factory coating.

The finished joint shall be free of air bubbles, and shall exhibit the same bond to steel as the factory coated pipe.

Joint preparation shall be subject to witness and hold inspection by the Engineer prior to application of the primer and coating. The finished joint shall be holiday tested at 15 kV and any holidays repaired in accordance with Clause 37.30.7.

37.31 THREE LAYER HIGH DENSITY POLYETHYLENE PIPE COATING SYSTEM

37.31.1 Introduction

This Section defines the minimum requirements for a shop applied three layer high density polyethylene (3LPE) coating system. The coating system shall comprise a layer of fusion bonded epoxy (FBE) overlaid with an adhesive and an outer layer of high density polyethylene (PE).

37.31.2 Standards

Equipment, materials and operational methods shall comply with the relevant SANS, ISO, BS, DIN or equivalent American Standard.

The Contractor shall ensure that he is in possession of the latest editions of all the relevant National Specifications, Codes of Practice or Standards referred to in this Section.

Reference is made to the latest issues of the following Standards:

DIN-Deutsche Institut Für Normung

DIN 30670	Polyethylene coatings for steel pipes and fittings.

ASTM–American Society for Testing and Materials

ASTM D2240	Standard test method for rubber property (Durometer hardness).
ASTM D4541	Standard test method for pull-off strength of coatings using portable adhesion testers.
ASTM G14	Standard test method for impact resistance of pipeline coatings (Falling weight test).
ASTM D4285	Standard test method for method for indicating oil or water in compressed air.

ISO – International Organization for Standardisation

ISO 178	Plastics - determination of flural properties.
ISO 527-2	Plastics - Determination of tensile properties. Part 2: Test conditions for moulding and extrusion plastics.
ISO 1133	Plastics - Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics.
ISO 3061A	Plastics - thermoplastic materials. Determination of vicat softening temperature.
ISO 11831A	Plastics methods for determining the density of non-cellular plastics.
ISO 3146	Plastics - Determination of melting behaviour (Melting temperature or melting range) of semi-crystalline polymers of capillary tube and polarizing – microscope methods.
ISO 6964	Determination of carbon black content by calcination and pyrolysis - Test method and basic specification.
ISO 11420	Method for the assessment of the degree of carbon black dispersion in polyolefin pipes, fittings and compounds.
ISO 1514	Paints and varnishes- Standard panels for testing.
ISO 2808	Paints and varnishes - Determination of film thickness.
ISO 4624	Paints and varnishes - Pull off test for adhesion.

ISO 8501-1	Preparation of steel substrates before application of paints 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.
	Informative supplement: Representative photographic examples of the change of appearance imparted to steel when blast-cleaned with different abrasives.
ISO 8502	Preparation of steel substrates before application of paints 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).
	Part 9: Field method for the conduct ometric determination of water-soluble salts.
ISO 8503	Preparation of steel substrates before application of paints and related products- Surface roughness characteristics of blast-cleaned steel substrates.
	Part 1: Specifications and definitions for ISO surface profile comparators for the assessment of abrasive blast-cleaned surfaces.
	Part 2: Method of grading of surface profile of abrasive blast-cleaned steel-comparator procedure.
	Part 4: Method for the calibration of ISO surface profile comparators and for the determination of surface profile – Stylus instrument procedure.
	Part 5: Replica tape method for the determination of surface profile.
ISO 8504-2	Preparation of steel substrates before application of paints and related products – Surface preparation methods – Part 2: Abrasive blast cleaning.
ISO 11124 – 1	Preparation of steel substrates before application of paints and related products – Specifications for metallic blast cleaning abrasives:
	Part 1: General introduction and classification.
	Part 2: Chilled iron grit.
	Part 3: High – carbon cast-steel shot and grit.
	Part 4: Low-carbon cast-steel shot.

NACE – National Association of Corrosion Engineers

NACE RP0274	High – voltage electrical inspection of pipeline coatings prior to installation.
NACE RP0287	Field measurement of surface profile of abrasive blast cleaned steel surfaces using a replica tape.
NACE RP0394	Application, performance and quality control of Plant – Applied, fusion-bonded epoxy external pipe coating; Errata.
NACE RP 0490	Holiday detection of fusion bonded epoxy external pipeline coatings of 10 to 30 mils (0.25 to 0.70 mm).

SSPC – Steel Structures Painting Council

SSPC SP 1	Solvent cleaning.
SSPC SP11	Power tool cleaning to bare metal.
SSPC PA 2	Measurement of dry coating thickness with magnetic gauges (Steel structures painting manual, Ch5 – Paint application specs).

37.31.3 Material

37.31.3.1 Handling of Materials

Materials shall be handled and stored in accordance with the material manufacturer's recommendations, which shall be available for review by the Engineer at the Contractor's premises. Materials shall be stored in an air-conditioned, temperature controlled environment until required for use.

Coating materials shall be segregated by type and batch during storage and handling. Materials from damaged containers shall be rejected, unless otherwise agreed with the Engineer.

Materials shall be used in the order in which they are delivered and before their expiry date for use.

37.31.3.2 Documentation from the Materials Manufacturer

Full traceability of each batch of coating material shall be maintained. As a minimum, the following data shall be compiled and shall be available for immediate review by all parties:

- Name of manufacturer;
- Complete material identification: Trade name, chemical name and type of product details;
- Batch number;
- Date of manufacture;
- Place of manufacture;
- Shelf life / expiry date (if appropriate);
- Health and safety, and environmental instructions;
- Hazard warnings;
- Storage instructions;
- Quantity; and
- Manufacturing standard.

Any material not labelled with the above information shall not be used.

37.31.3.3 FBE Powder

The FBE powder selected shall be suitable for use at the design temperatures in the proposed environment and be suitable for a 3LPE coating system. The FBE shall be endorsed by the Manufacturer of the adhesive and polyethylene as being compatible with these products under the specified service conditions.

Each FBE batch shall be accompanied by a certificate (BS EN 10204:1991 or equivalent) stating the following tests have been carried out on every batch, and results are in accordance with the Manufacturer's product specifications:

- Gel and cure times;
- Moisture content;
- Particle size distribution;
- Density;
- Infrared scan;

- Thermal analysis, including glass transition temperature;
- Shelf life; and
- Water Absorption.

The proposal for the specific FBE powder shall be accompanied by test data demonstrating its satisfactory performance in a 3LPE line pipe coating system.

37.31.3.4 Adhesive for 3LPE

The adhesive(s) selected shall be completely suitable for use at the design temperatures in the proposed environment and be suitable for a 3LPE coating system.

Each adhesive batch shall be accompanied by a certificate (BS EN 10204:1991 or equivalent) stating the following tests have been carried out on every batch, and results are in accordance with the Manufacturer's product specifications:

- Adhesion;
- Density;
- Melt flow index;
- Tensile strength; and
- Elongation.

The proposed polyethylene adhesive shall be accompanied by test data demonstrating equivalent performance in 3LPE coating systems.

37.31.3.5 Polyethylene for 3LPE

The polyethylene selected shall be of high density, shall contain additives as required to provide ultra-violet protection. The polyethylene shall be completely suitable for use at the design temperatures in the proposed environment. The polyethylene shall be suitable for the three layer polyethylene coating systems specified herein.

The carbon black requirements for the PE shall as follows:

- Carbon black content: 2 to 2.6% (ISO 6964); and
- Carbon black dispersion: ≤3.0 (ISO 11420).

Each polyethylene batch shall be accompanied by a certificate (BS EN 10204:1991 or equivalent) stating the following tests have been carried out on every batch, and results are in accordance with the manufacturer's product specifications:

- Density;
- Melt flow index;
- Melting point;
- Shore hardness;
- Tensile strength;
- Elongation;
- Moisture content;
- Carbon black content;

- Carbon black dispersion; and
- Oxidation induction time.

Current technical and health & safety data sheets from the proposed manufacturer of the PE outer layer for the proposed material shall be submitted to the Engineer.

37.31.3.6 Surface Preparation

Pre-preparation, primary cleaning and surface preparation shall comply with the requirements of Clauses 37.13 to 37.15. The pipe surface shall be blast-cleaned to grade Sa 3 with a sharp angular profile as specified in Clause 37.15.2.6.

37.31.3.7 Acid Wash Pre-treatment

a) Pipe surface pre-treatment shall be performed using a propriety brand of a 10% solution (or as otherwise proven by the Contractor) of phosphoric acid wash, e.g. Oakite 31 or 33. This shall be used to remove soluble salts and other soluble contaminants. This process shall be followed immediately by washing with de-ionised water (Alternative concentrations may be used subject to verification by the Contractor).

b) The pipe temperature immediately before the phosphoric acid treatment shall be in the range 45°C to 65°C or as proven appropriate.

c) If two abrasive blast cleaning machines are utilised, the phosphoric acid pre-treatment shall be carried out between the two blast cleaning operations. If only a single abrasive blast cleaning unit is used, phosphoric acid treatment shall take place after blast cleaning. Alternatively, and only with the Engineer's approval, phosphoric acid treatment may take place before surface preparation.

d) The pH of the pipe shall be determined both before and after the fresh water rinse at a minimum frequency of once per hour.

   The measured pH shall be as follows:

   - Before the demineralised water rinse: pH 1 to 2; and
   - Following the demineralised water rinse: pH 6 to 7.

e) Data sheets and supporting documentation for the proprietary phosphoric acid system to be used shall be provided. The documentation shall verify that the chemical is suitable for the treatment of line pipe before the application of the specific fusion bonded epoxy powder being applied and the final coating will meet the requirements of this Section.

f) Phosphoric acid pre-treatment may be omitted provided that this linepipe has been subjected to high pressure demineralised water wash, as part of the pre-cleaning operation prior to abrasive blast-cleaning.

37.31.3.8 Verification of Pre-treatment Solutions

Where chemical pre-treatment is utilised, as described above, solutions shall be checked to ensure they remain:

- Within the concentration range recommended by the chemical manufacturer (or as established during pre-production trials) for the pipe coating process. Concentration shall be checked at the make-up of each fresh solution, and once per shift thereafter; using a method approved by the chemical manufacturer; and
- Free from contamination at all times.

37.31.4 Coating Application

37.31.4.1 General

The application of the coating shall be in accordance with the material manufacturer's recommendations.

Prior to application of the fusion epoxy powder, the powder application and recovery systems shall be thoroughly cleaned. During coating application no container/hopper shall contain powder/pellets from more than one batch of material. The spray booth shall be cleaned of excess powder at the end of each shift.

37.31.4.2 Coating Thickness

The FBE layer shall be applied to a coating thickness as specified in Clause 37.10. The polyethylene shall be applied to provide a total thickness of the 3LPE system as specified in Clause 37.10.

37.31.4.3 FBE Layer

a) The FBE shall be applied to a minimum average thickness of 325 µm (250 – 400 µm).

a) The pipe shall be uniformly preheated in accordance with the FBE Manufacturer's instructions. This temperature shall have been confirmed during pre-production trials. The surface temperature shall not exceed 260°C.

b) The coating shall be applied by electrostatic spray with the pipe at earth potential and the epoxy powder charged to high potentials.

c) Pipe temperature shall be checked periodically using a recording pyrometer. The pyrometer shall be checked for error not less than every four hours against a calibrated temperature-measuring instrument according to the procedural requirements of ISO 9002.

d) Oxidation of the steel prior to coating in the form of 'blueing' or other apparent oxide formation is not acceptable. If such oxidation occurs, the pipe shall be set aside as rejected and unsuitable for use for this Contract.

e) The use of recycled powder is permitted only when that powder has been recovered from the powder booth and passed immediately through the adjacent closed system for screening. A maximum 20% closed system recycled powder is permitted in any single gun.

f) During application, the bevelled ends and pipe bore shall be protected against mechanical damage and from contamination with coating material.

37.31.4.4 Adhesive Layer

The adhesive layer shall be applied to a minimum average thickness of 250 µm (200 – 300 µm).

The adhesive layer shall be applied before gel time of the FBE has expired by using either the cross-head or lateral extrusion technique. Application of the adhesive shall not be permitted after the FBE has fully cured. The Contractor shall establish to the satisfaction of the Engineer that the adhesive is applied within the gel time window of the FBE and at the temperature recommended by the adhesive manufacturer. The supplier shall state the proposed minimum and maximum time interval between FBE and adhesive applications at the proposed pre-heat temperature.

37.31.4.5 Polyethylene Layer

a) The polyethylene layer shall be applied to obtain a minimum total coating thickness of 3.5 mm.

b) A polyethylene layer cut back of approximately 150 mm shall be provided at pipe ends. Pipe ends shall be supplied as bare steel, free of all coating, for a distance of 100 mm (+25 / -0 mm) from the pipe end. In addition, each pipe end shall be left without polyethylene/adhesive coating so that a 50 mm (+10 / -0 mm) FBE toe protrudes on the steel beyond the cutback polyethylene coating layer. Complete removal of the adhesive is not imperative and minor residual adhesive on the FBE toe is acceptable.

c) The polyethylene may be applied by either the cross-head or lateral extrusion technique. The polyethylene shall be applied over the adhesive within the time limits established during pre-production trials and within the temperature range recommended by the manufacturer.

d) The coating shall be cooled to below 85°C before handling. The ends of the coating shall be bevelled at 30° to 45°. Immediately after the coating is fully cured, pipe identification marks shall be re-applied to the coated pipe using a method approved by the Engineer.

37.31.5 Quality of Coating

The fully cured FBE coating shall have a uniform, smooth, gloss finish. The polyethylene outer layer shall be smooth and glossy.

37.31.6 Testing

37.31.6.1 Quality Assurance and Procedures

See Clause 37.4.1.

37.31.6.2 Visual Inspection

All surfaces (in particular adjacent to welds and the cutback at each end of the pipe) shall be inspected visually in adequate lighting. The coating shall be black (unless otherwise agreed with the Engineer) and shall not have any defects such as blisters, scratches, wrinkles, engravings, cuts, swellings, excess material, thickened zones, air inclusions, tears, voids, excessive orange peel, excessive runs or sags or entrained foreign matter, etc.

37.31.6.3 Thickness

The thickness of the cooled 3LPE coating system shall be checked using approved equipment in accordance with the requirements of DIN 30670.

Coating thickness shall be measured by use of an electronic thickness gauge. Calibration of this gauge shall be rechecked every 2 hours. The Contractor's proposed thickness gauge type, manufacturer and model shall be submitted to the Engineer for review and approval.

The coating thickness shall be determined by taking at least ten (10) measurements on the same point along the pipe circumference and uniformly distributed over the length of each pipe. In the case of pipes with raised seams, three (3) readings shall be made at the apex of the weld seam, uniformly distributed over the length of the pipe. All coating thicknesses measured shall meet the minimum thickness requirements specified (see Clause 37.31.4). Any individual reading less than the minimum value shall be cause for the coated pipe length concerned to be rejected and the particular pipe shall be held for further review by the Engineer.

37.31.6.4 Electrical Insulation Defects

Each fully coated pipe shall be inspected for electrical insulation defects over 100% of its coated surface using a high voltage DC Holiday Detector.

The detector shall be set to 10V for each micron of total coating thickness, to a maximum of 15 000V. This setting shall be checked once every two hours. The travel speed of the brush shall not exceed 300 mm/s.

All defects shall be marked for subsequent repair and re-testing. On re-testing, no defects shall be permitted in the final coating.

The number of defects for each pipe length shall be recorded. Coated pipe having defects in excess of 3 per individual pipe length shall be stripped and re-coated at no additional cost to the Employer. If there is an excess occurrence of defects (in excess of 3 per individual pipe length) on successive pipes, the Contractor shall immediately stop the coating operation to determine the cause of the defects and remedy it.

37.31.7 Repair Methods

37.31.7.1 Repair Methods for Minor Defects

This method shall be applicable to damaged areas smaller than 10 cm^2 and where the damage does not extend into the FBE layer of the 3LPE system. The repair shall be carried out with a melt stick (thermo-sensitive co-polymer) as follows:

- Trim off the damaged PE layer of the 3LPE system to remove the damaged area;
- Abrade the exposed area using an 80 grit emery cloth or sand paper;
- Vacuum clean the surface to remove dust, debris and dirt. Wipe the repair area with an appropriate cleaning solvent (Xylene or similar) and thoroughly wash with potable water and non-ionic detergent using brushes and lint free rags. Provide a final rinse with de-mineralized water; and
- Heat the area to be repaired with a gas torch to approximately 50°C. Heat the melt stick until it softens (max of 150°C) and apply to the prepared area of damage. Smooth the repaired area with a heated spatula.

37.31.7.2 Repair Methods for Major Defects

This method shall be applicable to damaged areas larger than 10 cm^2 or where the damage extends into the FBE layer of the 3LPE system. The repair shall be carried out as follows:

a) Trim back the damaged PE layer of the 3LPE system to expose the damaged area to a distance of at least 50 mm beyond the damage area. The coating edges shall be bevelled/chamfered to make a 10 mm minimum tapered transition between the full thickness coating and the exposed steel;

b) All corrosion products and/or contaminants (oil, grease, tar, chlorides, soluble salts, pipe end primer, etc.) on the exposed FBE layer or steel substrate shall be removed;

c) Following the removal of all corrosion products and/or contaminants, the surface shall receive a final high pressure (20-35MPa) de-mineralized water wash. Surface condition after pre-cleaning shall comply with SSPC-SP1;

d) The steel substrate shall be blast-cleaned to remove all mill scale, rust, oxides, corrosion products and other impurities to Sa 3 (ISO 8501-1). The main line pipe coating shall be protected from damage or contamination from the blasting operations;

e) The 3LPE coating shall be sweep blasted to a distance of 150 mm from the damaged area to provide a key for the application of the repair. Under no circumstances shall the FBE coating be completely removed during blast cleaning, the intention is that the surface be feathered / roughened only;

f) The main line pipe coating shall be protected from damage or contamination from the blasting operations. Where damage or contamination does occur, the affected area shall be cleaned and the coating reinstated;

g) The joint area shall be vacuum cleaned to remove all dust and debris in accordance with SANS 8502-3. With prior approval of the Engineer, dust and debris may be removed by blowing with clean uncontaminated compressed air;

h) The steel surface temperature shall always be 3°C above the dew point to remove any moisture prior to application of a primer;

i) The Contractor shall provide dust protective shields where Site conditions require such measures. The Contractor shall not execute surface preparation in an unprotected dusty environment; and

j) To complete the repair, apply the System (paint plus tape wrapping) as detailed in Clause 37.31.8.

37.31.8 Field Joints

37.31.8.1 General Requirements

Field joint repairs shall be suitable to be applied to steel pipes with welded joints and 800 – 1600 mm in diameter. The field joint repair system shall be able to provide effective corrosion protection of the welded field joint over the full design lifespan of the pipeline and shall be fully compatible with the coating of the pipeline. The field joint repair system shall be suitable for use with a cathodic protection system.

The following field joint repair system shall be used:

- A layer of applied liquid epoxy, polyurethane or urethane modified epoxy followed by the application of an additional cold applied tape wrapping system. The cold tape wrapping system shall consist of a primer, an inner wrapping tape and an outer wrapping tape.

37.31.8.2 Control of Environmental Conditions

During all surface preparation and field joint application operations, relative humidity, dew point temperature, other relevant environmental conditions in the immediate vicinity of item being worked on and the steel surface temperature shall be determined and recorded at two hour intervals.

Surface preparation and field joint application operations shall only be permitted when:

- The relative humidity is less than 85%;
- The ambient temperature is above 10°C; and
- The substrate temperature is $\geq$ 3°C (5°F) above the dew point.

37.31.8.3 Surface Preparation

(a) for Epoxy Paint Plus Tape Wrapping

The surface preparation of the field joint area for the epoxy paint application shall be as follows:

a) All corrosion products and/or contaminants (oil, grease, tar, chlorides, soluble salts, pipe end primer, etc.) on the exposed steel substrate shall be removed.

b) The edges of the HDPE coating shall be cut back to a distance of 150 mm from the weld joint. The HDPE coating edges shall be bevelled/chamfered to make a 15º minimum tapered transition between the full thickness coating and the exposed epoxy.

c) The steel substrate shall be blast-cleaned to remove all mill scale, rust, oxides, corrosion products and other impurities to Sa 3 (ISO 8501-1) for a distance of 100 mm from the weld joint. The main line pipe coating shall be protected from damage or contamination from the blasting operations.

d) The FBE coating shall be sweep blasted to a distance of 150 mm from the weld joint to provide a key for the field joint. Under no circumstances shall the FBE coating be completely removed during blast cleaning, the intention is that the surface be feathered / roughened only.

e) The main linepipe coating shall be protected from damage or contamination from the blasting operations. Where damage or contamination does occur, the affected area shall be cleaned and the coating reinstated.

f) The joint area shall be vacuum cleaned to remove all dust and debris in accordance with SANS 8502-3. With prior approval of the Engineer, dust and debris may be removed by blowing with clean uncontaminated compressed air.

The Contractor shall provide dust protective shields where Site conditions require such measures. The Contractor shall not execute surface preparation in an unprotected dusty environment.

37.31.8.4 Coating repair material for Epoxy Paint plus Tape Wrapping

The liquid coating component of the field joint repair system shall comprise of liquid epoxy, polyurethane or urethane modified epoxy. The liquid coating component shall be fully compatible with the FBE and polyethylene of the 3LPE coating of the line pipe and shall be subject to the approval of the Engineer. The Contractor shall provide full details of the liquid coating to be used (manufacturer and product number) as well as data and detail sheets.

The Contractor shall provide full details of the primer to be used (manufacturer and product number) as well as data and detail sheets for the application of the cold tape wrapping of the field joint repair system. The inner wrap shall consist of a 100 mm wide conformable polyethylene backed modified bitumen mastic tape, compliant with the requirements of SANS 1117 type C (e.g. DENSO ULTRAFLEX 1250/300 or similar product approved by the Engineer). The outer wrap shall consist of a 100 mm wide medium density adhesive polyethylene compliant with the requirements of SANS 1117 Type B & D (e.g. DENSO MDP 030 (B) or similar product approved by the Engineer).

37.31.8.5 Coating Repair Application

(a) Epoxy Paint plus Tape Wrapping

(i) Heating

a) The surface may be heated using an induction heating coil to a temperature as recommended by the coating material manufacturer and in accordance with this Section. In any event the temperature shall not exceed 50°C and qualification of this heating temperature shall be carried out by porosity checks as required by the Engineer.

b) The use of propane torches for pre-heating and post-heating is expressly prohibited. Infrared heaters may be used for post-heating.

c) The temperature of the bare steel shall be monitored using temperature-indicating crayons. The amount of crayon used shall be the minimum amount required for accurate measurement. Crayon markings shall be removed with a wire brush. Care shall be taken to ensure a uniform heating pattern.

(ii) Liquid Coating Application

a) A layer of liquid coating shall be applied to the blast cleaned field joints and adjacent prepared factory FBE coating using pre-packed joint repair kits. Pre-heating of the resin and/or the curing agent may be required prior to mixing and application in accordance with the manufacturer's recommendations. The minimum required dry film thickness for the external coating is 400 µm over any part of the surface / item to be coated.

b) For each coat, the overlap onto the factory applied coating shall not be less than 20 mm external.

c) If post-heating of the coating after application is required, this shall also be carried out in accordance with the product manufacturer's procedure.

d) The coating shall be uniform, free of defects and shall not show a tendency to laminate, to sag or to curtain.

e) The wet film thickness shall be measured in accordance with ISO 2808.

f) No thinner shall be used unless recommended by the product manufacturer. Tools and equipment shall be cleaned using only such solvents as are recommended by the product manufacturer.

g) Particular care shall be taken in the handling of the field joints before the coating has reached the minimum value of hardness recommended by the manufacturer and qualified during the impact test.

(iii) Finished Field Joint Coating

a) The finished coating shall be smooth and uniform and free of any defects.

b) When the coating has cured sufficiently, dry film thickness which shall be measured in accordance with SSPC PA 2.

c) Holiday detection shall be carried out in accordance with NACE RP0188.

(iv) Application of Cold Tape Wrapping

Primer Application

Once the Liquid Applied Field Joint Coating has cured to the extent required by the product data sheet and has been inspected, the cold tape wrapping procedure shall be as follows:

a) The factory applied polyethylene line pipe surface to which the cold tape wrapping is to be applied shall be abraded.

b) The entire joint surface to be wrapped shall be primed with a suitable primer (e.g. Denso Primer D).

c) Priming shall not be carried out further ahead of physical tape wrapping than a maximum of 8 hours.

d) Ensure the primer is dust free prior to application of a tape wrap system. If the primer has become severely contaminated with dust, a re-prime shall be carried out. Heavy contamination with sand or dirt shall require cleaning of the surface with a manufacturer recommended cleaning solvent (e.g. Denso Cleaning Solvent) and re-application of the primer.

e) Allow approximately 30 minutes drying time or until the primer is tacky to the touch.

Inner Wrap

a) The inner wrap shall consist of a 100 mm wide conformable polyethylene backed modified bitumen mastic tape compliant with the specifications in Clause 37.31.8.4.

b) Peel back approximately 0.5 m of interleaving. Align the edge of the 100 mm wide tape 50 mm beyond the exposed FBE toe onto the primed, factory applied, polyethylene line pipe coating. Press down firmly.

c) Before spiral wrapping commences, a full circumferential wrap of tape is applied by hand with sufficient tension to narrow the width of tape between 1 and 2 mm.

d) Whilst maintaining tape tension described above, the tape shall be applied spirally. Remove interleaving as wrapping proceeds.

e) The tape shall be applied to ensure that a minimum 25 mm overlap shall be achieved.

Outer Wrap

a) The outer wrap shall consist of a 100 mm wide medium density adhesive polyethylene compliant with the specifications in Clause 37.31.8.4.

b) Centre 100 mm wide outer-wrap tape on the edge of the applied inner wrap tape on the factory applied coating. Press down firmly.

c) Before spiral wrapping commences, a full circumferential wrap of tape is applied by hand with sufficient tension to narrow the width of tape between 1 and 2 mm.

d) Whilst maintaining tape tension described above, the tape shall be applied spirally.

e) The tape shall be applied to ensure that a minimum 55% overlap shall be achieved.

f) The tape shall be applied to a minimum width of 50 mm beyond the applied inner tape-wrapped area onto the primed shop applied coating.

(v) Finished Cold Tape Wrapping

a) Ensure that the tape is in full contact with the underlying surface with no wrinkles, fish-mouths or bubbles.

b) Holiday detection shall be carried out in accordance with NACE RP0188.

37.32 RIGID POLYURETHANE PIPE COATING SYSTEM

37.32.1 Introduction

This part of the Specification defines the minimum technical requirements for liquid applied coating for factory coated pipe and specials. The coating system shall comprise a homogenic layer of 100% solids rigid polyurethane mechanically bonded to the metal substrate.

Where specified it shall be used for the external coating of pipes. The pipeline will be buried and will be protected against external corrosion by the external coating and cathodic protection systems. The external coating (primary corrosion protection system) shall be suitable for the operating conditions applying to the specific pipeline.

37.32.2 Standards

Unless otherwise specified herein, the latest edition of the following Standards should be read in conjunction with this Specification:

37.32.2.1 American Society for Testing and Materials

ASTM D16	Standard Test Method for Paint, related coatings, materials and applications.
ASTM D 543	Standard Test Method for evaluating the resistance of plastics to chemical reagents.
ASTM D 570	Standard Test Method for Water absorption of plastics.
ASTM D 2240	Standard Test Method for Rubber Property (Durometer Hardness).
ASTM D 4060	Standard Test Method for Abrasion resistance of organic coatings by the Taber abraser.
ASTM D 4541	Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
ASTM G14	Standard test method for impact resistance of pipeline coatings (Falling Weight Test).
ASTM D 4285	Method for indicating Oil or Water in Compressed Air.

37.32.2.2 British Standard and European Norm

BS EN 10290	Steel tubes and fittings for onshore and offshore pipelines - External liquid applied polyurethane and polyurethane-modified coatings.

37.32.2.3 ISO – International Organisation for Standardisation

ISO 1514	Paints and varnishes - Standard panels for testing.

ISO 2808	Paints and varnishes - Determination of film thickness.
ISO 4624	Paints and varnishes - Pull off test for adhesion.
ISO 8501-1	Preparation of Steel Substrates Before Application of Paints 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.
ISO 8502	Preparation of steel substrates before application of paints and related products - Tests for the assessment of surface cleanliness
ISO 8503	Preparation of Steel Substrates Before Application of Paints and Related Products - Surface Roughness Characteristics of Blast-Cleaned Steel Substrates.
Part 1:	Specifications and definitions for ISO surface profile comparators for the assessment of abrasive blast-cleaned surfaces.
Part 2:	Method of grading of surface profile of abrasive blast-cleaned steel comparator procedure.
Part 4:	Method for the calibration of ISO surface profile comparators and for the determination of surface profile - Stylus instrument procedure.
Part 5:	Replica tape method for the determination of surface profile.
ISO 8504-2	Preparation of Steel Substrates Before Application of Paints and Related Products - Surface Preparation Methods - Part 2: Abrasive Blast Cleaning
ISO 11124-1	Preparation of Steel Substrates Before Application of Paints and Related Products - Specifications for Metallic Blast Cleaning Abrasives -
Part 1:	General introduction and classification.
Part 2:	Chilled iron grit.
Part 3:	High-carbon cast-steel shot and grit.
Part 4:	Low-carbon cast-steel shot.

37.32.2.4 NACE – International

NACE RP0274	High-Voltage Electrical Inspection of Pipeline Coatings Prior to Installation.
NACE RP0287	Field Measurement of Surface Profile of Abrasive Blast Cleaned Steel Surfaces Using a Replica Tape.
NACE RP0394	Application, Performance, and Quality Control of Plant-applied, Fusion- Bonded Epoxy External Pipe Coating.

37.32.2.5 SSPC – Society for Protective Coatings

SSPC SP11	Power Tool Cleaning to Bare Metal.
SSPC PA 2	Measurement of Dry Coating Thickness with Magnetic Gauges (Steel Structures Painting Manual, Ch 5 - Paint Application Specs.)
SSPC SP 10	Near-White Metal Blast Cleaning NACE No.2-2000 (Steel Structures Painting Manual, Ch 2 - Surface Preparation Specs.)

37.32.3 Materials

The required coating shall be a two-component liquid applied rigid polyurethane subject to the approval of the Engineer.

The two components shall have different colours allowing the verification of the correct mixing, and checking of the uniformity of the colour of the mixed product.

The coating is considered cured when it has attained the hardness recommended by the product manufacturer.

37.32.3.1 Handling of Materials

Materials shall be handled and stored in accordance with the material manufacturer's recommendations, which shall be available for review by the Engineer at the Contractor's premises. Materials shall be stored in an air-conditioned, temperature controlled environment until required for use.

Coating materials shall be segregated by type and batch during storage and handling. Materials from damaged containers shall be rejected, unless otherwise agreed with the Engineers representative in the factory or on Site.

Materials shall be used in the order in which they are delivered and before their expiry date for use.

37.32.3.2 Documentation from the Materials Manufacturer

The commercial rigid polyurethane coating system offered shall be qualified by the Contractor and will be subject to the Engineer’s approval prior to application. Testing should be conducted on each applicable coating and shall meet the acceptance criteria of Table 37/14. The qualification shall be based on tests carried out by an independent recognized certifying body and the relevant documents shall be submitted to the Engineer.

Full traceability of each batch of coating material shall be maintained. As a minimum, the following data shall be compiled and shall be available for immediate review by all parties:

- Name of manufacturer;
- Complete material identification: Trade name, chemical name and type of product details;
- Batch number;
- Date of manufacture;
- Place of manufacture;
- Shelf life / expiry date (if appropriate);
- Health and safety, and environmental instructions;
- Hazard warnings;
- Storage instructions;
- Quantity; and
- Manufacturing standard.

Any material not labelled with the above information shall not be used.

37.32.3.3 Rigid Polyurethane Properties

The coating material properties and characteristics with respect to the 100% solids rigid polyurethane coating shall comply with the requirements of a Type V coating type in terms of the ASTM D16 Standard. The coating material shall be a homogenic solvent free layer with a chemical three dimensional covalent cross-linked structure. The layer shall be made up from a liquid two pack coating system with Part A being poly-isocyanate rich and Part B consisting of polyols or amines that ensures relatively short curing times. Aliphatic polyurethanes shall be used above ground and aromatic polyurethanes shall be used below ground.

The performance properties of the coating shall comply with the requirements stated in Table 37/14. The Contractor shall submit a full and comprehensive product datasheet to confirm material compliance with the Specification.

TABLE 37/14
COATING MATERIAL PERFORMANCE PROPERTIES

PROPERTIES	TEST REFERENCE	ACCEPTANCE CRITERIA
Minimum application thickness	BS EN 10290 (Annexure A)	See Clause 37.10
Adhesion to steel	ASTM D 4541 Method E	> 15 MPa
Adhesion to factory coating	ASTM D 4541 Method	> 10 MPa
Hardness	ASTM D 2240 (Shore D)	As specified by coating manufacturer
Flexibility	BS EN 10290 (Annexure K)	Pass
Tensile strength	ASTM D 638	>15 MPa at 3mm thickness
Resistance to cathodic disbondment	BS EN 10290 (Annexure E)	r < 8mm (28 days)
Dielectric strength	ASTM D 149	Minimum 15 V/µm
Specific Electrical Insulation Resistance	BS EN 10290 (Annexure F)	10^6 ohm.m^2
Impact resistance	BS EN 10290	> 5J/mm at 23°C >3J/mm at 5°C
Indentation resistance	BS EN 10290 (Annexure H)	<0.2mm at 23ºC

37.32.4 Application

37.32.4.1 General

Refer to Clause 37.4 for the quality assurance required on the application of this coating.

37.32.4.2 Surface Preparation

Refer to Clause 37.15 for the general steel surface preparation requirements. The steel surface shall be grit blasted to Sa 3 in accordance with ISO 8504-1 for surface cleanliness with an anchor profile of minimum 75 µm. The hardness of the abrasive material must be Rockwell C 54 or greater. The abrasive material shall be dry, clean, and free from contamination. Salt contamination tests shall be regularly performed on abrasive to verify that total salt level in the soluble contaminants is less than 25 ppm. Extensive grinding shall not be performed without Engineer approval. The anchor pattern shall be restored on all ground surfaces.

The quality control plan (QCP) hold point at the completion of the surface preparation shall be subject to the signing off by the Approved Inspection Authority (AIA) prior to the application of the coating material for all pipes, specials and joint repairs Coating Application.

The application of the coating shall only proceed once the cleanliness of the steel substrate has been approved and the substrate temperature is more than 3ºC above the dew point temperature. The work area shall be kept dry as the material reacts with humidity and moisture.

When required the surface shall be heated using an induction heating coil, radiant heaters or hot air to a temperature as recommended by the coating material manufacturer and in accordance with this Specification. The temperature shall not exceed 85°C and the use of propane torches or gas burners for pre-heating and post-heating is expressly prohibited. Infrared heaters may be used for post-heating. The temperature of the bare steel shall be monitored using temperature-indicating crayons. The amount of crayon used shall be the minimum amount required for accurate measurement. Crayon markings shall be removed with a wire brush.

The individual liquid components of the rigid polyurethane coating shall be agitated thoroughly before use to disperse pigments and assure homogeneity. No thinning shall be done and the components shall not be mixed together.

The material shall be applied using a plural component, adjusted to the specified mix ratio on a heated airless spray unit with metering pumps. The width of the spray jet, the set up distance from the substrate surface and the overlap, the pipe rotation speed and the rate of application shall be predetermined for the final required dry film thickness applied in the workshop.

The wet film thickness shall be measured in accordance with ISO 2808. Particular attention shall be paid to the recommended dry film thickness which shall be measured in accordance with SSPC PA 2. No spot measurement may be less than 85% of the specified average thickness. Tools and equipment shall be cleaned using only such solvents as are recommended by the product manufacturer. Particular care shall be taken in the handling of the coated items before the coating has reached the minimum value of hardness recommended by the manufacturer. All pipes and other components shall be high spark holiday tested in accordance with NACE RP0274 at the test voltage recommended by the coating manufacturer.

For factory-coated pipe, bends and specials the cut back shall be 150 ± 20 mm. The edge of the cut-back shall be feathered at 30 – 45°.

37.32.5 Inspection and Testing

The Contractor shall demonstrate that the proposed coating material and procedures will meet the requirements of this Specification when applied to pipes and pipe specials. The Contractor shall provide the documentation proof that the final selected coating material complies with the requirements listed in Table 37/14.

The Contractor shall test the finished coating during production to demonstrate continued compliance with this Specification. Details of all inspections and testing shall be fully documented in accordance with the approved quality control plan mentioned in Clause 37.4.2.

All stages of the surface preparation, coating and testing shall be subject to 100% inspection by the Contractor. The Engineer shall be informed at least two weeks prior to the start of surface preparation to allow scheduling of inspection personnel in the factory as well as on Site.

37.32.6 Testing of Production Pipes

The Contractor shall execute the following tests and provide written documentation proof of the test results within the agreed time frames:

37.32.6.1 Visual Inspection (every pipe)

The coating shall be smooth, glossy, free from pin holes, excessive orange peel effect, bubbling or excessive runs or sags.

37.32.6.2 Dry Film Thickness (every pipe)

DFT shall be inspected in accordance with SANS ISO 2808. The minimum thickness shall be 1.8mm in order to comply with Clause 37.10.

37.32.6.3 Electrical Insulation Defects (Holiday) Inspection (every pipe)

The coating shall be free from electrical insulation defects when tested with a high voltage holiday detector set at 15 kV.

37.32.6.4 Hardness Shore ‘D’ (every pipe)

The Shore ‘D’ hardness shall comply with the minimum set by the manufacturer in pre-qualification.

37.32.6.5 Adhesion (1 test per shift)

The pull-off adhesion at 23ºC shall be greater than 15 MPa.

37.32.6.6 Cathodic Disbondment (1 test per 50 pipes and commencement of new batch or new production run))

The disbondment shall be less than 8mm radius. BS EN 10290 Annexure E 48hr.

37.32.6.7 Composition (1 test per 50 pipes or new batch or new production run)

The Thermo Gravimetric Analysis (TGA) scan shall be checked against the manufacturer’s qualification scan.

37.32.7 Handling

Further to the requirements of Clause 37.9, the coating materials shall be handled, stored, applied, and cured in accordance with the recommendation of the specific material manufacturers.

The coating is considered sufficiently cured and ready for handling when it has attained the hardness recommended by the product manufacturer.

37.32.8 Coating Repairs

Since polyurethane systems are chemically cured, very thorough abrasion of damaged or defective coating is required to ensure an adequate physical bond.

37.32.8.1 Repairs before Full Cure [Within Sixteen (16) Hours at 23°C of Application of Last Coat]

The area to be over-coated shall be abraded with abrasive paper grade 220 to a uniform matt finish.

The abraded surface shall be vacuum-cleaned or be blown clean with uncontaminated dry compressed air to remove dust and debris.

Brush grade polyurethane shall be applied in as many coats as are required to achieve the specified thickness free of electrical insulation defects.

37.32.8.2 Repairs after Full Cure [After Sixteen (16) Hours at 23°C of Application of Last Coat]

The area to be over-coated shall be abraded with abrasive paper grade 220 to a uniform matt finish.

The abraded surface shall be vacuum-cleaned or be blown clean with uncontaminated dry compressed air to remove dust and debris.

The coating manufacturer's adhesive primer or activating solvent shall be applied only to the abraded surface.

After the designated curing time, brush grade polyurethane shall be applied in as many coats as are required to achieve the specified thickness free of electrical insulation defects.

Repairs shall be carried out with repair grade materials of the same grade as the spray-applied coating. The repairs shall be tested in accordance with approved procedures recommended by the material manufacturers. The Contractor shall confirm material compatibility and surface preparation requirements.

Based on the above the Contractor shall prepare a detailed method statement on the repair of the coating for the approval of the Engineer.

37.32.9 Field Joints

37.32.9.1 General

The surface to be coated on Site shall at the time of application be dry and free of dust and any contamination detrimental to the adhesion of the coating to the steel substrate. The Contractor shall prepare a detailed method statement on how the field joint area will be kept dry and clean during the application operation. It shall also include the trench space requirements for the application equipment.

37.32.9.2 Blast cleaning abrasives

All types of abrasive that are used in the preparation of the field joints and small repairs shall comply with ISO 11124-2 to 4.

37.32.9.3 Surface preparation

Abrasive blast cleaning shall be used for field joint surface preparation as well as larger areas requiring repair. The minimum standard of cleanliness of the surface after abrasive cleaning shall be SA 3 in terms of ISO 8501-1. The surface profile shall be checked in accordance with ISO 8503-1, ISO 8503-4 and ISO 8503-5 with an average R_z larger than 75 µm.

All dust, detritus and salts shall be removed from the metal substrate. The level of salts shall be measured in accordance with the requirements of ISO 8502-9 and shall be ≤ 30 mg/m^2.

The edges of the mainline coating shall be chamfered and a minimum overlap of 50 mm onto the mainline coating shall be abraded to obtain a surface profile with an R_z value between 40 and 70 µm.

The quality control plan (QCP) hold point at the completion of the surface preparation shall be subject to the signing off by the Approved Inspection Authority (AIA) prior to the application of the coating material for joint repairs.

Hand or power cleaning can be used for small repair areas such as pinholes and areas inaccessible for blast cleaning. 80 Grit or coarser sandpaper can be used to suitably roughen and abrade the area to be prepared. The area shall be sanded to the substrate taking care not to polish the substrate.

37.32.9.4 Substrate Temperature Control

The application of the coating shall only proceed once the cleanliness of the steel substrate has been approved and the substrate temperature is more than 3ºC above the dew point temperature.

The temperature of the substrate shall be within the application temperature range specified by the coating manufacturer. When required the surface shall be heated using an induction heating coil, radiant heaters or hot air to a temperature as recommended by the coating material manufacturer and in accordance with this Specification. The temperature shall not exceed 85°C and the use of propane torches or gas burners for pre-heating and post-heating is expressly prohibited. Infrared heaters may be used for post-heating. The temperature of the bare steel shall be monitored using temperature-indicating crayons. The amount of crayon used shall be the minimum amount required for accurate measurement. Crayon markings shall be removed with a wire brush.

37.33 VISCO-ELASTIC COATING SYSTEMS

This part of the Specification is applicable to factory coating of pipe barrels and field joint coatings.

37.33.1 Materials

37.33.1.1 Visco-elastic inner wrap

For factory coating together with the glass reinforced epoxy outer wrap, the inner wrap shall be a fabric backed polyisobutylene tape 1 – 1.2mm thick.

For hand application, the inner wrap shall be a high temperature pipeline grade 1.5mm thick polyisobutylene tape of appropriate width for field joints, bend and specials.

37.33.1.2 Glass reinforced epoxy outer wrap

The glass tape for factory applied outer wrap shall be 600 gsm woven roving mat.

The epoxy for saturating the glass mat shall be a bespoke solvent free 2–component resin designed for pipeline encapsulation. An additional accelerant or retardant may be required based on seasonal application temperatures.

37.33.1.3 Synthetic Fibre Tissue

The outer veil for factory application shall be a non-woven 30 gsm tape which prevents the glass strands of the outer wrap from protruding outside the epoxy coating thus creating a smooth and uniform finish.

37.33.1.4 Adhesive PE/PVC outer wrap

Either polyethylene (PE) or PVC outer wrap shall be 300µm tape with synthetic butyl rubber adhesive.

37.33.2 Application

37.33.2.1 Surface Preparation

Surfaces shall be prepared in accordance with Clause 37.15 and shall conform to the requirements for the rough blast to ensure that all millscale is removed.

All requirements for contamination, residual dust and debris, surface temperature and environmental parameters shall be complied with.

37.33.2.2 Factory Coating

(a) Coating Procedure

Apply a single circumferential wrap at each end of the pipe to define the 100mm cut-back for welding.

Apply the inner-wrap in a spiral with a minimum 10 mm overlap, starting and finishing on the circumferential wrap each end of the pipe barrel.

Ensure that the inner wrap is free of folds, bubbles and fish-mouths.

Holiday test the inner wrap at 10kV and repair any insulation defects

Prepare the epoxy for the outer wrap by mixing the components in the according to the pumped mix ratios.

Saturate the start of the glass fibre outer wrap and draw it through the epoxy, ensuring that the glass fibre mat is fully coated.

Apply the saturated outer wrap in a spiral at 50% overlap ensuring that there are no wrinkles or entrapped air bubbles.

Whilst the epoxy is still wet, apply the synthetic veil tissue in a spiral to cover the woven roving edges, side by side with no overlap onto itself.

Allow the outer wrap to cure prior to handling and stock-piling.

(b) Armoured Coating

Where armored coating is specified, apply an additional layer of glass reinforced epoxy outer wrap in the factory, or apply a layer of moisture cured urethane impregnated glass tape at 55% overlap in the field.

(c) Pipe ends

No coating is to be applied to the pipe ends left bare for welding.

37.33.3 Hand Applied Coating of Specials

(Visco elastic Polyisobutene systems can be used in conjunction with any pipeline coating)

The inner wrap may be applied spirally or cigarette wrap as appropriate with 10 mm adjacent and 100 mm circumferential overlap.

The inner wrap shall be holiday tested at 15 kV prior to application of the outer wrap.

Adhesive PVC/PE outer wrap shall be applied spirally with 55% overlap.

37.33.4 Field joints

(Visco elastic Polyisobutene systems can be used in conjunction with any pipeline coating)

Field joints shall be free of all contamination, weld spatter and flux.

The (previously grit-blasted) surface shall be prepared to grade St2 of ISO 8501-1.

Prior to application of the field joint coating, the surfaces of the field joint and the adjacent factory coating shall be wiped down with isopropanol.

Apply the polyisobutylene inner wrap to the field joint with 50 mm overlap onto the factory applied coating and 100 mm overlap onto itself.

Ensure the circumferential overlap is correctly weather boarded.

Apply the adhesive PVC/PE outer wrap with 55% overlap and 100 mm overlap onto the factory applied coating.

37.33.5 Visual Inspection

The completed pipe or pipeline shall be visually inspected for mechanical damage prior to transport, on receipt at site and prior to backfilling. Any visual damage shall be assessed and repaired as appropriate.

37.33.6 Holiday testing

Holiday testing shall be conducted on completion of application of the inner wrap, whether applied to pipe barrels, specials or field joints.

In addition, the completed pipeline shall be tested at 25 kV after laying and prior to backfilling.

37.33.7 Repair Methods

37.33.7.1 Damage to Substrate

Areas dis-bonded or damaged through to the substrate shall be repaired as follows:

- Remove any loose or disbonded coating and chamfer the edges of the sound coating.
- Clean the exposed steel surface and wipe the steel and surrounding coating with isopropanol.
- Apply a patch of 1.5 mm pipeline grade inner wrap overlapping 50 mm onto the sound coating.
- For tape wrapped surfaces, apply a full circumferential wrap of adhesive PE/PVC with 55% overlap and 100 mm overlap onto the sound coating.
- For GRE coated surfaces, abrade the edges of the damaged area, apply a patch of the woven roving and saturate the mat with a repair kit of 2 part epoxy of the same kind as is used in the factory application.

37.33.7.2 Partially Damaged

Areas where the outer wrap is damaged without exposing the substrate shall be verified by means of holiday detection and repaired with a full circumferential wrap of adhesive PE/PVC with 55% overlap extending 100 mm beyond the damaged area or abrade the edges of the damaged area, apply a patch of the woven roving and saturate the mat with a repair kit of 2 part epoxy of the same kind as is used in the factory application, as appropriate.

37.34 PIPELINE EXTERNAL COATING PERFORMANCE REQUIREMENTS

37.34.1 Introduction

This section of the Specification provides the performance requirements for the external coatings after installation and field joint repairs.

Excessive apparent coating conductance may be caused by defective field joint coatings, mechanical damage, or spurious contacts to foreign objects or valve chamber reinforcement.

Location of such defective areas may be assisted by the construction DCVG survey (Clause 37.34.3).

The overall performance of the coated pipeline is defined in terms of specific coating conductance, in accordance with NACE TM 0102. Values normalised for soil resistivity are NOT utilised.

It should be noted that the requirements of BOTH the construction DCVG survey AND the coating conductance measurement must be fulfilled.

37.34.2 Standards

The following normative standards are referenced in this section:

NACE TM 0102	Measurement of Protective Coating Electrical Conductance on Underground Pipelines.
NACE TM 0109	Aboveground Survey Techniques for the Evaluation of Underground Pipeline Coating Condition.
NACE SP 0207	Performing Close-Interval Potential Surveys and DC Surface Potential Gradient Surveys on Buried or Submerged Metallic Pipelines.
NACE SP 0502 – 2002	Pipeline External Corrosion Direct Assessment Methodology.

37.34.3 Construction DCVG Survey

The coating system is required to be free of significant (as defined by %IR below) defects at the time of installation. This will be ensured by the use of over-the-ditch holiday detection and a DCVG survey after backfilling and consolidation.

A minimum of three months shall elapse between backfilling and evaluation, unless the backfill is hydraulically compacted or significant rainfall has occurred which ensures that the pipeline is fully bedded and in intimate contact with the soil. The timing of this inspection will be determined by the Engineer, and is dependent on the backfill becoming conductive. This may take considerably longer than three months, at least until the soil becomes conductive (due to infiltration of groundwater or seasonal rains).

The coating integrity survey shall be undertaken by means of DCVG survey technique in accordance with NACE TM 0109 Section 6. All DCVG indications shall be geo-referenced by means of DGPS

On completion of the survey, sufficient calibration digs shall be conducted to characterise %IR values in the range of 1 – 5% for determination of the repair level required.

Evaluation of the construction DCVG results shall be undertaken in accordance with the following categories for %IR

<1% IR	No repairs required.
1 – 5% IR	Repairs may be required based on results of calibration digs.
>5% IR	Repairs required.

The %IR values quoted above are only applicable to new construction. Pipeline coatings which have been buried for longer than 2 years shall be evaluated in terms of NACE SP0502 – 2002 Appendix A6.4.

All excavations and repairs shall be undertaken at the cost of the Contractor.

37.34.4 Coating Performance Requirements

The CP design is based on the use of coated pipe. The coating is required to be resistant to the effects of high voltage transients due to the proximity of high voltage overhead power lines and existing and future AC traction systems (e.g. of the railways). The performance of the coating is evaluated by means of a current drainage test (CDT).

The specific coating electrical characteristics form an integral part of the CP and ACM design in determining, inter alia, spacing between anode installations.

After installation and backfilling of the pipeline, the pipeline coating shall be evaluated in sections not exceeding 5 km in terms of NACE TM 0102.

A minimum of three months shall elapse between backfilling and evaluation, unless the backfill is hydraulically compacted or significant rainfall has occurred which ensures that the pipeline is fully bedded and in intimate contact with the soil.

The specific coating conductance of the 5 km construction sections shall be less than 60 μS/m².

In the event that the pipeline does not meet the coating conductance criterion, alternative survey techniques shall be utilised to determine the cause of the non-compliance. These techniques may include any of the surveys described in NACE TM 0109 or SP 0207 as appropriate and subject to the approval of the Engineer.

All surveys shall be conducted by Contractor.

37.34.5 Tests on Completion and end of Defects Notification Period

On completion of construction and prior to the issue of the Taking Over Certificate (TOC), the pipeline shall be subjected to a CDT and a coating integrity survey.

The coating conductance shall be calculated on the current requirement for the completed pipeline.

The specific coating conductance for the completed pipeline shall be <60 μS/m^2.

The pipeline coating integrity shall be evaluated over the entire pipeline length by means of a hybrid CIPS/DCVG survey, which shall be completed in accordance with NACE SP 0207 utilising a 10 m longitudinal DCVG component. The results of the survey shall be correlated with those of the construction DCVG surveys.

The significance of coating defects or other anomalies identified from the DCVG survey results will be evaluated by assessing the relative loss of polarisation at the coating defect utilising CIPS results. Where DCVG defects result in a local loss in polarisation to a level below the relevant cathodic protection criterion, the Contractor will be required to rectify the defect.

The hybrid CIPS/DCVG survey shall be repeated at the end of the Defects Notification Period (DNP) prior to the issue of the Performance Certificate.

The CDT and CIPS/DCVG tests related to TOC and DNP shall be undertaken by a Specialist Service Provider/Sub-Contractor approved by the Engineer.

Any non-compliance with the requirements of the CDT or the hybrid CIPS/DCVG survey shall be investigated and rectified by the Contractor. The Contractor shall prepare method statements for the investigation and rectification and submit it to the Engineer for approval.

37.35 APPLICABLE STANDARDS

The following Standards and Codes of Practice are referred to in this Section:

American Water Works Association	
AWWA M11	Steel pipe – A guide for design and installation (3rd edition)
AWWA: C207 - 1994	Steel pipe flanges 4” through 144”.
AWWA: C208 - 17	Dimensions for fabricated steel water pipe fittings.
South African National of Standards	
SANS 062-1	Steel pipes Part 1
SANS 064	The preparation of surfaces for coating.
SANS 044	Filler materials for manual welding
SANS 770	Cleanliness of blast-cleaned steel surfaces for painting (freedom of soluble salts).
SANS 772	Profile of blast-cleaned steel surfaces for painting (profile gauge).
SANS 769	Cleanliness of blast-cleaned steel surfaces for painting (freedom from dust and debris).
SANS 8502-3	Preparation of steel substrates before application of paint and related products — Tests for the assessment of surface cleanliness – Part 3
SANS 10044	Welding
SANS 10064	The preparation of steel surfaces for coating
SANS 10121	Cathodic protection of buried and submerged structures
SANS 10129	Plastics tape wrapping of steel pipelines
SANS 1091	National colour standard
SANS 1117	Plastics wrappings for the protection of steel pipelines
SANS 1123	Steel Pipe Flanges (1977 edition shall apply)
SANS 1130	Fibre reinforcing material for pipe wrapping
SANS 1344	Medium duty solvent detergent.
SANS 1178	The production of lined and coated steel pipes using bitumen or coal tar enamel
SANS 1200 L	Standardized specification for civil engineering construction Section L: Medium-pressure pipe lines
SANS 121	Hot-dip galvanised coatings on fabricated iron and steel articles
SANS 1217	The production of painted and powder-coated steel pipes
SANS 1274	Coatings applied by the powder-coating process
SANS 1344	Medium duty solvent detergent

SANS 1431	Weldable structural steels
SANS 14713	Protection against corrosion of iron and steel in structures - Zinc and aluminium coatings - Guidelines
SANS 1476	Fabricated steel pipework
SANS 1700	ISO metric black bolts, screws and nuts (hexagon and square)
SANS 1700	ISO metric precision hexagon-head bolts, screws and nuts (coarse thread medium fit series)
SANS 2063	Thermal spraying - Metallic and other inorganic coatings - Zinc, aluminium and their alloys
SANS 2808	Paints and varnishes - Determination of film thickness
SANS 32	Internal and/or external protective coatings for steel tubes - Specification for hot dip galvanized coatings applied in automatic Plants
SANS 5770	Preparation of steel substrates before the application of paints and related products - Test for the assessment of cleanliness of blast-cleaned steel surfaces - Freedom from certain soluble salts
SANS 5772	Preparation of steel substrates before the application of paints and related products - Surface roughness characteristics of blast-cleaned steel surfaces - Profile of blast-cleaned surfaces determined by a micrometre profile gauge
SANS 719	Electric welded low carbon steel pipes for aqueous fluids (ordinary duties)
SANS 9000	Quality management systems - Fundamentals and vocabulary
British Standards Institution	
BS 970	Specification for wrought steels
BS 2494	Materials for elastomeric joint rings for pipe work and pipelines
BS 2633	Class I arc welding of ferritic steel pipe work for carrying fluids
BS 2815	Compressed asbestos fibre jointing
BS EN 1092-1	Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Steel flanges
BS EN 1092-2	Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Cast iron flanges
BS BS EN 10311	Joints for the connection of steel tubes and fittings for the conveyance of water and other aqueous liquids
BS EN 10224	Non-alloy steel tubes and fittings for the conveyance of water and other aqueous liquids. Technical delivery conditions
BS 5493	Protective coating of iron and steel structures against corrosion
PD 5500	Unfired fusion welded pressure vessels
American Petroleum Institute	
API 1104	Standard for welding pipelines and related facilities
API 5L	Specification for line pipe

American Society for Testing of Materials	
ASTM A240	Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A312	Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes
Swedish Standards Institute	
SIS 05590	Pictorial surface preparation standards for painting steel surfaces
American Society of Mechanical Engineers	
ASME IX	Boiler and Pressure Vessel Code
South African Electrolytic Corrosion Committee	
SAECC/1	Code of Practice
American National Standards Institute	
ANSI B31.3	Standards of pressure piping
ANSII AWWA C203-91	Coal-tar Protective Coatings and linings for steel water pipelines – enamel and tape-hot applied.
International Organization for Standards	
ISO 11125	Preparation of steel substrates before application of paints – Metallic blast-cleaning abrasives.
ISO 11127	Preparation of steel substrates before application of paints – Non-metallic blast–cleaning abrasives.
ISO 2808	Paints and varnishes
ISO 752	Specifies the classifications, chemical compositions, markings and other requirements for primary zinc
ISO 8501-1	Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after overall removal of previous coatings.
ISO 8504-2	Preparation of steel substrates before application of paints and related products – Surface preparation methods – Part 2: Abrasive blast cleaning.
ISO 9000	A family of standards for quality management systems
European Standards	
EN 1179	Zinc and zinc alloys

37.36 MEASUREMENT AND PAYMENT

37.36.1 General

The rates tendered under this Section shall not include for the general obligations, Contractor's Equipment and work deemed to be covered by the Items provided in Section 1 - General.

Payment for the requirements of this Section will be included in the payment item for the particular item supplied including painting or corrosion protection. No separate payment shall be made for painting and corrosion protection unless specifically allowed for in the Bill of Quantities.

Separate Items will be provided in the Bill of Quantities for the:

- Submission and approval of the PQP and of all pre-manufacture documentation;
- Pipe coating; and
- Pipe lining.

37.36.2 Scheduled Items

37.001 PQP and documentation **Unit: lump sum (Sum)**

Separate Items are provided in the Bill of Quantities for the submission of the PQP and all other pre-manufacture documentation.

The rate shall include full compensation for the preparation and submission of the PQP and the submission of all pre-manufacture documentation in compliance with the Specification.

Payment will only be made after the PQP and all documentation has been approved by the Engineer.

37.002 Pipe coating (Factory Applied) **Unit: m**

Refer to Payment Item 32.005. The BoQ shall clearly indicate the corrosion protection system reference number, the pipe diameter and pipe length. The rate shall be all inclusive.

37.003 Internal pipe lining (factory applied) **Unit: m**

Refer to Payment Item 32.005. The BoQ shall clearly indicate the corrosion protection system reference number, the pipe diameter and pipe length. The rate shall be all inclusive.

37.004 External coating and internal lining of pipes and specials joints (Field Applied) **Unit: No.**

Refer to Payment Item 33.011. The BoQ shall clearly indicate the corrosion protection system reference number, the pipe diameter and number of joints. The rate shall be all inclusive.

ANNEXURE 37/1
PAINT COLOUR CODING AT VARIOUS APPLICATIONS

MECHANICAL AND GENERAL

ITEMS	COLOUR	SANS 1091 CODE
Structural steel, Gates	Light grey	G29
Hydraulic power Pack	Strong blue	F11
Hydraulic oil	Salmon pink	A40
Hazardous objects/areas (restricted headroom, crane hook etc.)	Golden yellow with black chevron	B49*
Handwheels and levers	Golden yellow	B49
Handrails: vertical - horizontal	Black Golden yellow	 G49
Handrails on dam walls - Aluminium - Stainless steel - Galvanized	 Un-coated Un-coated Light grey	 G29
Floors: - safe and walking areas - restricted areas - open flooring (gratings) – MS galvanized 3Cr12 Stainless steel	 Emerald green Golden yellow Un-coated Un-coated Un-coated	 E14 B49*
Fire protection Plant	Signal red	A11*
Control panels	Eau de nil	H43

PUMP STATION

ITEMS	COLOUR	SANS 1091 CODE
Electric motors	Light beige	C57
Pumps/control valves: for raw water for chem-treated water	Apple green Middle blue	H29 F07
Fan and coupling guards	Signal red	A11*
Base plates	Black	
Overhead traveling cranes	Golden yellow	B49
Isolating valves: for raw water for chem-treated water	Brilliant green Arctic blue	H10 F28

ELECTRICAL

ITEMS	COLOUR	SANS 1091 CODE
Low voltage panels: Indoor Outdoor	Light orange Light orange	B26* B26
Medium voltage panels: Indoor Outdoor	Admiral grey Admiral grey	G12 G12
Panel accessories (gland plates, back plates, interior)	White	
UPS Plant items	Light orange	B26
Transformers	Light stone	C37
LV distribution kiosks, mini subs	Light stone	C37
Standby electrical Plant items(Permanently powered)	Signal red	A11*
General outdoor	Light grey green	H40
All Plant– interior	White	

WATER TREATMENT PLANT

ITEMS	COLOUR	SANS 1091 CODE
Plant	Same colour of respective pipe work	
Handwheels (remote valves)	Same colour of respective pipe work	
PIPE WORK		
Raw water	Brilliant green	H10
Chemical treated raw water	Verdigris green	E22
Clarified raw water	Eau de nil	H43
Filtered water	Pale blue	E39
Chlorinated filtered water	Arctic blue	F28
Backwash water	Cornflower blue	F29
Air saturated water	Turquoise blue	E18
Wash water recovery	Middle buff	B33

SEWAGE PIPE WORK

ITEMS	COLOUR	SANS 1091 CODE
Raw sewage	Dark earth	B11
Settled sewage effluent	Brilliant green	H10
Biologically treated sewage effluent	Verdigris green	E22
Final/chlorinated effluent	Eau de nil	H43
Digested sewage sludge	Middle brown	B07
Raw sewage sludge	Dark brown	B03
Humus sludge	Golden brown	B13
Return activated sludge	Golden brown	B13
Waste activated sludge	Middle brown	B15
Supernatants/underflows returning to head of works	Middle buff	B33

DOSING/CONTROL PIPE WORK

ITEMS	COLOUR	SANS 1091 CODE
Poly-electrolyte	Pinotage	A08
Alum/Ferric chloride	Jacaranda	F18
Chlorine solution	Primrose	C67
Chlorine gas	Lemon	C54
Chlorine liquid	Light orange	B26
Lime slurry	Biscuit	B64
Lime hydrated	Biscuit	B64
Lime saturated water	Biscuit	B64
Air/compressed air	White	
Steam	Pastel grey	G54

NOTE: Colours marked thus ***** are restricted for specified Plant only.

ANNEXURE 37/2
REFERENCE NUMBERS FOR CORROSION PROTECTION SYSTEMS COVERED IN THIS SPECIFICATION

No.	Coating System
1	Abrasion resistant coating
2	Anodised
3	Armoured tape wrapping
4	Coal Tar Epoxy
5	Elastoplastic Polyurethane
6	FBE
7	FBE – plus top coat of pure Aliphatic Polyurethane
8	FBE coated plus threads coated with Molybdenum Disulphide lubricant or Nickel Anti-seize compound
9	FBE plus sealant of Polyurethane or Polysulphide
10	FBE plus tape wrapping
11	FBE plus top coat of pure Aliphatic Polyurethane plus sealant of Polyurethane or Polysulphide
12	FBE plus top coat of Recoatable Polyurethane
13	FBP
14	FBPE (“Sintakote”)
15	HDG
16	HDG - Epoxy primer for galvanised surfaces plus top coat of recoatable Polyurethane
17	HDG - Epoxy primer for galvanised surfaces plus top coat of recoatable Polyurethane plus grout under base plus Polyurethane sealant
18	HDG Pickling & passivation
19	HDG Plus duplex system.
20	HDG plus Epoxy primer plus Two pack Epoxy
21	HDG plus FBE
22	HDG plus Lubricating Rust Protector
23	HDG plus penetrating, water resistant & non-sticky dressing
24	HDG plus Rope dressing - water resistant with anon-sticky surface
25	HDG plus threads coated with Molybdenum Disulphide lubricant or wax
26	HDG plus threads coated with Molybdenum Disulphide lubricant or wax plus Bitumen or Tape wrapping
27	HDG plus wet assembly with Epoxy or threads coated with Molybdenum Disulphide lubricant
28	HDG with dry lubricant on pins
29	Long life Molybdenum Disulphide lubricant
30	Lubricating Rust Protector
31	Multi-purpose Epoxy
32	Multi-purpose Epoxyplus top coat of recoatable Polyurethane if required

No.	Coating System
33	Multi-purpose Epoxy plus top coat of recoatable Polyurethane if required plus grout under baseplus Polyurethane sealant
34	Multi-purpose Epoxy with dry lubricant on pins
35	Petrolatum wrapping system
36	Pickle and passivate
37	Pickle and passivate plus threads coated with Molybdenum Disulphide lubricant or Nickel Anti-seize compound
38	Pickle and passivate plus wet assembly with Epoxy
39	Polyester gelcoat
40	Reinforced bitumen
41	Reinforced bitumen – armour wrapping
42	Rope dressing - water resistant with a non-sticky surface
43	Tape wrapping
44	Threads coated with Molybdenum Disulphide lubricant or Nickel Anti-seize compound
45	Threads coated with Molybdenum Disulphide lubricant or Nickel Anti-seize compound plus Bitumen or Tape wrapping
46	Threads coated with Molybdenum Disulphide Lubricant or Nickel Anti-seize compound plus nut and washer FBE coated
47	Two pack Epoxy
48	Two pack Epoxy – plus top coat of Multi-purpose Epoxy
49	Two pack Epoxy - plus top coat of pure Aliphatic Polyurethane
50	Two pack Epoxy – plus top coat of recoatable Polyurethane
51	Two pack Epoxy – plus top coat of: A) Recoatable Polyurethane or B) Multi-purpose Epoxy or C) MIO pigmented Polyurethane
52	Two pack Epoxy for cement mortar lining with 100 mm overlap inside and outside
53	Two pack Epoxy or FBE
54	Two pack Epoxy or FBE to a smooth, glossy and uniform finish
55	Two pack Epoxy plus tape wrapping
56	Two pack Epoxy plus Polyurethane sealant on edges
57	Two pack Epoxy plus sealant of Polyurethane or Polysulphide
58	Two pack Epoxy plus top coat of pure Aliphatic Polyurethane plus sealant of Polyurethane or Polysulphide
59	Two pack Epoxy plus top coat of recoatable Polyurethane plus grout under base plus Polyurethane sealant
60	Two-pack Epoxy – plus top coat of Multi-purpose Epoxy with Al flakes
61	Polymer Modified Bitumen Coating. (“Bituguard”)

No.	**Coating System**
62	3LPE – (FBE layer plus adhesive layer plus polyethylene layer)
63	Rigid Polyurethane
64	Cement Mortar Lining