CONSTRUCTION STANDARD

FOR

PROTECTIVE COATINGS

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1. SCOPE

1.1 This construction Standard gives the minimum requirements for initial construction and maintenance of coating of steel pipelines.

1.2 This Standard is intended for corrosion protection of pipelines in Oil, Gas and Petrochemical Industries, underground facilities of gas transmission and distribution system, marine and subsea facilities and where applicable.

1.3 Inspection and test methods for quality control are also specified throughout this Standard.

1.4 The engineering requirements of coating shall be in accordance with IPS-E-TP-270.

1.5 This Standard covers construction requirements of the following coating systems for pipelines:

- **a)** Cold applied tape coating (see 7).
- **b)** Fusion bonded epoxy coating (see 8).
- **c)** Hot applied enamel coating (see 9).
- **d)** Concrete coating (see 10).
- **e)** Polyethylene coating (see 11).

2. REFERENCES

API (AMERICAN PETROLEUM INSTITUTE)

API-RP-5L5 "Recommended Practices for Unprimed Internal Fusion Bonded Epoxy Coating of Line Pipe"

ASTM (AMERICAN SOCIETY FOR TESTING AND MATERIALS)

ASTM-A-185 "Specification for Steel Welded Wire, Fabric Plain for Concrete Reinforcement"

ASTM-A-390 "Specification for Zinc-Coated (Galvanized) Steel Poultry Netting and Fencing"

ASTM-A 615 M "Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement (Metric)"

ASTM-C-171 "Specification for Sheet Materials for Curing Concrete"

ASTM-C-309 "Specification for Liquid Membrane-Forming Compounds for Curing Concrete"

ASTM-G 14-83 "Test Method for Impact Resistance of Pipeline Coating (Falling Weight Tests)"

AWWA (AMERICAN WATER WORKS ASSOCIATION)

AWWA C 203 "Coal Tar Protective Coatings and Lining for Pipelines-Enamel and Tape-Hot Applied"
AWWA C 205 "Cement-Mortar Protective Lining and Coating"
AWWA C 209 "Cold Applied Tape Coating for the Exterior at Special Sections"
AWWA C 210 "Liquid Epoxy Coating Systems"
AWWA C 213 "Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines"
AWWA C 214 "Tape Coating Systems for the Exterior of Steel Water Pipeline"
AWWA C 216 "Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines"

BS (BRITISH STANDARDS)

BS 3900 "Paint and Varnishes Tests"
BS 4482 "Specification for Cold Reduced Steel Wire for the Reinforcement of Concrete"

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-C-PI-140	"Plant Piping systems"
IPS-C-TP-101	"Surface Preparation"
IPS-C-TP-102	"Painting"
IPS-E-TP-270	"Protective Coatings"
IPS-G-TP-335	"Three Layer Polyethylene Coating System"
IPS-M-CE-105	"Building Materials"
IPS-M-CE-165	"Materials for Concrete, Mortars, and Admixture"
IPS-M-TP-105	"Bitumen Mastic"
IPS-M-TP-275	"Fast Drying Synthetic Primer".
IPS-M-TP-280	"Coal Tar Primer (Cold Applied)"
IPS-M-TP-285	"Bitumen Primer (Cold Applied)"
IPS-M-TP-290	"Coal Tar Enamel (Hot Applied)"
IPS-M-TP-295	"Bitumen Enamel (Hot Applied)"
IPS-M-TP-300	"Glass Fiber Mat for Inner Wrap"
IPS-M-TP-305	"Coal Tar Impregnated Glass Fiber Mat for Outer Wrap"
IPS-M-TP-306	"Bitumen Impregnated Glass Fiber Mat for Outer Wrap"
IPS-M-TP-310	"Cold Applied Laminated Plastic Tape for Inner Layer"
IPS-M-TP-311	"Cold Applied Laminated Plastic Tape for Outer Layer"
IPS-M-TP-313	"Hand Applied Laminated Tape Suitable for Cold Applied Coating Systems"
IPS-M-TP-314	"Hand Applied Laminated Suitable for Hot Applied Coating Systems"
IPS-M-TP-316	"Plastic Grid for Rockshield (Sheet)"
IPS-M-TP-317	"Petrolatum Impregnated Tape & its Primer"
IPS-M-TP-318	"Heat-Shrinkable Cross-Linked Polyethylene-Coating (Two-Layers)"
IPS-M-TP-321	"Primer for Use with Cold Applied Plastic Tape"
IPS-M-TP-322	"Primer for Use with Hand Applied Laminated Tape Suitable for Cold Applied Coating Systems"
IPS-M-TP-323	"Primer for Use with Hand Applied Laminated Tape Suitable for Hot Applied Coating Systems"

ISO (INTERNATIONAL ORGANIZATION FOR STANDARDIZATION)

ISO 9002	"Quality Systems-Model for Quality Assurance in Production and Installation"

SIS (SWEDISH STANDARD)

SIS 05 59 00	"Rust Levels of Steel Structure and Quality Levels for Preparation of Steel Surfaces for Rust Protecting Surfaces"

3. DEFINITIONS AND TERMINOLOGY (see also IPS-E-TP-270)

Coating applicator qualification

Coating application shall be done only by applicator qualified by field experience in applicating the type of coating proposed. To satisfy this experience requirement, the applicator shall submit a list of application and installation and where such data is available the service condition and reported record of performance.

Inspector

The inspector or engineer employed by the Purchaser and acting as the company's representative. The inspector's respective assistants properly authorized and limited to the particular duties assigned to them, or the Company acting as the inspector.

4. UNITS

This Standard is based on International System of Units (SI), except where otherwise specified.

5. GENERAL REQUIREMENTS

5.1 General Condition for Application

5.1.1 Weather is an externally important condition that must be taken into consideration during any coating application. The temperature and humidity limits for each coating shall be considered.

5.1.2 The coating shall not be applied under windy conditions.

5.1.3 The coating shall not be applied where the temperature is less than 3°C above the dewpoint.

5.1.4 The coating shall not be applied on wet or damp surface, as adhesion will be affected.

5.1.5 The coating shall not be applied when the ambient temperature is less than 4°C.

5.2 Coating Materials

5.2.1 Only coating system which comply with IPS-E-TP-270 shall be used.

5.2.2 When the Company supplies coating materials, the materials shall be certified by the Company ensuring that all coating materials comply with all of the provisions contained in the relevant IPS Material Standards for coating, originally and prior to application and contractor may make any investigations necessary, by way of testing or other means to satisfy itself of compliance by the Company.

5.2.3 When the contractor is responsible for coating materials supply, the coating materials supplied shall be certified by the manufacturer in accordance with the requirements cited in the relevant IPS-M-TP Standards for coating. The contractor shall obtain and retain all certificates and manufacturer's data sheets. These data sheets shall be made available for examination by the Company on request. The Company may make any investigation necessary, by way of testing, batch sampling, manufacturing and factory inspection, to satisfy itself of compliance by the contractor.

5.3 Materials Handing and Storage

5.3.1 The materials shall be stored in the manufacturer's original packaging under ventilated conditions and away from direct sunlight. Where required and applicable air-conditioned storage shall be observed.

5.3.2 The materials shall be handled in such a way that they do not suffer any damage.

5.3.3 All coating materials consigned to the coating site shall be properly stored in accordance with the manufacturer instructions at all times to prevent damage and deterioration prior to use. Materials shall be used in the order in which they are delivered.

5.4 Identification of Coating Materials

All materials supplied for coating operations shall be suitably marked giving the following information:

5.4.1 The manufacturer's name and address.

5.4.2 The material and order number.

5.4.3 The batch number.

5.4.4 Date of manufacture and stable working shelf life (including storage condition limits).

5.4.5 Directions for mixing and/or thinning with solvents as required.

5.4.6 Directions for handling and storing of the coating materials.

5.4.7 Safety data sheet.

5.5 Pipe Identification

5.5.1 All identification marking, whether internal or external to the pipes, shall be carefully recorded before surface preparation begin.

5.5.2 The date of coating finish and the coating factory markings including pipe identification shall be legibly marked on coating surface of each pipe.

5.6 Protection of Weld End Preparation

5.6.1 Weld end preparations shall be protected from mechanical damage during handling, storage, surface preparation and the coating processes. The methods used shall also ensure that no damage occurs to the internal surface of the pipe. Protection during handling and storage shall be in accordance with 6.1.

5.6.2 Weld end preparations shall be protected from coating during coating application process by a method approved by company.

5.6.3 For technical welding reasons the ends of the pipes shall be free of any coating layer (cut back) over a length of 100 mm up to size DN 500 mm (20 in.) inclusive and over a length of 150 mm for sizes over DN 500 mm, unless specified otherwise by the Company.

5.6.4 The uncoated ends of pipes shall not exceed 150 mm unless specified otherwise by the Company.

5.6.5 The uncoated ends of pipes shall be temporarily protected against atmospheric corrosion by a temporary paint or primer easily removable by brushing.

5.7 Surface Preparation

5.7.1 The method of surface cleaning and surface preparation shall be specified by the contractor as part of the coating procedure qualification and shall take into account the requirements specified in 5.7.1 to 5.7.5 inclusive, in accordance with (IPS-C-TP-101). In preparation for the application of the coating, the surface preparation shall be performed in accordance with the requirements 5.7.2 to 5.7.7 inclusive.

5.7.2 Where oil, grease or other contaminants are present they shall be removed, without spreading them over the surface, with a suitable solvent. For pipes which have been subjected to contamination, the contaminant shall be removed by washing either with potable water or an approved chemical cleaner. If a chemical cleaner is used, subsequent washing with potable water will be necessary. The pipe shall be dried before blast cleaning. All processes shall be in accordance with IPS-C-TP-101.

5.7.3 Pipes shall be blast cleaned to a minimum of Sa 2½ finish to SIS 05 5900. The blast profile shall be between 40 μm and 100 μm height, unless specified otherwise by individual coating system, measured by an agreed method. The blast cleaning medium used shall be according to IPS-C-TP-101.

5.7.4 The metal surface shall be inspected immediately after blast cleaning and all slivers, scabs, etc., made visible by blast cleaning and detrimental to the coating process shall be removed using a method approved by company. After the removal of defects, the remaining wall thickness shall comply with the relevant pipe specification. Any rectified areas shall be blast cleaned to meet the requirements of 5.7.3.

5.7.5 Any pipe found to have defects which exceed the levels permitted in the relevant pipe specification shall be set aside for examination by an authorized company representative and no subsequent action taken without the agreement of the Company.

5.7.6 Directly before coating, any dust, grit or other contaminants shall be removed from the pipe surface by a method established as acceptable by the relevant coating procedure test and recorded in the relevant coating procedure.

5.7.7 Where rust blooming or further surface contamination has occurred, the pipe shall be cleaned again in accordance with 5.7.2 and again blast cleaned in accordance with 5.7.3. Coating shall take place before any further contamination or rust blooming appears.

5.8 Coating Process

The coating application process shall be carried out using the procedures specified in this Standard.

5.9 Coating Procedure Tests

The coating process shall comply with the procedure established in the coating procedure qualification (See 5.10). Any changes in coating materials, pipe dimensions, pipe manufacturing process or the coating process may, at the discretion of the Company, necessitate a new coating procedure approval tests.

Additionally, approved procedure tests shall be confirmed as proving tests, at intervals of not more than 1 year for each type of coating material used by the contractor and for each size of pipe and pipe manufacturing process as requested by the Company.

5.10 Inspection and Testing (Quality Control)

5.10.1 The quality control system shall include as a minimum the requirements listed in Table 1.

5.10.2 All inspections and testings listed in Table 2 shall be made by the contractor and witnessed and certified by the inspector.

5.10.3 After examination or test, should the inspector find out that any pipe has not been cleaned or coated in accordance with this construction Standard, the contractor shall be required to remove the coating which is considered defective or inadequate, and to reclean and recoat the pipe to the requirements for approval of the inspector.

5.10.4 The inspector shall have access at any time to the construction site and to those parts of all plants that are concerned with the performance of work under this Construction Standard.

5.10.5 The contractor shall provide the necessary inspection tools and instruments for the inspector as well as normal facilities necessary for inspection.

TABLE 1 - MINIMUM QUALITY CONTROL REQUIREMENTS

REQUIREMENTS	REFERENCE STANDARD
a) Check cleanliness of components immediately prior to cleaning	IPS-C-TP-101
b) Monitor size, shape, and cleanliness of the blast cleaning material and process	IPS-E-TP-270
c) Check visually in good light, the surface of the components for metal defects, dust and entrapped grit	IPS-C-TP-101
d) Check component surface blast profile	IPS-C-TP-101
e) Check for residual contamination of component surfaces	IPS-C-TP-101
f) Check temperature control of the component surface by an agreed method	IPS-C-TP-101
g) Check the weather condition	IPS-C-TP-102
h) Check the coating thickness	This Standard
i) Check the coating continuity	This Standard
j) Check the coating adhesion	This Standard
k) Check the cure of coating	This Standard
l) Supervision to ensure the adequate and proper repair of all defects	This Standard
m) Check on coating appearance	This Standard
n) Check for damage to weld and preparations	This Standard

5.11 Quality System

5.11.1 The contractor shall set up and maintain such quality assurance and inspection systems as are necessary to ensure that the good and service supplied comply in all respects with the requirements of this construction Standard.

5.11.2 The Company will assess such system against the recommendations of applicable parts of ISO 9002 and shall have the right to undertake such surveys as are necessary to ensure that the quality assurance and inspection system are satisfactory.

5.11.3 The Company shall have the right to undertake inspection and testing of goods and services during any stage of world at which the quality of the finished good may be affected and to undertake inspection or testing or raw material and/or purchased pipes and components.

5.11.4 Compliance certificates

For each contract, the contractor shall issue the required certificates in accordance with DIN 50049 (Para.: 2.1-1986) and presented to the Company.

5.11.5 Test certificates

5.11.5.1 The contractor shall issue the required certificates in accordance with DIN 50049 (Para.: 2.3-1986) for all coating production tests identified in 12.1 to 12.3 inclusive and presented to the Company.

5.11.5.2 For all tests witnessed by the inspector a certificate shall be prepared and issued by the contractor and certified by the inspector in accordance with DIN 50049 (Para.: 3.1.A-1986).

5.12 Procedure Qualification

5.12.1 General

5.12.1.1 Before bulk coating of pipes commences the requirements of (5.12.2) shall be met and a detailed sequence of operations to be followed on the coating of components shall be submitted to company for checking the compliance with this Construction Standard and formal approval.

5.12.1.2 The Company shall also specify which coated pipes are to be subjected to the tests specified in (5.12.3.2) and (5.12.3.3) for formal approval of coating procedure. No coated pipes shall be dispatched to the Company or no coating process shall be done until the coating procedure has been approved and approval confirmed in writing by the Company.

5.12.2 Coating procedure specification

The coating procedure specification shall incorporate full details of the following but not limited to them:

a) The coating system(s) to be used together with appropriate data sheets as defined in 5.7.2.
b) Cleaning of pipe and component and method of cleaning.
c) Cleaning medium and technique.
d) Blast cleaning finish, surface profile, type of abrasive and surface cleaning in the case of blast cleaning.
e) Dust removal.
f) Coating application methods.
g) Preheat time and temperature, if any
h) Powder spray, if any, including use of recycled material.
i) Curing and quenching time and temperature.
j) Post cure time and temperature.
k) Repair technique.
l) Coating stripping technique.

5.12.3 Coating procedure approval tests

5.12.3.1 General

A batch of 10 to 20 pipes of any specific pipe mill shall be selected by the inspector and coated by the contractor in accordance with the approved coating procedure specification (See 5.12.2), the coating operations being witnessed by the inspector. Three pipes from the coated pipes shall be selected by the inspector and subjected to the complete set of tests specified in 5.12.3.2 and 5.12.3.3. Testing shall be witnessed by the inspector and a full set of records shall be presented to the Company for consideration.

- Bulk coating of pipes shall not commence until all short and long term tests (see 5.12.3.2 and 5.12.3.3) results have been approved officially by company, unless the contractor takes responsibility of failure for any long term test.

- All test methods shall be in accordance with Table 2.

- For polyethylene coating see 11 and IPS-G-TP-335.

5.12.3.2 Short term approval tests

5.12.3.2.1 Thickness

For this purpose, at least 12 measurements shall be made in accordance with Table 2 at locations uniformly distributed over the length and periphery of each pipe selected for the test and checked for compliance with the thickness specified by Company with reference to IPS-E-TP-270.

50% of these measurements shall be made along and over the longitudinal weld seam, if any.

5.12.3.2.2 Porosity

Each pipe selected for the test shall be holiday detected over 100% of its coated surface. No defect shall be observed when tested in accordance with Table 2.

5.12.3.2.3 Adhesion

This test shall be carried out on each pipe at 5 locations uniformly distributed over the length and periphery of the pipe, in this respect the requirements and the method of test shall comply with Table 2.

None of these tests must fail.

5.12.3.3 Long term approval tests

The tests identified in 5.12.3.3.1 to 5.12.3.3.7 inclusive shall be performed, when specified by the Company, on test sections taken from all three coated pipes selected for the coating procedure approval tests.

5.12.3.3.1 Adhesion

This test shall be carried out at 5 different locations on 5 test sections in accordance with 5.12.3.2.3, but after 30 days keeping in the hot air of 80°C. No change in the mean force necessary to pull of the coating must occur.

5.12.3.3.2 Cathodic disbonding

The test sections shall be tested and checked for compliance with Table 2.

5.12.3.3.3 Penetration resistance

The test sections shall be tested and checked for compliance with Table 2.

5.12.3.3.4 Temperature resistance

The test sections shall be tested and checked for compliance with Table 2.

5.12.3.3.5 Impact resistance

The test sections shall be tested and checked for compliance with Table 2.

5.12.3.3.6 Elongation

The samples taken from the three pipes shall be tested and checked for compliance with Table 2.

5.12.3.3.7 Insulation resistance

The samples taken from the three pipes shall be tested and checked for compliance with Table 2.

TABLE 2 - COATING REQUIREMENTS AND TEST METHODS FOR COATING PROCEDURE APPROVAL TESTS

APPROVAL TESTS	HOT-APPLIED ENAMEL	COLD-APPLIED TAPE	FBE	CONCRETE
1) Surface preparation	1) Visual inspection 2) Acceptable limit: as specified in 5.7			
2) Coating thickness	AWWA C 203	AWWA C 214	AWWA C 213	AWWA C 205
	Minimum requirements: as specified by the design data			
3) Porosity (holiday)*	AWWA C 203	AWWA C 214	AWWA C 213	Not applicable
	Acceptable limit: as specified in 5.15.4			
4) Adhesion	AWWA C 203	AWWA C 214	AWWA C 213	Not applicable
5) Impact resistance	AWWA C 203	AWWA C 214	AWWA C 213	Not applicable
6) Elongation/shear adhesion	Not applicable	AWWA C 214	AWWA C 213	Not applicable
7) Temperature resistance	AWWA C 203	AWWA C 214	AWWA C 213 (hot water resistance)	Not applicable
8) Penetration resistance	AWWA C 203	AWWA C 214	AWWA C 213	Not applicable
9) Insulation resistance	AWWA C 203	AWWA C 214	Not applicable	Not applicable
10) Cathodic disbonding	AWWA C 203	AWWA C 214	AWWA C 213	Not applicable

*** For operating voltage see also 12.3.5.**

5.13 Production Coating Requirements

5.13.1 Surface preparation

The surface of the pipe to be coated shall be prepared in accordance with Clause 5.7.

5.13.2 Coating process

5.13.2.1 The production coating process shall be carried out using a procedure approved in accordance with Clauses 5.2, 5.9 and 5.12.

5.13.2.2 The thickness of the coating shall comply with the values specified by the Company when tested in accordance with method specified in Table 2.

5.13.2.3 Where pipe is to be concrete coated reference shall be made to Company who will advise the correct thickness of anti-corrosion coating to be applied.

5.13.3 Protection of weld end preparations

Protection of weld end preparations shall be in accordance with Clause 5.6.

5.14 Inspection and Rejection of Finished Coating

5.14.1 General

The inspection of finished coating shall be in accordance with Clause 5.15. The quality and values to be achieved shall be the same as those identified in 5.14.2 and 5.15.

5.14.2 Check on Coating Color and Appearance

Coating color and appearance shall be uniform and free from runs, sags, blistering, roughness, foaming and general film defects.

5.15 Coating Requirements and Test Methods

5.15.1 General

5.15.1.1 After formal approval of all short term tests and long term tests when specified by Company, the contractor will be authorized to commence the bulk production.

5.15.1.2 The contractor shall perform the routine inspection and tests in accordance with 5.15.2 to 5.15.5 inclusive during coating production.

5.15.1.3 All the inspection and tests witnessed by the inspector shall be certified.

5.15.1.4 The pipe coating shall comply with all requirements identified in 5.15.2 to 5.15.5 inclusive.

5.15.2 Surface preparation

This test shall be carried out on each individual pipe and check with Table 2. Every pipe which does not comply with the minimum requirements shall be rejected for repreparation.

5.15.3 Thickness

Unless specified otherwise this test shall be carried out on each individual coated pipe in accordance with 5.12.3.2.1. Every pipe which does not comply with the minimum requirements specified (see 5.12.3.2.1) shall be rejected for subsequent stripping and recoating. Should two consecutive pipes fail to satisfy the requirement, the cause shall immediately be investigated. If the cause is not resolved after four consecutive pipes, the coating process shall be stopped for full investigation; this shall involve checking all pipes back to the preceding acceptable pipe.

5.15.4 Porosity

Each individual line pipe shall be holiday detected over 100% of its coated surface in accordance with Table 2. Up to 2 holidays per pipe length will be allowed on a max. of 5% of coated pipe lengths during each 8 hours production shift.

Any individual pipe with more than 2 holidays shall be rejected for subsequent stripping and recoating. If more than 2 holidays per pipe length are detected on two consecutive pipes, the cause of the high holiday rate shall immediately be investigated. If the cause is not resolved after four consecutive pipes, the coating process shall be stopped for full investigation. All holidays detected on non-rejected pipes shall be repaired in accordance with Clause 15.7 and satisfactorily retested.

5.15.5 Adhesion

This test shall be carried out 3 times during each 8 hours production shift, each time on one individual line pipe. The test shall be carried out in accordance with Table 2 and at ends of the pipe coating surface and checked for compliance with Table 2. If the coating adhesion at any location is below the requirement of Table 2 the pipe shall be rejected for subsequent stripping and recoating; in this case the second consecutive pipe shall be checked. Should two consecutive pipes fail to satisfy the requirement, the cause shall immediately be investigated; if the cause is not resolved after four consecutive pipes, the coating process shall be stopped for full investigation, this shall involve checking all pipes back to the preceding acceptable pipe.

5.16 Defect Rate

Should tests specified in 5.15.2 to 5.15.5 inclusive in any production shift show a rejection rate of more than 10% for 50-457 mm (2″-18″) and 5% for 508-1420 mm (20″-56″) of coated pipes for any one test, then every pipe in that shift shall be individually subjected that test.

In such cases the contractor shall simultaneously conduct an investigation to establish the cause of the defect.

The cost of retrieval and/or any additional expenses incurred as a result of additional examination shall be borne by the contractor.

5.17 Repairs

Repairs of holidays and damaged areas due to destructive tests shall be made in accordance with procedures specified in each individual coating system.

All repairs shall be retested for holidays in accordance with Table 2.

After field repair of coating and before lowering the pipe into the ditch, the pipe again shall be tested for holidays. All defective places shall be plainly marked and repaired using the methods of identified in Clause 5.17.

5.18 Stripping of Coating

Rejected coating shall be removed only by the procedures specified by Company. The process shall cause no mechanical damage to the pipe and the steel temperature shall not exceed 250°C.

6. TRANSPORTATION, HANDLING AND STORAGE

6.1 Handling and Storage Requirements

6.1.1 Uncoated pipes shall be handled and stored in accordance with IPS-C-PI-140.

6.1.2 All coated pipes shall be handled and stored in such a manner as to prevent damage to the pipe walls, the weld end preparations and the coating.

6.1.3 Nylon slings or protected hooks which do not damage pipe ends shall be used for loading, unloading and stacking.

6.1.4 The coated pipes shall be stored at all times free from the ground. Storage may be effected by the use of battens suitably covered with soft material such as rubber sheet.

6.1.5 The coated pipes may only be stacked to a height such that no flattening of the coating occurs, in this respect the formula given in API RP 5L5 shall be used for the calculation of static load stress.

6.1.6 The pipes shall be separated from each other with sufficient and proper dunnage.

6.1.7 During long storage the coating shall be protected from contact with petrol, oil or grease, as some of these substances can cause swelling in the coating layer, and/or damage the coating otherwise.

6.1.8 The contractor shall clean the end cutback of concrete coated pipes, to remove all concrete spatter and any deleterious material, prior to load out. The contractor shall propose a method of cleaning for approval by the Company.

6.1.9 The contractor shall rebevel concrete coated pipe ends only when specifically instructed to do so by the Company. The procedure for rebevelling shall be agreed with the Company prior to any rebevelling being carried out. The contractor shall not carry out repairs to the pipe other than rebevelling, minor filing or grinding.

6.1.10 Concrete coated pipes shall not be stocked more than 4 m high. Pipes fitted with anodes/arresters shall form a top tier, and shall be laid out individually on top of the pipe stacks at the frequency required for load out and laying.

6.2 Transportation Loading

6.2.1 The loading operations shall be witnessed and certified by the inspector.

6.2.2 The coated pipes shall be loaded on trucks with provisions of 6.1.3.

6.2.3 The coating manufacturer shall provide all necessary means, such as saddles, battens, etc., for safe transporting of the coated pipes.

7. COLD-APPLIED TAPE COATINGS

7.1 General

7.1.1 The cold-applied tape coatings application shall be a continuous three-step operation starting with a properly prepared pipe surface. The three steps following immediately one after the other shall consist of:

a) Priming (for Material Standard see IPS-M-TP-321).
b) Inner-layer tape application (for Material Standard see IPS-M-TP-310).
c) Outer-layer tape application (for Material Standard see IPS-M-TP-311).

7.1.2 The coating materials shall be stored and applied at temperature as recommended by the manufacturer.

7.1.3 The coating shall be applied by one of the following methods:

a) Over the ditch application

- In this procedure the pipe is welded together beside the ditch. Then the surface preparation, priming and wrapping is performed continuously over the ditch. The coating is inspected simultaneously and the approved coated pipeline will be buried.

b) Field application

- In this procedure the pipes are surface prepared and primed at yard. The primed pipes are transported to the field, jointed, cleaned from contamination, reprimed, wrapped, inspected and buried.

7.2 Surface Preparation Prior to Coating

7.2.1 Surface preparation shall be in accordance with 5.7.

7.2.2 Preheating to remove oil, grease and mill scale may be used provided that all pipe is preheated in a uniform manner to avoid distortion.

7.2.3 The blast profile shall have the profile of 40 to 75 μm or as specified by the tape manufacturer of coating materials.

7.2.4 Blast cleaned pipe surface shall be protected from conditions of high humidity, rain fall, or surface moisture. No pipe shall be allowed to flash-rust before coating.

7.2.5 For pipe sizes bigger than 750 mm prior to placing the coating materials each longitudinal weld seam shall be primed and covered with 100 mm strip of inner-layer tape.

7.3 Coating Application

7.3.1 Primer application

The primer (IPS-M-TP-321) shall be applied in a uniform thin film at the coverage rate recommended by the manufacturer. The primer shall be thoroughly mixed and agitated as needed during application to prevent settling. The primer may be applied by spray-type or rug-type application, or other suitable means, to cover the entire exterior surface of the pipe. After application, the primer coat shall be uniform and free from floods, runs, sags, drips, or bare spots. The primed pipe surface shall be free of any foreign substances such as sand grease, oil, grit, rust particles, or dirt. The state of dryness of the primer prior to application of the inner-layer tape shall be in accordance with the recommendation of the manufacturer.

7.3.2 Application of inner-layer tape

The inner-layer tape (IPS-M-TP-310) shall be applied directly onto the primed pipe surface with mechanical coating/wrapping equipment having suitable tape dispensing equipment. The inner-layer tape shall be spirally applied with overlap width of 25 mm (1 inch) and application tensions as recommended by the manufacturer. When applied to spirally welded pipe, the direction of the tape spiral shall essentially conform to the weld spiral. The applied tape shall be tight, wrinkle-free, and smooth. When a new roll of tape is started, the end lap shall be overlapped on the previous roll a minimum of 150 mm measured circumferentially, and shall be smooth and placed so as to maintain the continuity of the inner-layer coating.

7.3.3 Application of outer-layer tape

The outer-layer tape (IPS-M-TP-311) shall be applied over the inner-layer tape using the same type of mechanical equipment used to apply the inner-layer tape. The overlap of the outer-layer tape shall not coincide with the overlap of the inner-layer tape. The outer layer may be applied at the same time as the inner-layer. The minimum overlap of the applied tape and the minimum end lap of two rolls shall be the same as 7.3.2.

7.3.4 Cutbacks

Cutbacks shall be a minimum of 150 mm (6 in.) from the ends of the pipe or as specified by the Company. The cutbacks may be a straight edge for the total thickness of the coating, or they may be tapered as specified by the Company.

7.4 Coating of Welded Field Joints

- The joints shall be coated with cold-applied tapes (IPS-M-TP-313 and IPS-M-TP-322) in accordance with 12.2.

- Welded joints shall be cleaned free of mud, oil, grease, and other foreign contaminants; and the exposed metal in the weld zone shall be wire brushed by hand or power brushed so as to remove all corrosion products. The adjacent cold-applied tape coating shall be cleaned of all foreign matter and shall be dry a distance of 50 mm back from the cutback zone. For this purpose, the weld zone is the uncoated area that results when two joints with coating cutback are assembled in the field in accordance with Paragraph 7.3.4 of this Standard.

7.5 Mechanical Coupling and Pipe Ends

Where rubber-gasketed joints or mechanical couplings are used, the coating may extend to the ends of the pipe, but the coating thickness on the pipe surfaces that receive the rubber sealing gaskets shall not be in excess of that recommended by the manufacturer of the sealing device. If coating the pipe to the ends will interfere with the proper seating of the seal, the coating shall be removed a distance required by the type of joint used so that the tape coating system will not interfere with the seal.

7.6 Coating Repair

All holidays detected, such as damaged or flawed areas or mislaps, shall be repaired by peeling back and removing the outer and inner layers from the damaged area. The holiday area shall then be brushed with primer, and either (a) a length of inner-layer tape shall be wrapped around the pipe to cover the defective area, or (b) a patch of inner-layer tape shall be applied directly to the defective area as specified by the Company. The minimum lap at the damaged area shall be 100 mm all around. The repaired area shall be tested with a holiday detector after the repair is completed. If no holidays are found, the repaired area shall then be covered with outer-layer tape with a minimum lap of 100 mm beyond the inner-tape patch.

7.7 Inspection and Rejection

For inspection and rejection see 5.14.

8. FUSION-BONDED EPOXY COATING (FBE)

8.1 General

8.1.1 Epoxy powder coating shall be applied in the shop to pipe, whose supplier has been informed that the pipe is to be epoxy powder coated.

8.1.2 The 75 mm of pipe ends shall be masked throughout the cleaning and coating operations and shall be suitably protected from mechanical damage at all times.

8.1.3 The average coating layer thickness shall be 400 microns with a minimum of 350 microns and a maximum of 450 micron, unless otherwise specified by the Company.

8.2 Surface Preparation

Surface preparation shall be in accordance with 5.7.

8.3 Coating Application

8.3.1 Preheating

8.3.1.1 The pipe shall be heated to the temperature (between 220°C and 245°C) recommended by the epoxy powder manufacturer. The heating equipment shall be suitably controlled to maintain uniform temperatures and to achieve the required uniform temperature along the entire surface of the pipe joint. On no account shall the pipe heated in excess of 260°C.

8.3.1.2 Prior to coating, the pipe temperature shall be checked with approved and calibrated instruments to ensure that the temperature complies with the established coating procedure.

8.3.1.3 Oxidation of the steel prior to coating in the form of 'blueing' or other apparent oxide formation is not acceptable. If such oxidation should occur, the pipe shall be cooled to ambient temperature and recleaned.

8.3.2 Application

8.3.2.1 The epoxy powder shall be applied by electrostatic spray to give a coating uniform in color, gloss and thickness and free from any runs, sags and holidays.

8.3.2.2 The production coating process shall be performed strictly in accordance with the qualified coating procedure and this specification.

8.3.2.3 Failure to comply with the above requirements shall result in the coating being rejected and completely removed and the pipe being recoated at no expense to the Company.

8.3.2.4 Recycling of the powder is allowed up to a proportion of 30%, well mixed with fresh powder, provided that the recycled powder has passed through a magnetic filter to remove all metallic dust and through a sieve to remove all aggregates in order to ensure that the particle size of the recycled powder is within the acceptable limits of fresh, unused powder as specified by the manufacturer. In no case shall powders of different batches be mixed deliberately.

8.3.2.5 Traceability of the coating material on each individual pipe should be ensured.

8.3.2.6 After application of the epoxy powder, the coating shall be allowed to cure in accordance with the qualified coating procedure before being quenched in water to permit handling, inspection (see 8.6) and, if required, repaired.

8.3.2.7 The pipe shall be allowed to cool to at least 60°C and the coating thickness determined with an approved gauge (see 8.4.2.2).

8.4 Field Coating of Welded Joints

8.4.1 Preparation - Surface preparation of welded shall be in accordance with 5.7.

8.4.2 Epoxy application

8.4.2.1 The weld area shall be heated to a temperature of (260°C) using a circumferential induction heating coil of sufficient size, width, and power to provide the required heat in the weld zone and 50 mm back under the fusion-bonded pipe coating.

8.4.2.2 Immediately after heating, the weld shall be coated with a powder coating meeting this Standard to minimum thickness of 380 μm using air or electrostatic spray. The powder coating shall attain full performance properties in accordance with this Standard when cured according to Clause 8.4.2.3. Application shall be done as rapidly as possible to prevent premature cool down of the heated zone. The welded-joint coating shall overlap the original pipe coating by no less than 25 mm.

8.4.2.3 The joint coating shall cure from the residual heat remaining in the heat zone. No quenching or forced cooling shall be allowed, and the heat zone shall be protected from adverse weather conditions such as rain or high winds that would cause cooling at high rates.

8.4.2.4 On completion of the coating operation, the joint coating shall be inspected for continuity as provided in 8.6. Holidays shall be repaired according to 8.7. Inspection and repair may begin after the heat zone has cooled sufficiently.

8.4.3 Alternative joint coatings - The exterior of field-welded joints may be coated with hot applied tape (see 9), cold applied tape (see 7.4) or liquid epoxy (AWWA C 210) or polyethylene shrink sleeve (12.3) or as otherwise specified or approved by the Company.

8.5 Coating of Connections and Appurtenances

8.5.1 Preparation - Surface preparation of connections and appurtenance shall be in accordance with 5.7.

8.5.2 Preheating - Fusion-bonded coatings can be applied to articles preheated to between 150°C and 245°C. Preheat temperatures should be in accordance with the manufacturer's recommendation. The articles may be heated by any controllable means that does not leave a residue or contaminant on the surface to be coated. Care should be exercised to ensure that the articles or parts thereof can sustain the preheat without damage.

8.5.3 Coating application - The fusion-bonded epoxy coating shall be uniformly applied on the specified surfaces at the specified thickness (8.1.3) by fluid bed, electrostatic spray, or air spray according to the manufacturer's recommendations. Selection of the method of application depends on the size, shape, and configuration of the article to be coated.

Mechanical thread system parts, such as nuts and bolts, can be coated with this coating provided the thickness of the coating will not gall or impede the normal operation of the thread system. At the option of the Company, thread systems may be left bare of all coating and protected with rust-preventing oil. In this case, the oil shall be removed after final field assembly by means of solvent cleaning, and the threads shall be coated using liquid epoxy as provided in 8.7.1.3. The Company should also specify the coating requirements for flange faces or other appurtenances.

8.5.4 Curing - If it is necessary to post cure the fusion-bonded coating, the coated article should be heated immediately after application of the coating according to the coating manufacturer's recommendations until total cure is achieved.

8.5.5 Imperfections - On completion of the coating operation, the coating shall be visually inspected for blisters, bubbles, voids, or other discontinuities. The coatings shall also be electrically inspected for holidays in accordance with 8.6.1. Inspection and repair may begin after the article has cooled sufficiently.

8.5.6 Coating repair - Holidays and imperfections detected by electrical inspection or visual means shall be repaired in accordance with Sec. 8.7.

8.6 Inspection and Rejection

For inspection and rejection see 5.14.

8.7 Coating Repair

8.7.1 Minor defects

8.7.1.1 Pipe requiring repair due to scars, sitvers, coating imperfection, and other small defect (less than 25 mm diameter) shall be repaired using repair material from the same manufacturer as the fusion-bonded epoxy as follows:

8.7.1.2 Areas of pipe requiring spot repairs shall be cleaned to remove dirt, scale, and damaged coating using surface grinders, files, or sanders. The adjacent coating shall be roughened. All dust shall be wiped off.

8.7.1.3 A two-part, 100-percent solids, liquid epoxy patching compound or a hot-melt adhesive patching compound shall be applied on the prepared areas to a minimum thickness of 305 μm. The freshly coated area shall be allowed to cure in accordance with the manufacturer's recommendations prior to handling and storage. Liquid epoxy shall not be applied if the pipe temperature is 13°C or less, except when manufacturer's recommended heat curing procedures are followed.

8.7.2 Major defects

Pipe sections with coating defects, such as partial coating, unbonded coating, inadequate film thickness, or holidays in excess than 1 per 0.9 m² pipe shall be reprocessed.

8.7.3 The applicator shall demonstrate the integrity of the techniques used to repair defects by carrying out adhesion, hot water resistance and holiday detection test in accordance with Table 2.

9. HOT APPLIED ENAMEL COATING

9.1 General

9.1.1 Two types of coating system are generally specified for hot-applied coating as follow:

a) Single coat system consists of:

- One coat of primer.
- One coat of hot-applied enamel.
- One wrap of glass fiber inner wrap.
- One wrap of glass fiber outer wrap.

b) Double coat system consists of:

- One coat of primer.
- One coat of hot-applied enamel.
- One wrap of glass fiber inner wrap.
- One coat of hot-applied enamel.
- One wrap of glass fiber outer wrap.

9.1.2 The coating may be applied in a coating yard, field or over-the-ditch. (See 9.3.1)

9.1.3 To reduce surface oxidation in sunlight and sagging due to excessive heat of yard-applied coatings during storage, the application of a coat of whitewash can be specified (see AWWA C203). When concrete application is to follow enamel coating, this step is normally omitted.

9.1.4 For coating materials see IPS-M-TP-275, IPS-M-TP-280, IPS-M-TP-285, IPS-M-TP-290, IPS-M-TP-295 , IPS-M-TP-300, IPS-M-TP-305 and IPS-M-TP-306.

9.2 Surface Preparation

Surface preparation shall be in accordance with 5.7.

9.3 Coating Application

9.3.1 General

The hot-applied coating may be applied by one of the following procedures:

a) Yard application

In yard procedure the pipes are surface prepared and primed, enameled and wrapped at yard or factory. The coated pipes are transported to the field and jointed. The welded joints, connections, fittings and special section shall be coated according to 9.4.

b) Field application

In this procedure the pipes are surface prepared and primed at yard. The primed pipes are transported to the field, jointed, cleaned from contamination, reprimed, coated, inspected and buried.

c) Over-the-ditch

In this procedure the uncoated pipe line shall be surface prepared, primed and also joined together and the coated over-the-ditch.

During over-the-ditch coating work care must be taken to handle them so that they will remain clean and dry. Foreign matter and dirt, as well as moisture, will reduce their effectiveness.

9.3.2 Primer application

a) The prepared surfaces shall be dry at the time the primer is applied, and no primer shall be applied during rain or fog unless the pipe to be primed is protected from the weather by suitable housing.

b) At the option of the contractor, the application of the primer shall be by hand brushing, spraying or other suitable means and shall be in accordance with instructions for application, as supplied by the manufacturer of the

primer. The apparatus to be used for application of the primer shall be acceptable to the inspector. Spray-gun apparatus to be used shall include a mechanically agitated pressure pot and an air separator that will remove all oil and free moisture from the air supply.

c) After application, the priming coat shall be uniform and free from floods, runs, sags, drips, holidays, or bare spots. Any bare spots or holidays shall be recoated with an additional application of primer. All runs, sags, floods, or drips shall be removed by scraping and cleaning, and the cleaned area shall be retouched or remedied by reblasting and repriming. Suitable measures shall be taken to protect wet primer from contact with rain, fog, mist, spray, dust or other foreign matter until completely hardened and enamel applied.

d) In cold weather, when the temperature of the steel is below 7°C, or at any time when moisture collects on the steel, the steel shall be warmed to a temperature of approximately 30-38°C which shall be maintained long enough to dry the pipe surface prior to priming. To facilitate spraying and spreading, the primer may be heated and maintained during the application at a temperature of not more than 49°C.

e) The minimum and maximum drying times of the primer, or the period between application of primer and application of enamel, shall be in accordance with instructions issued by the manufacturer of the primer.

If the enamel is not applied within the allowed maximum time after priming, the pipe shall be reprimed with an additional light coat of primer or the entire prime coat shall be removed by reblasting and the pipe reprimed as determined by Company.

9.3.3 Preheating of primed pipe

Enameling of primed pipe during cold weather or high humidity. During cold weather, when pipe surface temperature is below 7°C, or during rainy or foggy weather, when moisture tends to collect on cold pipe, enameling shall be preceded by warming of the primed pipe. Warming shall be done by any method that will heat pipe uniform to recommended temperature without injury to primer. Steel temperature of pipe shall not exceed 70°C.

9.3.4 Preparation of enamel for use

9.3.4.1 Preparation of bitumen enamel

a) The enamel shall be heated in kettles approved by the Engineer and equipped with accurate and easily read thermometers.

b) The enamel shall not be overheated nor shall it be held in the kettle for an excessive period of time. Operating kettles shall be completely emptied at least once each day and cleaned, when necessary, before another charge of unmelted enamel is added; except, in the practice of field patching, the Engineer may permit continuous use of a heating kettle not exceeding 200 litre capacity.

c) The enamel shall be maintained moisture and dirt free at all times before and during the time of heating and application.

d) In loading the kettles the enamel shall be broken into pieces not exceeding 10 kg each.

e) In heating the enamel the charge shall be melted and brought up to application temperature without injury to the enamel and in a manner approved by the Engineer. The hot enamel shall be thoroughly and continuously stirred. A patching kettle, 200 litre or smaller, shall be thoroughly stirred with an iron paddle at intervals not exceeding 15 minutes.

9.3.4.2 Preparation of coal tar enamel

a) The enamel shall be heated in suitable agitated heating kettles equipped with accurate and easily read recording thermometers. The thermometers will be checked and adjusted by the inspector whenever necessary. The charts therefore shall constitute a basis for acceptance or rejection of any enamel due to improper heating or handling, or both.

b) The maximum temperature of the supply or operating kettles to which the enamel may be heated and the maximum time that the enamel may be held in the kettles at application temperature shall be in accordance with the instructions supplied by the manufacturer.

c) Enamel that has been heated in excess of the maximum allowable temperature or that has been held at application temperature for a period in excess of that specified, shall be rejected. Fluxing the enamel will not be permitted.

d) Excess enamel remaining in a kettle at the end of any heating shall not be included in a fresh batch in an amount greater than 10 percent of the batch. Kettles shall be emptied and cleaned frequently, as required. The residual material removed in cleaning the kettles shall not be blended with any enamel.

e) A minimum of 50 percent of the original enamel penetration at 25°C shall be retained in the applied enamel. This minimum penetration shall be evidence of satisfactory melting and handling practice. The inspector may periodically take samples of the enamel as it is being applied to the pipe. If the penetration is less than 50 percent of the original enamel penetration at 25°C in any kettle, the inspector may reject the enamel in that kettle. The cost of such tests shall be borne by the Company, if the penetration exceeds 50 percent of the original value, or by the contractor, if it is less.

f) When applying the enamel, all kettles shall be equipped with suitable screens to exclude particles of foreign matter or other deleterious materials that could cause flaws in the finished coating.

9.3.5 Application of enamel

The enamel shall be applied by pouring on the revolving pipe and spreading to the specified thickness. Enamel shall be applied so that each spiral resulting from the spreading operations shall overlap the preceding spiral, producing a continuous coat that is free from defects, skips, or holidays. The thickness of coating shall be 2.4 mm and the allowable variation in thickness shall not exceed ±0.8 mm. Where the protrusion of the weld seam interferes with this thickness, the thickness of the enamel above the weld seam shall meet the minimum thickness specified (see 5.12.3.2.1).

9.3.6 Application of inner and outer wrap

a) Inner wrap and outerwrap shall be mechanically applied in a continuous end-feed machine or in a lathe-type machine or by other suitable wrap application equipment. In single wrap system, only one wrap of glass fiber outer wrap shall be applied. In double wrap system, one wrap of glass fibre inner wrap shall be applied and then followed by one coat of hot-applied enamel (9.3.5) and finally one wrap of glass fiber outer wrap shall be applied.

b) If low-porosity outerwrap, which has been stored, is applied under ambient high-humidity conditions, "gassing", that is, the formation of craters or voids in the enamel beneath the outerwrap, may occur. To prevent gassing, apply a film of outerwrap saturant or hot enamel to the underside of the outerwrap before it is drawn into the enamel on the pipe.

Note:

Some outerwraps, because of composition, are required to be stored in a dry, covered area and in the original packaging until immediately prior to use. Check with the manufacturer for proper storage and stacking requirements.

c) Conditioning of outerwrap surface after application. The outside surfaces are to be given a whitewash, water-emulsion latex paint, or kraft-paper finish coat following final inspection. The spirally wrapped kraft paper shall be tack-bonded with enamel at frequent intervals.

d) Handling pipe immediately after application. The coated pipe shall not be rolled or supported on its enameled and wrapped surface until sufficiently cooled and hardened to avoid deformation of the coating system.

9.4 Coating of Joint, Fitting, Connections

9.4.1 Pipe sections to be field welded

9.4.1.1 When pipe section are to be joined together by field welding, a band that is free of protective materials shall be left at the ends of the sections. This band shall be of sufficient width of 250 mm from each end of each of length to permit the making of field joints without injury to the coating.

9.4.1.2 The welded joints shall be cleaned (see 5.7) and dried, primed and then coated in accordance with 12.

9.4.1.3 For irregular shapes such as valves and fittings the buried petrolatum tape (IPS-M-TP-317) shall be used. For application of this coating the special primer shall be applied by brush and then petrolatum tape shall be wrapped over the parts.

9.4.1.4 The bellow ground unburied valves shall be coated with asphalt mastic. The cold applied asphalt mastic shall be applied by brush over the valves in accordance with 12.4. (See also IPS-M-TP-105).

9.4.2 Pipe sections to be joined with mechanical coupling and bell-and spigot ends

9.4.2.1 In sections to be joined by mechanical coupling a band free of protective materials shall be left on the ends of sections. This band shall be of sufficient width to permit joint make up.

9.4.2.2 For bell & spigot ends with rubber gasket, the coating shall extend from the lip of the bell to the holdback on the spigot end. The exposed steel surfaces on the inside of the bell and the outside of the spigot end shall be given a coating of fast-drying-synthetic primer (IPS-M-TP-275) to a dry-film thickness of 0.06 mm ±0.01 mm, or bitumen primer or coal tar primer as appropriate.

9.5 Inspection and rejection

For inspection and rejection see 5.14.

9.6 Coating Repair

9.6.1 All damages, flawed areas, and holidays

These areas shall be repaired using repair materials made by the manufacturer of the material originally used to coat the pipe. In no case is damaged enamel to be repaired by applying enamel over loose or damaged enamel where the damage goes down to the metal or where the bond of the enamel has been destroyed. Damaged areas are generally categorized into three types: pinpoint or bubble, exposed metal, or extensive damage. Repair of these types is discussed in the following clauses. Repairs are to be made using materials meeting the original specification.

Repaired area shall be inspected in accordance with AWWA C 203.

9.6.2 Repair of pinpoint or bubble-type damage

Remove dirt, foreign matter, kraft paper, and outerwrap with a sharp knife, taking care not to damage surrounding enamel. Pour correctly heated enamel over prepared area to specified thickness and cover with a patch of outerwrap.

9.6.3 Repair of exposed-metal type damage

These damaged areas are those up to approximately 100 mm by 100 mm in size. Repair by removing the dirt, foreign matter, and all disbonded enamel, and then bevel the surrounding edges. Clean metal surface properly, using wire brushes if required, and reprime bare area. After primer has dried, apply correctly heated enamel over prepared area to specified thickness and cover with a layer of outerwrap.

9.6.4 Extensive-damage type damage

This type relates to defects such as partially uncoated, unbonded enamel; severe cracking; excessive holidays; or inadequate film thickness. Enameled pipe having these conditions shall be reprocessed.

9.6.5 Electrical inspection

Repaired areas shall be electrically inspected in accordance with Table 2.

9.7 Rejection

The requirements of rejection shall be specified in scope of work.

10. CONCRETE COATING OF LINE PIPE

10.1 General

10.1.1 This Clause 10 of standard covers minimum requirements for the application of reinforced concrete coating to the exterior surface of steel line pipe (which has been coated previously with anti-corrosion coating) for use in marine environments, estuaries, rivers, wadis, swamps, etc.

10.1.2 Concrete coating thicknesses less than 25 mm is not included. In such case the coating shall be applied in accordance with AWWA C 205.

10.1.3 The materials used for concrete coating include cement, aggregates, water and additives (if required) shall be specified as IPS-M-CE-165.

10.1.4 Concrete coating shall not be carried out when the pipe, coating or air temperature exceeds 35°C or falls below 4°C.

10.1.5 Pipes shall be handled at all times in a suitable manner to avoid damage to pipe attachments, coating or concrete.

10.2 Reinforcement Steel

10.2.1 Steel reinforcement shall be provided to limit spalling and control cracking of the concrete. The minimum circumferential reinforcement shall be 0.5 percent of the longitudinal cross sectional area of the concrete coating. The minimum longitudinal reinforcement shall be 0.05 percent of the transverse cross-sectional area of the concrete coating. (see Fig. 1).

10.2.2 The reinforcement provided shall be either the steel welded wire fabric type or cage type. The selection of the type of reinforcement shall be made by the Company as stated in the scope of work.

Note:

The use of galvanized steel poultry netting, or chicken wire (e.g. to ASTM A-390) is generally not recommended. However, it may be used in certain applications, such as small river crossings on lend lines, where external forces on the concrete would be minimal.

10.2.3 The minimum distance between the reinforcement and the anti-corrosion coating shall be 10 mm. When more than one layer of reinforcing is used there shall be a minimum spacing of 10 mm between layers. Contacts shall not be made with anodes and/or buckle/crack arresters, and if the reinforcing passes over arresters the minimum gap shall be 10 mm.

10.2.4 Reinforcing shall terminate 20 mm (±5 mm) from the end of the concrete coating and adjacent to anodes. There shall be no electrical contact between reinforcing and pipe or between reinforcing and anodes.

10.2.5 The reinforcement shall be free of oil, grease and dirt.

10.2.6 The steel welded wire fabric shall be galvanized. The chemical and physical properties shall be in accordance with IPS-M-CE-105. The minimum diameter of reinforcing wire shall be 1.6 mm. The longitudinal overlap shall be at least 30 mm. For concrete thickness up to 50 mm, one wrap of reinforcing shall be used. For thicknesses of more than 50 mm up to 120 mm, two layers shall be considered. The reinforcement shall be positioned at least 10 mm below the outer concrete surface.

10.2.7 The cage type (Fig. 2) reinforcement shall be positioned within the middle third of the concrete coating with a concrete cover of at least 9 mm.

10.2.8 The material used shall be hard drawn wire to BS 4483, or ASTM A 615 M.

10.2.9 The reinforcement shall be positioned within the middle third of the concrete coating with a concrete cover of at least 9 mm.

10.2.10 The diameter of the circumferential and longitudinal bars shall be calculated from the required percentage of reinforcing, with a minimum diameter of 3 mm.

10.2.11 The Contractor shall propose the welding procedure in accordance with a National/International code or standard to be approved by the Company. The procedure shall be qualified prior to use.

10.2.12 The Contractor shall carry out shear testing of four welds each month in accordance with BS 4483 or ASTM A 185. The welding at intersections of the cage shall result in a minimum shear strength as specified in BS 4483 or ASTM A 185.

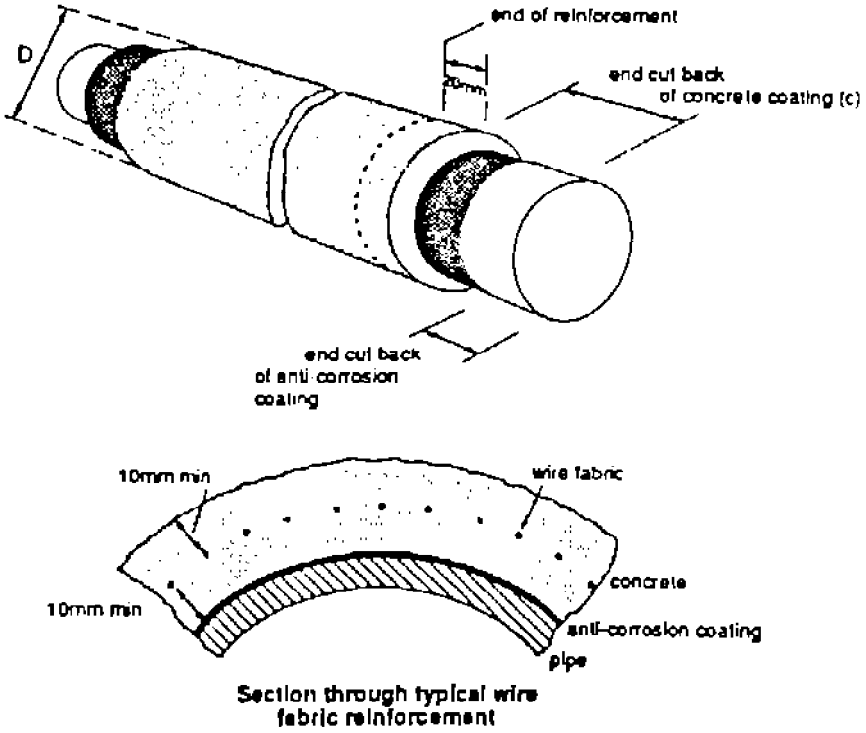
10.2.13 The spacing of the longitudinal bars shall be between 50 and 250 mm but not less than four longitudinal bars (at approximately equal spacing) shall be provided. The circumferential bar spacing shall be not more than 150 mm. Cages shall have two loops spaced 50 mm apart at each pipe end and adjacent to anodes and arresters.

Note:

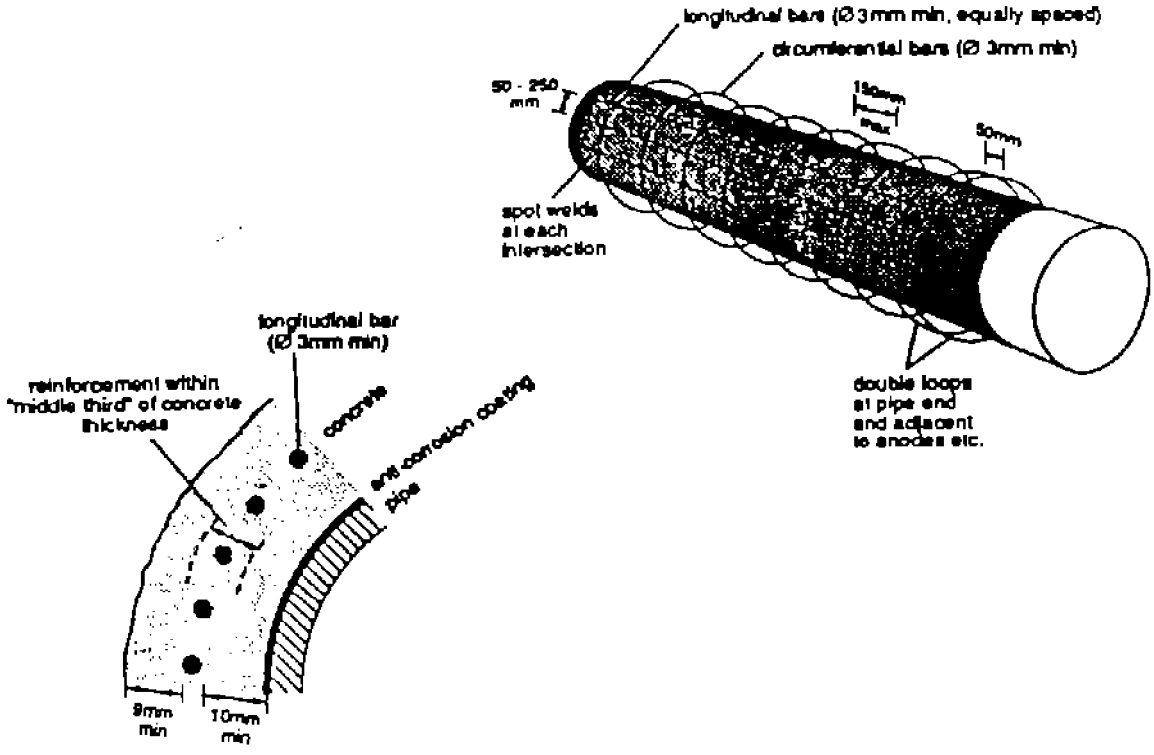
Close fitting arresters may be designed to have the concrete around them, in which case this requirement is not applicable.

10.2.14 Where a lap is required, one part cage shall have its longitudinal wires extended to ensure a minimum overlap of 200 mm with the longitudinal wires of the other cage and with the circumferential wires of each cage having not less than 25 mm between them. Lap wires shall be bent down as necessary to maintain alignment.

10.2.15 Cages shall be rigidly held concentric to the pipe at the correct location by electrically insulating plastic or concrete spacers. The type of spacer shall be proposed by the contractor for approval by the Company. Spacers shall have flush bases to prevent indentation into the anti-corrosion coating.



REINFORCEMENT DETAILS
Fig. 1



CAGE REINFORCEMENT DETAILS
Fig. 2

10.3 Coating Process

10.3.1 Proportioning of materials

The Contractor will be permitted to select any proportioning of materials to produce the requirements of concrete strength and density/submerged weight. The Contractor shall prove the suitability of his mix design by pre-qualification testing, to be witnessed and approved by the Company prior to the start of production coating. Approved mix designs shall not be changed without re-testing and approval by the Company. Mix designs submitted to the Company for approval shall at least contain following information:

- The proportions and weights of the component materials used for the mix,
- the water/cement ratio (not to exceed 0.45 by weight),
- the grading of the aggregates accompanied by appropriate curves,
- the test results of the mix for strength, density and water absorption,
- the measures taken to minimise drying shrinkage.

10.3.2 Application of concrete coatings

10.3.2.1 Prior to application of concrete coating, pipe shall be coated by anti-corrosion coating and then inspected and tested with a holiday detector specified by this Standard for each individual coating (see 5.14).

Any pipes containing coating defects shall be put aside or repaired in accordance with this construction Standard. The testing shall take place just prior to the fitting of the reinforcement steel and, additionally, prior to the attachment of anodes or buckle/crack arresters.

Special care shall be taken with pipes to which sacrificial anodes and/or buckle/crack arresters have been fitted. Anode attachment and cable-to-pipe connectors shall be inspected to ensure that they are secure and are properly coated with an anti-corrosion coating determined by the use of the holiday detector.

10.3.2.2 The concrete shall be applied to the pipe by either the impingement or the compression method.

10.3.2.3 The concrete shall be placed on the pipe within 30 minutes of the water being first added to the mix. Each pipe shall be coated in a continuous operation in such a manner that the thickness of coating is applied uniformly, smoothly, without corrugations and concentric with the steel pipe.

10.3.2.4 If more than one application is required to produce a coating of the specified thickness, then the time allowed between the first coat and the second coat shall not exceed 30 minutes. If a period exceeding 30 minutes does occur, the previous coating layer shall be removed and the entire pipe shall be recoated.

10.3.2.5 Both ends of each pipe (i.e. the bare pipe and the anti-corrosion coating) shall be completely free of concrete or any other foreign matter. The concrete shall be terminated either square or tapered back at an angle to the pipe surface as specified in the Scope of Work.

10.3.2.6 The outer surface of each anode (with the exception of the ends) shall be kept free of concrete.

10.3.2.7 Each concrete coated pipe shall be weighed immediately after the coating operation and its submerged weight established and recorded.

10.3.3 Limitations

Concrete coating shall not be carried out when the pipe, coating or air temperature exceeds 35°C, or when there is evidence of flash setting of concrete.

In the event that the ambient temperature falls below 4°C the contractor may request to use a 'Winter Concrete Application' procedure. Prior to use, this procedure shall be qualified by the Contractor in the manner specified by the Company.

The use of recycled rebound material is allowed. Secondary mixing of the freshly batched concrete with the recycled material shall follow immediately and shall produce a homogeneous cohesive mixture. The amount of recycled material used shall not exceed 10% of the total mix by weight. When breaks in the operation for whatever reason exceed thirty minutes then the recycled material not previously added to mix shall be discarded and removed from the coating area.

10.4 Curing

10.4.1 General

10.4.1.1 Immediately after completion of coating, the pipe shall be removed from the coating machine and transferred, after weighing and diameter measurements, to the storage yard for curing. The coated pipe shall be gently lifted and transported to the curing yard and placed, so as to prevent cracking or damage to the concrete, in a single layer.

10.4.1.2 Curing shall be performed either by using water curing, steam curing, curing by sealing compounds or polyethylene wrapping. The exposed surfaces of the concrete shall be protected during curing from any adverse effects of sunshine, drying winds, rain or running water.

10.4.1.3 The curing process shall continue until a minimum compressive strength of 14 N/mm² has been achieved (as demonstrated by the qualification tests and/or subsequent core tests), after which the pipe can be lifted, transported or stacked.

10.4.1.4 If the curing process involves steam or warm high humidity air, then it shall be demonstrated that the process will have no deleterious effects on the concrete. Under no circumstances shall the pipe wall be allowed to reach a temperature that would cause any damage to the anti-corrosion coating 60°C, or as advised otherwise by the Company.

10.4.1.5 Prior to use, the curing facilities and procedure shall be proposed by the Contractor for approval by the Company.

10.4.2 Water curing

Water curing shall consist of wetting and moistening the concrete coating, starting not later than 6 hours after concrete placing completion.

The concrete coating shall be kept continuously moist by intermittent spraying for a period of at least 7 days. The interval between spraying shall not be more than 24 hours. At temperatures below 4°C, suitable precautions shall be taken to prevent damage due to freezing.

10.4.3 Steam curing

10.4.3.1 Curing by steam shall not start sooner than 3 hours after concrete application completion.

10.4.3.2 Concrete coated pipes shall be enclosed in plastic or a similar cover suitable to maintain steam circulation.

10.4.3.3 Steam circulation shall start at ambient temperature and shall be controlled to give a temperature gradient of approximately 10°C/hour up to a maximum steel/coating temperature of 60°C.

10.4.3.4 The pipes shall be held under steam curing at least 6 hours and then allowed to cool for a similar period. The Contractor shall demonstrate by pre-qualification that the curing time used is sufficient to meet the required strength levels specified.

10.4.4 Curing by sealing compounds (membrane)

10.4.4.1 Sealing compounds shall meet requirements as per ASTM C 309-89. The material shall be stored, prepared and applied in strict conformity with the printed instructions supplied by the compound manufacturer. The compound shall be non-toxic and non-inflammable and shall not react with any constituent of the concrete, the reinforcement, the anodes, the protective coating or the pipe steel.

10.4.4.2 Unless otherwise specified by the compound manufacturer's instructions, membrane sealing compounds shall be sprayed over the concrete surface within 6 hours after concrete placing completion and shall remain for a minimum of 7 days. The materials shall not be applied at a temperature of less than 4°C.

Sealing compound shall not be sprayed on any part of the anode surface.

10.4.5 Curing under polyethylene wrapping

Wrapping in plastic film (e.g. polyethylene film), shall take place by mechanical apparatus immediately after the coating is applied to the pipe and preferably before the pipe is removed from the concrete coating apparatus. A light spray of water shall be applied before applying the plastic film. The film shall have a minimum thickness of 0.1 mm and overlap of the sheet shall not be less than 25% of the sheet width. Polyethylene film shall be in accordance with ASTM C 171.

The polyethylene wrapping shall be removed prior to load-out of pipe.

10.5 Inspection and Testing

10.5.1 General

10.5.1.1 The Company may have a full-time or part-time representative(s) at the Contractor's plant, to monitor sampling, testing, calibrating and curing during production.

10.5.1.2 The Contractor shall supply details of all sampling and testing procedures and shall receive the Company's approval prior to use.

10.5.1.3 Strength, density and water absorption tests shall be carried out by a third party proposed by the Contractor and approved by the Company, unless the contractor's own facilities and procedures are accepted by the Company.

10.5.2 Miscellaneous inspections/tests

10.5.2.1 Steel reinforcement check

a) When steel wire fabric reinforcement is used, at least 2 pipes per shift shall be selected at random for checking that the distribution of the reinforcement is as specified in 10.2. The method of checking shall be to remove a small area of concrete coating (200 mm long × 100 mm wide) by means of a high pressure water jet. Any pipe inspected found satisfactory shall be reinstated.

b) An electrical resistance check shall be made between the pipe and the (inner) reinforcement on at least 2 pipes per shift. This shall be carried out in the period between concrete application and curing, using an Ohm-meter. The resistance shall be at least 1000 Ohms.

c) Pipes with unsatisfactory distribution of reinforcement, or which fail the electrical resistance test, shall be stripped and recoated after correct installation of reinforcement. In this event, three additional pipes from the same batch shall also be checked to gain acceptance of the batch.

10.5.2.2 Diameter measurements

The diameter measurements immediately after concrete coating application shall satisfy the following two requirements:

a) The radial distance between any high and low points of the coating surface shall not exceed 8 mm in any 500 mm length, nor 5 mm in the last 1 m length at each end.

b) The diameter of each coated pipe shall be measured using a girth tape in six positions spaced at approximately equal intervals with the two end measurements being approximately 600 mm from the ends of the concrete coating. All diameter measurements shall be recorded and the mean value per pipe shall be used to calculate the mean concrete thickness. The concrete thickness and acceptance tolerance shall be as stated in the Scope of Work.

Coated pipes outside the stated tolerances shall be repaired or stripped and re-coated, at the discretion of the Company.

10.5.2.3 Visual inspection

10.5.2.3.1 General - All Concretes coated pipes shall be visually inspected and examined for damage, cracks, or other defects.

All cores removed for strength testing shall be visually examined for voids and other defects.

10.5.2.3.2 Cracking - Circumferential surface cracking of the concrete, with a crack width less than 5 mm, shall not be considered a defect.

Longitudinal surface cracks of any width and less than 250 mm in length shall not be considered defects, but holes of 10 mm nominal diameter shall be drilled at the crack tips to prevent crack propagation. Longitudinal cracks in excess of 1000 mm in length or extending the full depth of the coating are not acceptable and coating with such a crack shall be removed from the entire length of the pipe. Longitudinal cracks with a length between 250 mm and 1000 mm shall be repaired (see 10.6.3).

Circumferential annular cracking visible at pipe ends is not acceptable. Any such cracking noted shall be reason to consider the concrete suspect and liable to rejection. An investigation shall be made, including a back check of pipe produced prior to and following the suspect pipe. Any concrete coating noted with annular cracking of the concrete shall be destructively tested by the Contractor. This testing shall take the form of saw cutting and removal of sections of the concrete from the pipe to determine whether the concrete is a homogeneous mass throughout the length of the pipe.

10.5.2.3.3 Damage - Surface damage will not be considered a defect if:

a) The total surface area of damage per pipe is less than 0.1 m², and
b) the maximum depth does not exceed 20% of the coating thickness, and
c) the remaining concrete is sound.

Damage at the ends of the concrete need not be repaired provided that the damaged area is less than one third of the circumference for a length less than 200 mm.

10.5.3 Strength and density testing

The compressive strength and density of the applied concrete after 7 and 28 days shall be determined by two different methods of testing:

a) taking of test cubes from the transfer belt between the concrete batching plant and the application machine (or from the mixer outlet for continuous mixing equipment);

b) taking of core samples from the actual concrete coating on the pipes.

Acceptance shall be based only on 28 days core sample strength results.

10.6 Repairs and Rejection

10.6.1 General

10.6.1.1 Concrete coated pipes may be rejected by the Company when any of the previously stated acceptance criteria are not met, and in such case the coating shall be completely removed rather than partially repaired. Damage, cracks and core holes shall be repaired in accordance with this Clause (10.6).

10.6.1.2 Concrete used for repairs shall contain the same proportions of dry constituents as the original coating but the water/cement ratio may be higher, to improve workability.

10.6.1.3 Prior to application of repair material, the defective area shall be thoroughly cleaned by removing concrete coating sufficiently to clean under the reinforcing bars and the concrete edges shall be cut so as to form a holding key.

10.6.1.4 All repairs shall be moist cured for a minimum period of 48 hours.

10.6.1.5 The contractor shall demonstrate that the procedures for repair application and cure will result in an acceptable coating with the compressive strength of repair being at least equal to the strength of the coating. All repair methods shall be subject to the Company approval prior to use.

10.6.1.6 Repairs shall be effected by removing the concrete to expose uninjured reinforcements throughout the damaged areas. Any damaged reinforcement shall be replaced.

10.6.1.7 The edges of the removed area shall be undercut to provide a key lock for the repair material.

10.6.1.8 A stiff mixture of cement, aggregate and water shall be troweled into and through the reinforcement, and built-up until the surface is even and smooth with the original coating around the repair. The coating resulting from the repair, shall be equal in strength to the coating originally applied.

10.6.1.9 Any repair made by the concrete applicator shall be appropriately positioned and allowed to properly cure for a minimum of 36 hours before further handling, however, if a shield is used over the repair and allowed to remain in place the pipe may be handled immediately.

10.6.2 Damaged areas

10.6.2.1 Damaged areas shall be repaired when they are considered defects as defined in 10.5.2.3.3.

10.6.2.2 Areas of damage not in excess of 0.8 m² in any 3 m length of pipe (restricted to two such areas in any 12 m length of pipe) may be repaired by hand patching if repairs are carried out while the concrete is in a 'green' state (i.e. within 4 hours of coating application and prior to curing).

10.6.2.3 In the event that the Contractor wishes to repair areas on cured concrete, a guniting process shall be used and the procedure shall be approved by the Company prior to use.

10.6.2.4 Areas where coating has been damaged during coating application in excess of 0.8 m² but not more than 25% of the total coating area, shall be repaired immediately prior to the pipe being removed from the coating applicator by re-application of the spalled areas using the application machine used to coat the pipe.

10.6.2.5 Where damage to concrete is in excess of 25% of the total coating area, repairs shall not be allowed. All coating shall be removed and the pipe re-coated.

10.6.2.6 The Contractor shall propose a procedure for removing rejected coating and shall receive the Company approval prior to use.

10.6.3 Cracks

Longitudinal cracks in excess of 250 mm in length shall be repaired as specified below with the addition that the ends of each crack shall be drilled with a hole of 10 mm nominal diameter to prevent crack propagation. The bottom of this hole shall be 7-10 mm from the anti-corrosion coating.

Repairs to cracks shall be made by opening the crack to 25 mm width by chiseling out. The prepared area shall be undercut to form an adequate key for the repair material. The repair material shall be troweled or impinged into the prepared area and smoothed down to the level of the original coating. Prior to repairing, the prepared area shall be inspected by the Company for damage to the coating or metal surface.

10.6.4 Core holes/inspection areas

Core holes shall not be refilled without prior inspection and approval by the Company. The core holes shall then be hand filled with a stiff mix similar to that used in the coating process. Prior to use, the detailed procedure shall be proposed by the contractor and approved by the Company.

11. POLYETHYLENE COATING APPLICATION

11.1 General

Application requirements for three types of shop-applied polyethylene coatings for the exterior of steel pipe are considered bellow; the type of coating shall be specified by the Company.

Type 1: The extruded polyethylene sleeve, shrunk over a primed pipe by cross heat extruded method. This type of coating shall be applied in accordance with DIN 30670.

Type 2: The dual extrusion (side extrusion method) where the soft primer is extruded on to the blast-cleaned or epoxy primed pipe followed by multiple fused layers of polyethylene. This type of coating shall be applied in accordance with IPS-G-TP-335.

Type 3: Powder sinter coating (fusion bonded PE coating) consists of PE powder distribution from an applicator running the length of the pipe, on to the continuously rotating heated pipe below.

This type of coating which is not included in IPS-E-TP-270, when specified by the Company, shall be applied in accordance with Clause 11.2.

11.2 Fusion-Bonded Low Density Polyethylene Coating (Powder Sintering)

11.2.1 General

11.2.1.1 The standard specifies requirements for application of fusion-bonded low-density polyethylene coating of pipes and fittings, that are installed in location not subject to weather exposure.

11.2.1.2 Polyethylene materials complying with this Standard are intended for application to pipes and fittings where the pipeline operating temperatures are not normally more than +60°C nor less than -40°C.

11.2.2 Coating thickness

Unless specified otherwise by the Company, the minimum coating thickness of the fusion bonded polyethylene shall be as specified in Table 3.

TABLE 3 - COATING THICKNESS

NOMINAL SIZE OF PIPE DN	MINIMUM COATING THICKNESS, mm	
	Normal	Heavy (see Note 1)
≤ 100	1.8	2.5
> 100 ≤ 250	2.0	2.5
> 250 ≤ 499	2.2	3.0
≥ 500 ≤ 749	2.5	3.5
≥ 750	3.0	3.5

Notes:

1) Where additional protection is required (e.g. because of rocky backfill expansive or clays), consideration may be given to specifying the heavy thickness.

2) When the specified minimum coating thickness exceeds 45 percent of the pipe wall thickness, the Company shall consult the applicator.

11.2.3 Surface preparation

Surface preparation shall be in accordance with 5.7.

11.2.4 Application of coating

11.2.4.1 Immediately prior to the application of polyethylene compound, the surface to be coated shall be free of deleterious contaminants and surface defects.

11.2.4.2 At this process the surface prepared steel pipes are heated by direct gas flame or hot air heated oven to 320-360°C, to obtain good adhesion of the PE to metal.

The hot pipe is placed beneath a chute, running the length of the pipe, from which a PE powder of maximum particle size 400 microns falls continuously, or intermittently as required, onto the rotating pipe. The coated pipes are cooled by blowing cold air through them after having been put onto end supports to keep them clean of the ground, in order to prevent damage to the still soft PE coating.

The resultant coating is claimed to be virtually stain-free.

11.2.4.3 During coating, the beveled ends of the pipes shall be protected against mechanical damage and against contamination with coating material.

11.2.4.4 The coating shall be applied in such a way as to obtain a smooth outer surface resulting in a coating comply with Clause 11.2.8.

11.2.4.5 If after being heated, a pipe or fitting is allowed to cool below the coating temperature without being coated, the surface shall be re-prepared by abrasive blast cleaning before being reheated for coating.

11.2.5 The pipe ends

At the pipe ends the coating shall be cut back over a length of 150 mm ±20 mm unless otherwise specified. At the cut-back the coating edge shall be shaped to form a bevel angle of 30 to 45 degree. For stainless steel pipes non-ferrous or stainless steel mechanical tools shall be used.

11.2.6 End treatment of coating

The junction at the ends of the pipe coating and the pipe surface shall be finished as follows:

a) Tapered to a feathered edge over a distance not less than 5 times the coating thickness.
b) Sealed with lacquer.

11.2.7 Protection of welded joints on PE coated steel pipes (coating of field joints)

The protection of the uncoated area of steel pipe adjacent to the welded joints can be achieved by means of:

- Thermo shrinkable polyethylene tubing (see 12.3).
- Fused polyethylene powder (see 11.2).
- Wrapping with plastic adhesive tape (cold applied tape) (see 12.2).

11.2.8 Finished coating system requirements

The finished coating shall comply the requirements described in IPS-G-TP-335, except that the cathodic disbonded length can increase up to 15 mm.

11.2.9 Repairs

11.2.9.1 Where a flaw is located, the PE coating shall be repaired to the satisfaction of the Company.

11.2.9.2 The application of a hot spatula is a satisfactory method for small repairs (up to 650 mm²), provided that there is a residual layer of polyethylene still adhering strongly to the steel surface.

11.2.9.3 Apart from repairs resulting from destructive testing the number of repairs shall not exceed three per pipe or fitting.

11.2.9.4 Except for repairs resulting from destructive testing, the area of any single repair shall not exceed 0.1 m² and the length of such repair shall not exceed the nominal pipe diameter in the circumferential direction, nor twice the nominal pipe diameter in the longitudinal direction.

11.2.9.5 Testing of repaired area shall comply with (11.2.8).

11.2.10 Inspection and rejection

Inspection and rejection shall be in accordance with IPS-G-TP-335.

12. COATING APPLICATION OF FITTINGS AND CONNECTIONS

12.1 General

Application method of following coatings, when specified, for fitting, connections and special parts of pipelines shall be as described bellow:

a) Cold applied primer and prefabricated tape (see 12.2).
b) Polyethylene shrink sleeves (see 12.3).
c) Asphalt mastic coating (see 12.4).

The selection of type of coating for connections and fitting shall comply with requirements described in IPS-E-TP-270.

12.2 Cold Applied Primer and Prefabricated Tape

12.2.1 Surface Preparation

Prior to application of primer and prefabricated tape, the surfaces of connection and fillings shall be prepared at least to St_3 in accordance with SIS 05 5900 and then coatings applied in accordance with Clause 12.2.2.

Welded joints shall be allowed to cool prior to surface preparation.

12.2.2 Coating application

12.2.2.1 Priming

A uniform and continuous coat of primer (IPS-M-TP-322 or IPS-M-TP-323 as appropriate) shall be applied on prepared surface in accordance with manufacturer's recommendations.

The primer coverage and curing or drying time shall be sufficient to ensure an effective bond between the substrate and the coatings. Priming application shall be limited to that amount that can be wrapped during the same workday; otherwise the steel must be reprimed.

12.2.2.2 Wrapping

Prefabricated tape (IPS-M-TP-313 or IPS-M-TP-314 as appropriate) shall be applied by hand spirally to the primed surface with the following considerations:

- The total applied thickness of tape shall not be less than 500 μm using the overlap of 50%.
- Tape laps shall not be used unless the pipes circumference is less than the length of the tape.
- Maximum and minimum temperature for application and handling specified by the manufacturer shall be followed.

12.2.3 Coating repair

All damages, flawed areas, holidays, or mislaps shall be repaired by peeling back and removing the tape layers from the affected area. The repair area shall be brushed with primer, then a patch of tape covering a minimum of 100 mm around the affected area shall be applied by wrapping around the pipe, or by application of a patch of tape as specified by the Company. The repaired area shall be tested with a holiday detector as described in Sub-Clause 12.2.4 after the repair is completed.

12.2.4 Inspection of coated surfaces

After wrapping operations have been completed, the contractor shall conduct an electrical inspection of all wrapped surfaces with an electrical holiday detector (see 5.12.3.2.2). Any defect in the wrapping shall be satisfactorily repaired at the expense of the contractor.

12.3 Polyethylene Heat shrinkable Coatings

12.3.1 General

12.3.1.1 Heat-shrinkable coatings are radiation cross-linked polyethylene (see IPS-M-TP-318) and are available in the following types:

- **Type 1:** Tubular type
- **Type 2:** Cigarette wrap
- **Type 3:** Wrap-around tape

12.3.1.2 Type 1: Tubular-type coatings - These are installed before joining the pipe ends by sliding the coating from a free end of the pipe onto the area to be coated.

12.3.1.3 Type 2: Wraparound coatings - These are wrapped circumferentially around the pipe area to be coated. Each wraparound coating is provided with either a separate or a built-in closure to secure the overlap during shrinking.

12.3.1.4 Type 3: Tape-type coatings - These are helically wrapped around the pipe area to be coated with an overlap of 50%.

12.3.1.5 They have the advantage over conventional cold-applied tapes that they are self-tensioning, resistant to direct sunlight and some brands can be used at elevated temperatures up to 90°C.

12.3.1.6 Their major disadvantage is that they require a source of heat for application which is a flame torch. Field construction crews must be skilled to apply the heat-shrink sleeves properly. Shrink sleeves are extensively being used for the field-joint protection of polyethylene and fusion-bonded epoxy-coated pipes.

12.3.2 Surface preparation

Wire-brush cleaning - Surfaces that have been blast cleaned and primed in a mill or shop before shipment to a field location may be cleaned using solvent wash and wire brushing or other approved means at the time the heat-shrinkable coating is applied. All wire-brushed metal surfaces shall be prepared according to IPS-C-TP-101.

12.3.3 Coating application

12.3.3.1 The specific application procedure used for each type of coating system (see 12.3.1.1) shall be as described by the manufacturer.

Maximum and minimum temperatures for application and handling specified by the manufacturer shall be followed (see also AWWA C 216).

12.3.3.2 Where the heat-shrinkable coating joins with a mill-applied coating, it shall bond to and overlap the mill coating by a minimum of 50 mm. The supplied width should be a minimum of 127 mm wider than the exposed steel area to be covered. When the heat-shrinkable coating is applied to pipe coated, coal-tar enamel coating, kraft paper or white-wash shall be removed from the area to be overlapped.

12.3.4 Coating repair

12.3.4.1 All damaged or flawed areas, holidays and mislaps shall be repaired by using heat shrinkable coating (12.3) or cold applied primer and prefabricated tape (see 12.2).

12.3.4.2 The damaged area shall be covered with a minimum of (50 mm) overlap around the damaged area by using either a precut patch or wraparound coating. The repaired area shall be tested with a holiday defector as described in (5.12.3.2.2), after the repair is completed.

12.3.5 Inspection of coated surface

After the heat-shrinkable coating has been properly applied, the contractor shall conduct an electrical inspection of all wrapped surfaces with an electrical holiday detector.

The heat-shrinkable coating shall pass the electrical inspection test if no electrical spark occurs. The primary input power shall be no higher than 20W, and the minimum pulses at crest voltage shall be 20 Hz.

The operating voltage of the detector shall be determined by the following formula:

$$\mathbf{V = 1250\ \sqrt{t}}$$

Where:

V = The inspection voltage
t = The total coating system thickness, in mils

12.4 Asphalt Mastic Coating (for IPS-M-TP-105)

12.4.1 General

Mastic should not be used with primer. The material should be such to bond firmly to clean steel surface. It shall be cold applied by brush.

12.4.2 Application of mastic for bellow ground unburied valves and fitting

12.4.2.1 All bellow ground valves and fittings which are not furnished coated shall be thoroughly cleaned, and brush coated.

12.4.2.2 The mastic shall be applied in 2 or 3 coats to a total dry film thickness of 3 mm minimum. Each coat of mastic shall be allowed adequate time to dry, set or harden before handling or before a further coat is applied. (12 hours minimum each coat). The mastic shall be applied evenly and be free of voids, runs, and missed spots.

13. INSTALLATION OF COATED PIPE AND BACKFILLING

13.1 General

At all times during construction of the pipeline, the contractor shall use every precaution to prevent damage to protective coating on the pipe. No metal tools or heavy objects shall be permitted to come into contact unnecessarily with the finished coating. Workmen shall not be permitted to walk upon the coating except when absolutely necessary; in such case, they shall wear shoes with rubber or composition soles and heels or other suitable footwear that will not damage the coating. Any damage to the pipe or the protective coating from any cause during the installation of the pipeline and before final acceptance by the Company shall be repaired in accordance with this construction Standard and to the satisfaction of the Company and at the expense of the laying contractor.

13.2 Bending

Cold field bending shall be done using padded machines designed for bending coated pipe. Field bends shall be uniform and shall not exceed 1½ degrees for each section of pipe length equal to the pipe diameter.

13.3 Protection During Welding

A 460 mm (18 in.) wide strip of heat-resistant material shall be draped over the top half of the pipe on each side of the coating holdback during welding to avoid damage to the coating by hot weld splatter. No welding ground shall be attached to the coated part of the pipe.

13.4 Application of Rockshield

The contractor shall apply rockshield (IPS-M-TP-316) to the coated pipe when specified by the Company before hoisting the pipe (see 13.5).

13.5 Hoisting

Pipe shall be hoisted from the trench side to the trench by means of wide-belt slings. Metal chains, cables, tongs, or other equipment likely to cause damage to the coating shall not be permitted, nor shall dragging or skidding of the pipe be permitted. The contractor shall allow inspection of the coating on the underside of the pipe while the pipe is suspended from the slings. Coated pipe shall be handled with nylon sling choker belts or equivalent. Caliper clamps shall not be used. Any damage shall be repaired in accordance with this Standard.

13.6 Pipe Bedding and Trench Backfill

13.6.1 Backfilling shall be conducted at all times in such a manner as to avoid abrasion or other damage to the coating on the pipe. Unless otherwise specified by the Company, the following requirements shall be met:

13.6.2 Where the trench traverses rocky ground containing hard objects that could penetrate the protective coating, a layer of screened earth or sand, not less than 150 mm thick, or other suitable beddings shall be placed in the bottom of the trench prior to installation of the pipe.

13.6.3 Placement of backfill around the exterior of the coated pipe shall be done only after the inspector has made final inspection and has accepted the exterior coating. Backfill shall be placed in accordance with 13.7.

13.7 Backfilling

Backfilling shall be conducted at all times in such a manner as to avoid abrasion or other damage to protective coating on pipe. Unless otherwise specified by the Company, the following requirements shall be provided:

13.7.1 Placing of backfill

Placing of backfill around exterior-protected pipe shall be done only in the manner approved by the inspector after the inspector performs final inspection and acceptance of the exterior protection.

13.7.2 Installation and type of backfill

Immediately after pipe is placed and aligned in the trench and before the joint is completed, loose backfill shall be placed about the pipe, except at field joints, to a depth of 150 mm above the pipe. This backfill shall be free of large stones, frozen lumps, trash, or material that may decay.

13.7.3 Rocks and hard objects

If rocks or other hard objects are present in the backfill along any section of the pipeline, such backfill shall be screened before being placed about the pipe, or, at the option of the contractor, suitable waste backfill from other parts of the line may be transported to and placed about the pipe in such sections.

13.7.4 Methods of compaction

Compaction of backfill in the trench shall be by means of flooding, puddling, tamping, jetting, or a method agreeable to both the Company and the contractor. Rodding with metal rods or other metal tools that will come in contact with the pipe coating shall not be permitted.