



TAPI Pipeline Company Limited

**Project Management & FEED
Consultancy Services
SPECIFICATION 3 LAYER PP COAT-
ING**

21/03/2018

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1 INTRODUCTION

1.1 Project

The TAPI Project was originally conceived in the 1990s with a view to monetise Turkmenistan's vast natural gas reserves through gas exports to Afghanistan, Pakistan and India.

In 2013, the Governments of Turkmenistan, Afghanistan, Pakistan and India respectively nominated state-owned gas companies State Concern "Turkmengas", Afghan Gas Enterprise, Inter State Gas Systems (Private) Limited, and GAIL (India) Limited to promote and invest in the TAPI Project.

The TAPI Project aims to export up to 33 billion cubic meters of natural gas annually for 30 year period through a 1814 km pipeline from Turkmenistan to Afghanistan, Pakistan and India.

In November 2014, with the collaboration of the four abovementioned state-owned gas companies, TPCL was incorporated with the main objective of implementing the TAPI Project.

TPCL is a company limited by shares and incorporated in Isle of Man with a registered office at the following address: Fort Anne, Douglas, Isle of Man, IM1 5PD. The head office of TPCL is located in Dubai, United Arab Emirates.

In June 2015, State Concern "Turkmengas" was unanimously elected as a Consortium Leader for the TAPI Project.

The stone-laying ceremony for the TAPI Project was held in the Mary region of Turkmenistan, near the Galkynysh natural gas field, on 13 December 2015 and was attended by Gurbanguly Berdimuhamedov, the President of Turkmenistan, Nawaz Sharif, the Prime Minister of Pakistan, Ashraf Ghani Ahmadzai, the President of Afghanistan and Mohammad Hamid Ansari, the Vice-President of India.

The Shareholders' Agreement was signed concurrently with the TAPI Project stone-laying ceremony. In April 2016, the Shareholders of TPCL signed the Investment Agreement.

In January 2017, TPCL entered into a Project Management and FEED Development Contract in connection with the Afghanistan and Pakistan section of TAPI Project with ILF Beratende Ingenieure GmbH.

The implementation of the TAPI Project is divided into three main phases:

- a) Natural gas source development;

- b) Turkmenistan portion of the TAPI Project; and
- c) Afghanistan and Pakistan portion of the TAPI Project.

TPCL will act as the employer in relation to the construction works, as well as the owner of the Afghanistan and Pakistan portion of the TAPI Project.

The “Galkynysh” gas field, which is listed among the world’s largest natural gas fields and holds 26.2 trillion cubic meters of gas reserves, will be the source of natural gas for the TAPI Project.

Phase III of the development of the Galkynysh gas field has been initiated by State Concern “Turkmengas” so as to meet its obligations to supply natural gas to the TAPI Project.

The length of the Turkmenistan portion of the TAPI Project is 214 km. State Concern “Turkmengas” has already started the engineering and initial phase of the construction works on this portion of the TAPI Project.

The length of Afghanistan and Pakistan portion of the TAPI Project is 1600 km.

1.2 Purpose of the Document

Purpose of this document is to define minimum requirements for manufacturing, application, inspection, and testing of externally applied three layer polypropylene coating (3 LPP), which will be applied to the specific pipeline sections including any section to be used for a HDD crossings and pipeline components/fittings.

This Specification supplements the requirements for coating of pipelines in accordance with ISO 21809-1 and associated codes and standards listed in the following section.

Pipes and fittings coated for the purposes of the contract shall meet or exceed all the requirements of these codes and standards and the additional provisions of this Specification.

The properties of the externally applied coating shall be such as to guarantee a design life of minimum 40 years in onshore buried application.

This Specification is not all inclusive and the use of the guidelines set forth does not relieve the Manufacturer of his responsibility to provide a finished product capable of performing its intended service.

This specification does not include requirements for internal lining and 3 layer polyethylene (3LPE) external coating covered by relevant documents listed in Section 1.5 below.

1.3 Definitions

Company	: TAPI Pipeline Company Limited
Consultant	: ILF Beratende Ingenieure GmbH
Contractor	: Companies under contract with the Company for the performance of works/services for the Overall Project
Manufacturer	: Company or corporation responsible for making, marking and delivering the product in accordance with the requirements of the Tender Documents. Where a Manufacturer is mentioned in this document, the Contractor is responsible for the full scope of work of, and performance by, that Manufacturer.
Overall Project	: Turkmenistan – Afghanistan – Pakistan – India (TAPI) Gas Pipeline Project
Project	: Project Management and FEED Consultancy Services for the Afghanistan and Pakistan portions of the TAPI Pipeline Project
Subconsultants	: Companies under contract with the Consultant for the execution of the Project
Subcontractor	: Companies under contract with the Contractor for the execution of works/services for the Overall Project

1.4 Abbreviations

3LPE	: 3-layer Polyethylene
3LPP	: 3-layer Polypropylene
ANSI	: American National Standards Institute
API	: American Petroleum Institute
ASME	: American Society of Mechanical Engineers
ASTM	: American Society for Testing and Materials
CPQT	: Coating Procedure Qualification Testing
DFT	: Dry Film Thickness
EN	: European Standard
ESCR	: Environmental Stress Cracking Resistance

FBE	: Fusion Bonded Epoxy
HDD	: Horizontal Directional Drill
MDS	: Material Data Sheet
MFR	: Melt Flow Rate
NPS	: Nominal Pipe Size
PE	: Polyethylene
PQT	: Procedure Qualification Test
QA	: Quality Assurance
QC	: Quality Control
TBD	: To be defined
TAPI	: Turkmenistan – Afghanistan – Pakistan – India

1.5 Referenced Documents

Document Number	: Document Name
K358-ILF-OVA-PLG-GE-SPC-0001	: Specification 3 Layer Polyethylene External Coating of Line Pipe
K358-ILF-OVA-PLG-ME-SPC-0002	: Specification for Internal Lining of Line Pipe
K358-ILF-OVA-PLG-ME-SPC-0003	: Specification for Line Pipes (LLI)
K358-ILF-OVA-PLG-ME-SPC-0004	: Specification for Transportation, Handling and Storage of Line Pipe
K358-ILF-OVA-PLG-ME-DAT-0003	: Data Sheet for Line Pipes and Mother Pipe for Hot Induction Bends (LLI)
K358-ILF-OVA-PLG-QA-CON-0002	: Specification for Quality Management System

1.6 Codes and Standards

Document Number	: Document Name
API RP 5L9	: External Fusion Bonded Epoxy Coating of Line Pipe
EN 10204	: Metallic products – Types of inspection documents
EN ISO 21809-1	: Petroleum and natural gas industries - External coatings for buried or submerged pipelines used in pipeline transportation systems - Part 1: Polyolefin coatings (3-layer PE and 3-layer PP)

Document Number	Document Name
ISO 9001:2008	: Quality management systems – Requirements
ISO 14001	: Environmental Management System - Requirements
OHSAS 18001	: Occupational Health and Safety Management System – Requirements
ASTM 4940	: Standard Test Method for Conductimetric Analysis of Water Soluble Ionic Contamination of Blasting Abrasives
ASTM D 638	: Standard Test Method for Tensile Properties of Plastics
ASTM D 1505	: Standard Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D 1508	: Standard Test Method for Carbon Black, Pelleted Fines and Attrition
ASTM D 1693	: Standard Test of Environmental Stress Cracking of Ethylene Plastics
ASTM G 8	: Standard test methods for Cathodic Disbonding of pipeline coatings
ASTM G42	: Standard Test Method for Cathodic Disbonding of Pipeline Coatings Subjected to Elevated Temperatures
EN ISO 179	: Plastics - Determination of Charpy impact properties
EN ISO 306	: Plastics - Thermoplastic materials - Determination of Vicat softening temperature (VST)
EN ISO 527	: Plastics - Determination of tensile properties Part 1 - General principles Part 2 - Part 2: Test conditions for moulding and extrusion plastics Part 3: Test conditions for films and sheets
EN ISO 868	: Plastics and ebonite - Determination of indentation hardness by means of a durometer (Shore hardness)
EN ISO 1183	: Plastics - Methods for determining the density of non-cellular plastics

Document Number	Document Name
EN ISO 2808	: Paints and varnishes - Determination of film thickness
EN ISO 8501-1	: Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings
EN ISO 8502-2	: Preparation of steel substrates before application of paints and related products – Tests for the assessment of surface cleanliness – Part 2: Laboratory determination of chloride on cleaned surfaces.
EN ISO 8502-3	: Preparation of steel substrates before application of paints and related products – Tests for the assessment of surface cleanliness – Part 3: Assessment of dust on steel surfaces prepared for painting (pressure-sensitive tape method)
EN ISO 8502-4	: Preparation of steel substrates before application of paints and related products – Tests for the assessment of surface cleanliness – Part 4: Guidance on the estimation of the probability of condensation prior to paint application
EN ISO 8502-5	: Preparation of steel substrates before application of paints and related products – Tests for the assessment of surface cleanliness – Part 5: Measurement of chloride on steel surfaces prepared for painting (ion detection tube method)
EN ISO 8502-9	: Preparation of steel substrates before application of paints and related products – Tests for the assessment of surface cleanliness – Part 9: Field method for the conductometric determination of water-soluble salts
EN ISO 8503-1	: Preparation of steel substrates before application of paints and related products – Surface roughness characteristics of blast-cleaned steel substrates – Part 1: Specifications and definitions for ISO surface profile comparators for the assessment of abrasive blast-cleaned surfaces

Document Number	: Document Name
EN ISO 8503-2	: Preparation of steel substrates before application of paints and related products – Surface roughness characteristics of blast-cleaned steel substrates – Part 2: Method for the grading of surface profile of abrasive blast-cleaned steel – Comparator procedure
EN ISO 8503-4	Part 4: Method for the calibration of ISO surface profile comparators and for the determination of surface profile; stylus instrument procedure
EN ISO 11124	: Preparation of steel substrates before application of paints and related products – Specifications for metallic blast-cleaning abrasives
EN ISO 11357	: Plastics - Differential scanning calorimetry (DSC)
EN ISO 15512	: Plastics - Determination of water content

2 TECHNICAL REQUIREMENTS

The coating system shall consist of three layers:

- 1st Layer: epoxy primer coat for corrosion protection
- 2nd Layer: intermediate layer ensuring adequate adhesion between the primer coat and
- 3rd layer: polypropylene top coat, providing the necessary mechanical protection

The applied coating system shall be suitable for service at temperatures up to 90°C and for heavy duty services. The coating shall meet the requirements for Coating Class C of ISO 21809-1 and shall fulfil the supplementary and/or amended requirements as per this Specification.

The coating system intended to be used for application under the provisions of this Specification shall require a track record and performance demonstration (apart from the essential requirement to pass the CPQT) based on existing data. This information shall be submitted to the Company in advance and materials shall not be used without Company approval.

2.1 Coating Materials

2.1.1 General

The following sections provide physical and chemical properties and acceptance criteria for raw materials. Manufacturer shall provide data / certificates to show compliance to this Specification. Company reserve the right to request additional testing during the detail design phase.

Raw materials shall be handled and stored in accordance with the material Manufacturer's recommendations, which shall be available for review by Company at the Manufacturer's premises. Materials shall be stored in a temperature controlled environment until required for use.

Coating materials shall be segregated by type and batch during storage and handling. Materials from damaged containers shall be rejected unless otherwise agreed with Company.

As a minimum, all packages of raw materials shall be marked with the following data:

- a) Name of Manufacturer
- b) Complete material identification – trade name, chemical name and type of product details
- c) Batch number
- d) Date of manufacture
- e) Place of manufacture
- f) Shelf life/expiry date (if appropriate)
- g) Health and safety, and environmental instructions
- h) Hazard warnings
- i) Storage instructions
- j) Quantity
- k) Manufacturing standard

Any material not labelled with the above information shall not be used.

2.1.2 Abrasive Grit

The abrasive shall be steel grit, also in combination with steel shot of the required grade to achieve the specified surface profile. The use of sand is not permitted.

Abrasives shall be produced in conformance and shall be certified to ISO 11124 and approved working procedures. Application of other abrasive varying from EN ISO 11124 requirements in terms of particle-size distribution is acceptable provided that requirements regarding cleanness, roughness, dust and salt are fulfilled, and requirements regarding abrasive properties e.g. chemical composition, defects etc. as defined in ISO 11124 are also fulfilled.

Storage of abrasives shall be in accordance with abrasive Manufacturer's instructions. Blasting abrasives shall be kept dry, clean and free from contamination, as a minimum. When recovered metallic grit systems are used, a stabilised working mix of blast cleaning material shall be established. This mix shall be maintained throughout the entire course of the production, by frequent small additions from fresh or cleaned stock at a rate sufficient to replenish consumption. Blasting and other dust producing areas shall be kept separate from coating application areas.

2.1.3 FBE Powder

The FBE powder selected shall be suitable for use at the design temperatures in the proposed environment and be suitable for a three-layer polypropylene coating system. The FBE shall be endorsed by the Manufacturer of the adhesive and polypropylene as being compatible with these products to produce a composite coating suitable for specified service conditions.

FBE shall be in compliance with the Table 3 requirements Class C of the ISO 21809-1.

2.1.4 Adhesive

The adhesive selected shall be completely suitable for use at the design temperatures in the proposed environment and be suitable with epoxy primer and polypropylene.

Adhesive material shall be in compliance with requirements for class C from Table 4 of the ISO 21809-1.

2.1.5 Polypropylene

The polypropylene selected shall be suitable for use at the design operating conditions and temperatures in the described environment. The polypropylene shall be compatible with the epoxy primer and adhesive material.

For the pipeline sections and fitting installed aboveground PP layer has to contain UV-protection additives.

Polypropylene material shall comply to Table 5 Class C of the ISO 21809-1.

2.1.6 Batch certificate

Each batch of FBE, adhesive or PP shall be accompanied by a certificate supplied by Manufacturer of each material stating the tests have been carried out on every batch and results are in accordance with the coating material Manufacturer's product Specifications. Material data sheet (MDS) and certification documents shall be provided by the Manufacturer to Company for review. MDS shall include indication of minimum shelf life. The batch certificate shall contain information as given in 8.3.1 (Table 6) of ISO 21809-1.

2.2 Acceptance of Pipe Materials

2.2.1 Handling and Stocking

See document no. "K358-ILF-OVA-PLG-ME-SPC-0004 Transportation, Handling and Storage of Line Pipe".

Proper equipment for the handling, unloading, and temporary storage of bare pipes/fittings shall be used to avoid any damage to bare pipe/fittings and pipe ends, or obliteration of necessary pipe markings.

Bevel protectors should be reinstated if removed for any reason. If bevel protectors are to be removed during blasting process alternate arrangement like end plugs/metal protectors should be installed to prevent entry of abrasive into pipe and to protect the pipe ends during grid blasting.

Internal lining of the pipes/fittings shall be applied after the application of 3LPP coating system.

2.2.2 Identification and Tracking

Upon receipt at the Manufacturer's (applicator of the coating) receiving point, the Manufacturer shall record the following pipe information:

- The unique pipe identification number, purchase order number, measured length, measured weight and wall thickness (to be found stencilled in paint on one end of the pipe).

This data shall be used as a basis for monitoring pipe from the time of receipt until the delivery of coated pipe to Company.

The Manufacturer shall identify (or maintain identification of) every coated item, by using a weatherproof mark on the inside of the pipe and on the outside of the coated item. The pipe identification shall be the unique pipe identification number (the number required by the applicable pipe Specification). The Manufacturer may use additional tracking numbers at his discretion but these shall relate simply to the unique pipe number in the QC documentation.

Pipe tracking shall be carried out in accordance with approved procedures.

2.2.3 Preliminary Inspection

Prior to commencing any work, Manufacturer shall carry out visual inspection of all pipes/fittings.

The Manufacturer shall record all external damage on pipes/fittings against the unique item serial number. This damage shall be brought to the attention of Company and the pipe shall not be coated without prior release by Company.

Bevel protectors at each end of every pipe joint shall not be removed unless showing signs of damage or if removal is required to facilitate surface preparation, or they would be damaged by coating operations. If the protectors are removed the condition of the bevel shall be recorded against the pipe serial number and any damage shall be brought to the attention of Company.

2.2.4 Damage to Pipes, Fittings and Pipe Ends and Repair

No repair work shall proceed until a written procedure has been prepared by the Manufacturer and approved by Company.

Minor damage to pipe/fittings and pipe ends/bevels, identified either at time of receipt or after abrasive blasting shall be repaired by grinding. The number of such damages shall be not more than 3 per pipe/fitting. Repair by grinding on the pipe or pipe ends/bevels outside diameter shall not reduce the wall thickness to less than the minimum requirements of the line pipe Specification, when measured using ultrasonic thickness measurement equipment.

All other damage to pipe ends/bevels shall be advised to Company for review. Subject to Company approval, these defects may be repaired by removal of damaged pipe material and re-bevelling. No welding on the pipe surface shall be allowed.

Pipe identification numbers shall be preserved during repair. Any reduction in pipe lengths shall be recorded in the relevant forms and files.

2.3 Surface Preparation

2.3.1 General

The principle stages of pipe coating shall be as follows:

- Inspection of pipe surface for corrosion
- Rounding of edges and removal/equalisation of irregularities
- Solvent cleaning followed by steam or hot bath cleaning (if required)

- Abrasive blasting of external surface
- Application of fusion bond epoxy (FBE) layer
- Application of adhesive layer
- Application of polypropylene layer

2.3.2 Inspection of pipe surface for corrosion

Pipes/fittings should be inspected before preparation for corrosion in accordance with the ISO 8501 Part1. Pipes in condition A&B only should be acceptable for coating.

2.3.3 Rounding of Edges and Irregularities

All sharp edges shall have been rounded at a radius of no less than 2 mm before any surface preparation may commence.

All welding slag, spatter, burrs, laminates, sharp welds and the like shall be removed or rounded.

The received pipes due for coating shall be inspected by Manufacturer to make sure that mentioned treatments are performed to a satisfactory level.

2.3.4 Cleaning Prior to Abrasive Blasting

All surface contaminants such as oil, grease, tar, salt, or other contaminants on the pipe/fitting shall be removed by solvent cleaning followed by steam or hot bath cleaning, in accordance a Company approved procedure.

The inspection of surface preparation before blasting shall comply with ISO 21809-1, Table 8.

Following the steam or hot bath cleaning the pipe/fitting shall be tested for salt and chloride contamination in accordance with the requirements of ISO 8502-2, ISO 8502-5 or DIN EN ISO 8502-9. Salt contamination testing after blasting only could be acceptable however if test results are not qualified the respective pipe will be rejected to proceed. Salt contamination testing by SCM400 device as per SSPC Guide 15 is acceptable.

The removal of hydrocarbon contamination shall be confirmed by a water spray test, where a fine spray is applied to the surface and uniform wetting confirms the removal. This check shall be performed before and after blasting, as a pre-qualification test and as a minimum, once per 100 items during production.

Items found to be contaminated shall be cleaned as above and re-blasted if testing after blasting establishes that salt, chloride or hydrocarbon contamination is still present. The remainder of the batch concerned shall all be checked individually.

All water used for rinsing or cleaning purposes shall be potable with less than 200 ppm total dissolved solids and 50 ppm chlorides.

2.3.5 Abrasive Blasting

Blasting and other dust producing areas shall be separate from coating application areas.

After cleaning and prior to abrasive blasting the pipe/fitting lengths shall be uniformly heated to at least 50°C or to at least 3°C above the dew point, whichever is the higher to remove all moisture, and preclude any condensation of moisture on the pipe after blast cleaning.

Abrasive and dust, which entered the inside of the pipe/fitting during blasting operation, shall be removed by suitable means.

Weld joints, sharp-edge projections, weld spatter and slag etc. shall be dressed prior to blast cleaning.

Using dry blasting techniques only, the exterior surface of the pipe joints shall be abrasively cleaned to remove all mill scale, and other impurities from the surface.

No blast cleaning shall take place when the prevailing relative humidity is higher than 80 percent unless pipe/fitting is preheated to at least 3°C above the dew point.

Twice per shift, or after blasting of 50 pipes, samples of the abrasive mixture shall be removed from the hopper and checked for hydrocarbon contamination. The sample shall be placed in a beaker to which deionised water is added. The beaker shall then be sealed and shaken vigorously. Once the grit has settled the surface of the water shall be examined for signs of hydrocarbon contamination. If any signs are found all the abrasive in the hopper shall be rejected and not re-used.

Additionally, abrasive materials shall be checked at least once per shift to ensure that only uncontaminated angular grit with an acceptable size distribution is used. As a minimum the following shall be carried out:

- Correct abrasive size distribution shall be carried out by sieve analysis in accordance with ISO 11124-3 / ISO 11125
- Placing a sample of abrasive on a clean, dry sheet of absorbent paper to determine water contamination

The surfaces of the pipes/fittings shall be blasted until a finish of Grade 2.5 to ISO 8501-1 is attained. The surface profile shall be between 60 and 90 microns or as per manufacturer's recommendation, measured in accordance with ISO 8503-4. Profile measurements shall be made with a Keane Tator Profile Comparator, Testex Press-O-Film or other Company Approved method suitable for the abrasive being used.

Following abrasive blasting, the surface shall not be contaminated with dirt, dust, metal particles, hydrocarbons, water, chlorides, sulphates or any other foreign matter, which would be detrimental to the coating. The maximum allowed dust level as per ISO 8502-3 shall be Class 2, whilst the maximum allowed salt and chloride contamination shall not exceed 20 ppm as per ISO 8502-5, -6 and/or -9. Salt contamination testing by SCM400 device as per SSPC Guide 15 is acceptable and acceptance value shall be maximum 2 µg/cm².

Prior to the coating application, the exterior surface shall be thoroughly inspected under adequate lighting. Any damage such as surface imperfections, slivers, scabs, burrs, gouges, or sharp edged defects, shall be repaired in accordance with this Specification. Pipes/fittings that have damage repaired by grinding and have ground areas greater than 50 mm diameter shall be re-blasted to meet the requirements of the clauses above. After grinding or mechanical repairs the wall thickness shall be ultrasonically examined and compared with the minimum requirements of the applicable code / standard. Pipes/fittings that cannot be repaired and fail to meet the specified requirements shall be clearly marked (HOLD or Reject), removed from the process and placed on a reject rack for adjudication by the Company as to its disposition.

After the abrasive blast rinsing of pipe/fittings by chromate or phosphoric or combination of both acids shall be performed.

The presence of identification markings shall also be checked after grit-blasting.

Any dust or loose residue that has accumulated during blasting and/or grinding operations shall be removed by the use of clean compressed air or by vacuum extraction. Alternative methods for removing dust and lint shall require approval of Company.

The total elapsed time between the start of blasting and the heating of pipes shall be indicated in the application procedure submitted by the Manufacturer and shall be reflected on his plant scheme.

The total elapsed time between the start of blasting of any pipe/fitting and the heating of that pipe/fitting to the specified temperature shall not exceed the following time-humidity table:

PERCENT RELATIVE HUMIDITY	ELAPSED TIME (HOURS)
85	0.5
80	1.0
70	1.5
60	1.75
50	2.0

Any pipe/fitting surface not processed within the above time-humidity table shall be completely re-cleaned and re-blasted before coating.

The maximum time limit between blasting and coating for humidity below 50% shall be 4 hrs.

2.4 Coating Application

2.4.1 General

The application of the coating shall be in accordance with the material Manufacturer recommendations and the procedure outlined below.

The Manufacturer shall perform coating procedure qualification testing (CPQT) prior to commencing production or on his own risk at the start of production in accordance with this Specification.

Prior to start-up of the coating process the powder application and recovery systems shall be thoroughly cleaned to remove any powder other than that in use, minimum once per day and the collected powder shall be disposed of.

2.4.2 Heating

Blast cleaned and accepted pipe/fitting shall be heated for pre-determined time based upon the diameter and wall thickness of components and coating temperature specified in Manufactures specification. This temperature shall have been confirmed during CPQT.

Pipe/fitting temperature shall be checked periodically using a recording pyrometer. The pyrometer shall be checked for error not less than every four hours against a calibrated temperature-measuring instrument.

Under no circumstances shall the component be heated to a temperature in excess of 260°C, in the unlikely event that this occurs the affected pipe shall be rejected and set aside, and the Client's representative informed.

2.4.3 FBE Layer

The FBE shall be applied to a minimum thickness of 200 microns and a maximum of 400 microns.

The coating shall be applied by electrostatic spray with the pipe/fitting at earth potential and the epoxy powder charged to high potential.

The use of reclaimed FBE powder is only permitted if the reclaimed powder is screened to remove foreign or deleterious material before being reintroduced into the powder application system.

The clean reclaimed powder up to a maximum of 15% shall be introduced back into the fresh virgin material by means of proportional weight.

During application, the bevelled ends and pipe/fitting bore shall be protected against mechanical damage and from contamination with coating material.

2.4.4 Adhesive Layer

The adhesive shall be applied to a thickness of 200 to 400 microns.

The adhesive layer shall be applied before gel time of the FBE has expired. Application of the adhesive shall not be permitted after the FBE has fully cured. The Manufacturer shall establish to the satisfaction of Company that the adhesive is applied within the gel time window of the FBE and at the temperature recommended by the adhesive Manufacturer. The Manufacturer shall state the proposed minimum and maximum time interval between FBE and adhesive applications at the proposed pre-heat temperature.

2.4.5 Polypropylene Layer

The polypropylene layer shall be applied by extrusion to a minimum thickness of 4.0 mm over the pipe body and to a minimum of 3.6 mm over the weld seam.

This minimum required thickness is applicable for the complete coating system, thus FBE + Adhesive + PP.

The polypropylene shall be applied over the adhesive within the time limits established during pre-production testing.

The coating shall be cooled (water quenching) to below 60°C before handling.

Immediately after the coating is fully cured, pipe identification marks shall be re-applied to the coated pipe using a method approved by Company.

2.4.6 Cutback and Bevelling

After application of the 3LPP, the ends of the pipes shall be cut back over a length of 150 mm \pm 10 mm, providing that a minimum of 50 mm of protruding FBE coating shall be visible beyond the end of the PP coat. The cut back length shall be measured from the root face of the pipe to the beginning of the coating bevel.

The PP (+ adhesive) shall be bevelled to an angle $\leq 30^\circ$ measured in direction to the pipe axis.

3 INSPECTION, TESTING AND CERTIFICATION

3.1 General

In order to demonstrate that the Manufacturer's proposed coating application procedure is capable of meeting the Specification, the Manufacturer shall undertake coating procedure qualification testing (CPQT) prior to commencing production, or at his own risk at the start of production.

The Manufacturer shall also be required to test the finished coating during production to demonstrate continued compliance with this Specification. Details of all inspections and testing shall be fully documented in accordance with this section and test results submitted for Company's approval.

All stages of the surface preparation, coating and testing shall be subject to 100% inspection by the Manufacturer. Company shall be informed at least two weeks prior to the start of surface preparation to allow scheduling of inspection supervision work.

3.2 Coating Procedure Qualification Testing (CPQT)

Prior to commencing or at the start of full production 3 pipes - coated with the full 3LPP coating - shall be selected for CPQT. All coating shall be in accordance with the coating procedure Specifications and shall be witnessed by Company.

The produced pipes will not be released until the successful results of the CPQT can be provided. In case of long-term tests the CPQT report shall be updated once the results can be provided. Any failure in meeting the specified acceptance criteria for the CPQT will result in rejection of the coated pipes. Company shall approve any remedial action, repairs or re-use.

The test methods for all tests required for CPQT on the complete coating system shall be performed in the same manner as the production tests described in this Specification.

Pipes selected for CPQT testing shall pass all the criteria contained in 3.2.1 before full production commences.

Any change in the coating material or coating procedure shall require re-qualification.

If any of the tests fail to meet the minimum acceptance criteria defined in this Specification, then the pre-qualification pipes shall be rejected. Further pipes may be prepared and coated using revised procedures and further tests performed. Once acceptable results are obtained and Approved by Company, the Manufacturer's quality plan and procedures shall be revised, and submitted to Company for Approval. All items coated using the rejected procedures shall be stripped and recoated to the revised procedures.

3.2.1 CPQT Inspection and Test Summary

Inspection and testing summary for procedure qualification test (PQT) and testing of finished coating during production for three layer coating system is shown in Table 1. The testing parameters and acceptance criteria of this Specification shall prevail over those possibly given in the referenced test procedures and Standards.

The applicable procedures for the execution of tests are just referenced, for details refer to the respective Standards.

No.	Property	Acceptable Values	Frequency of Tests	
			CPQT	Production
	Receipt			
1	Notification	5 days before production	Each Starting	Each starting
2	Inspection of raw material	As per Manufacturing Specification	Review of material certificate for each material batch	Each batch
3	Pipe damage	Definition and disposal as per pipe manufacturing Specification	Each pipe/fitting	Each pipe/fitting
4	Pipe condition	Condition A&B of ISO 8501-1	Each pipe/fitting	Each pipe/fitting
	Blast Cleaning			
5	Environmental conditions	Recording of air temperature, calculation of dew point. Rel. humidity $\leq 80\%$	At start up and 1x/shift	At start up every 4 hours
6	Pipe temperature before blasting	3°C > dew point or > 50°C, whichever is higher.	Each pipe/fitting	Each pipe/fitting
7	Size, Shape and Properties of abrasive	Compliance with ISO 11124 and with approved working procedures	Once prior to start of operation	1x/shift
8	Water soluble contamination of abrasives	Conductivity max. 60 mS/cm Procedure as per ASTM 4940	Once prior to start of operation	1x/shift
	After Cleaning/ Blasting			
9	Salt and Chloride	<2µg/cm² (<20ppm) Procedure as per ISO 8502-5, -6 and/or -9	Each pipe/fitting	5 pipes at start of production and 1pipe/shift
10	Oil & Dust	No oil contamination, Dust level: max Class 2 of ISO 8502-3	Each pipe/fitting	1x/hour
11	Cleanliness	Sa 2.5 acc. to ISO 8501-1	Each pipe/fitting	Each pipe/fitting
12	Surface Roughness	60µm -90µm. Procedure as per ISO 8503-4	Each pipe/fitting	1x/hour

	Conditions prior/ during coating application			
13	Environmental conditions	Recording of air temperature, calculation of dew point. Rel. humidity \leq 80%	At start up and every 4 hours	At start up and every 4 hours
14	Test of reclaimed FBE powder	Max. 15%, screened. Properties and test according to Specification requirements	At start up	At start up
15	Pipe condition	No rust, pipe temperature at least $3^{\circ}\text{C} >$ dew point	Each pipe/fitting	Each pipe/fitting
16	Preheating temperature prior to coating	In compliance with Contractor recommendations	Each pipe/fitting	Each pipe/fitting
17	FBE thickness	200 – 400 μm DFT	At start up	At start up and 1x/shift
18	Intercoat time	In compliance with Contractor recommendations		
19	Adhesive layer	200 to 400 μm DFT	At start up	1x/hour and 1x/shift
20	Temperature of extruded adhesive and PP	In compliance with Contractor recommendations	Each pipe/fitting	1x/hour
21	Degree of cure	$\Delta T_g \leq +3^{\circ}\text{C}$ for FBE. Procedure as per ISO 11357-2	One sample	At start up and 1x/shift
22	Total thickness FBE + Adhesive + PP	Pipe body 4 mm Weld seam 3.6 mm ISO 21809-1 Annex A	Each pipe/fitting	1x/hour
23	Continuity or holidays (complete coating system)	No discontinuities or holidays, test voltage 10 kV/mm (min 25 kV) Procedure as per ISO21809-Annex B In case of defect, the component shall be repaired	Each pipe/fitting	Each pipe/fitting
24	Repairs	Maximum one defect per 1 m^2 - Maximum area per defect 10 cm^2	If necessary	Each pipe/fitting
25	Visual Inspection	The coating shall be of a uniform colour and aspect and free of any surface defect detrimental to its quality. It shall not show any crack, blister, lamination, wrinkle or disbonding..	Each pipe/fitting	Each pipe/fitting

	Conditions prior/ during coating application			
26	Cutback and beveling	150mm (±10mm) with 50 mm protruding FBE. Bevel ≤ 30°	Each pipe/fitting	Each pipe/fitting
27	Bond strength (peel test)	>25 N/mm at 23°C ±3°C, No peeling of FBE layer >4 N/mm at 90°C ±3°C, , No peeling of FBE layer Procedure as per ISO 21809-1 Annex A	Each pipe/fitting	Every 4 h, both ends
28	Impact Resistance	>10 J/mm The impact energy shall not cause any perforation Procedure as per ISO 21809-1 Annex G	Each pipe/fitting	1x/batch
29	Elongation at break (at 23±2 °C)	At least 400% at failure. Procedure as per ISO 527	Each pipe/fitting	1x/batch
30	UV resistance and thermal ageing	Δ MFR≤35% ISO21809-1 Annex G	acc. to MTC	acc. to MTC
31	Oxidation induction time (intercept in the tangent method)	≥ 30 min. at 220°C ISO 11357	acc. to MTC	acc. to MTC
32	Vicat softening temperature A/50 (9.8 N)	≥ 130°C ISO 306	acc. to MTC	acc. to MTC
33	Notched impact strength at min. temperature	≥ 3 kJ/m2 ISO 179-1	acc. to MTC	acc. to MTC
34	Tensile yield strength at 23 • } 2°C	≥ 20 MPa ISO 527	one sample	1x/batch
35	Hardness	≥ 60 Shore D ISO 868	acc. to MTC	acc. to MTC

	Cathodic Disbondment			
36	24 hrs, - 3.5 Volt at 65°C ± 2°C	Max. diameter of disbonded area ≤ 7mm (Initial Diameter of artificial hole 6 mm)as per ISO/DIS 21809-1	one sample	1x/shift
37	28 days, -1.5 Volt at 70°C ± 2°C	Max. diameter of disbonded area ≤ 15mm (Initial Diameter 6mm) as per ISO/DIS 21809-1	one sample	N/A
38	Water absorption test	After 24 hours in water at 23°C, a maximum weight increase of 1.2 % is acceptable. Procedure as per ASTM D570	acc. to MTC	acc. to MTC

28	Coating Repair	No holiday after repair, uniform colour, free of defects and discontinuities, delaminations.	Once for demonstration purpose	After each repair
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Table 1: Overview Inspection and Testing

3.2.2 Coating Repairs

Localised defects in the finished coating, both superficial and through-thickness, caused by the application process, transportation, handling or storage in the coating plant or in the storage area, as well as those which have been subjected to destructive testing shall be repaired

Manufacturer shall submit detailed coating repair procedures as part of CPQT for approval by Company or its nominated representative, in order to demonstrate successful repair and defect removal by the proposed/ chosen methods. These shall include procedures for repair of 'pin-hole', 'small area' and 'large area' defects based on guidance provided in para 12 of ISO 21809 and para 7 of API RP 5L9. The minimum and maximum areas for which each type of repair is applicable shall be stated taking into consideration the below mentioned requirements:

1. The maximum defected area to be repaired shall be 10 cm².
2. The total amount of defects to be repaired shall not exceed one defect per square meter of the coated surface.

If the above requirements (1 & 2) are not met, the coating shall be rejected.

In addition, Manufacturer shall provide a procedure with recommendations and methods for performing field repairs to damaged coatings during transport, handling, stringing, etc., at Facility Sites and during pipeline construction.

Repair procedures/methods shall consider, as a minimum, different types of damage as follows:

- Superficial damage within the PP layer (surface damage, not exposing adhesive/FBE);
- Through-thickness damage in PP layer exposing the bare steel surface;

4 PRESERVATION, MARKING AND SHIPPING

4.1 Preservation

The bare ends of each pipe/fitting shall be painted outside with a removable varnish as temporary corrosion protection during transportation.

Bevel protectors of a type to be approved by the Company shall protect the bare ends of each pipe.

4.2 Marking

In addition to the marking required by API 5L, the line pipe Specification and other Specifications or as specified in the purchase order the Coating Manufacturers unique coating number shall be marked to the internal surface of the pipe with synthetic resin paint.

Further marking details like colour coding etc. shall be specified in the purchase order.

The marking shall have at least a distance of 150 mm to the pipe end.

4.3 Shipping

Shipping and Loading preparation shall be in accordance with API Specification 5L and doc. K358-ILF-OVA-PLG-ME-SPC-0004 Transportation, Handling and Storage of Line Pipe.

The Manufacturer shall submit detailed loading-, stacking- and shipping procedures for approval by Company.

5 DOCUMENTATION

5.1 At the Bid Stage

The Manufacturer shall submit the following documentation to Company for review at the bid stage:

- a) Incoming Inspection of pipes and pipe tracking;
- b) Details of the coating materials including data from the raw material Manufacturers detailing test results which demonstrate that the proposed system conforms to the requirements of this Specification.
- c) Full details of the Manufacturer's product Specification shall be provided for FBE, adhesive and polypropylene materials, together with details of material properties as required by this Specification.
- d) A plant layout identifying the major equipment, the material flow and the details of coating methods including surface preparation, application temperature, and required working conditions (humidity, dust and temperature etc.).
- e) Full details and results of tests on similar coatings, or trials performed by the Manufacturer, which document the quality of the finished coating.

- f) An outline quality control plan detailing the inspection and testing that will be carried out to ensure the final product meets or exceeds the requirements of this Specification.
- g) Details of any proposed sub-contractor.
- h) A copy of the QA accreditation certificate.
- i) Draft repair procedure

Following review by Company the Manufacturer shall incorporate any agreed comments into the pre-production documentation.

5.2 Pre-Production Documentation

The Manufacturer shall submit the following documentation to Company for Approval prior to commencing production:

- a) The Manufacturer's trade name and data sheets for all proposed coating materials. This includes cleaning and abrasive blasting consumables.
- b) Procedure for identifying, or maintaining the identification of each coated item.
- c) Handling procedure.
- d) Stacking procedure.
- e) Materials control and traceability procedure for the batches of coating materials.
- f) Materials storage procedure (pipe and coating materials).
- g) Procedure for steel surface preparation including materials, cleaning, inspection, verification of cleanliness and surface profile.
- h) Coating application procedures, including fusion bonded epoxy (FBE), adhesive and polypropylene layers.
- i) The results of the batch tests for batches to be used for pre-qualification tests.
- j) Details of testing methods including instrument types and copies of current calibration certificates.
- k) Details of inspection methods for bare and coated pipe.
- l) Full test results from the coating Procedure Qualification Test (PQT).
- m) Repair procedure and results of tests on demonstration of repairs.
- n) Project specific Quality Plan.

Work shall not commence until these procedures have been reviewed and approved by Company.

The selection of proposed coating materials shall be subject to Company approval.

5.3 Production Records

A daily log containing the following data shall be maintained and be available for inspection by Company during and/or after production. Data shall be recorded against the pipe unique identification number.

- a) Bare pipe inspection data
- b) Ambient temperature (every 4 hours)
- c) Humidity (every 4 hours)
- d) Coating progress (no. of items coated, including item serial numbers)
- e) Blast pipe surface amplitude
- f) Tests for cleanliness of blast surface
- g) Tests for cleanliness of blast medium
- h) Film thickness measurements
- i) Average, maximum and minimum coating thickness during each shift
- j) Details of any coating defects recorded and defect density on respective pipe lengths
- k) Details of any coating repairs
- l) The unique identification number of all items that are stripped for re-coating
- m) Pipe coating test results
- n) Non-conformance and rejection reports

The log shall be available to Company throughout all coating operations.

5.4 Release Documentation

The Manufacturer shall submit to Company the following documentation in hard copy and softcopy (format to be specified in the purchase order) with each batch of pipes released:

- a) Production listing for each batch
- b) Unique pipe identification numbers
- c) Unique coating identification number (if different)
- d) Pipe length
- e) Reductions in lengths due to use in tests, damage or repairs, recorded against pipe unique identification number
- f) Date of coating

- g) Batch numbers of coating materials used

This shall be followed within two weeks by the following:

- a) Manufacturer's certificates for each batch of coating materials
- b) Certification/calibration certificates for all testing and coating equipment
- c) Inspection and test records, results, and other documentation of all materials and coating tests

All reports shall be signed by the Manufacturer to signify compliance with the requirements of this Specification.