REQUEST FOR EXPRESSION OF INTEREST FOR THE PROVISION OF FIELD JOINT COATING-HDPE JACKETS FOR PIPELINE

REFERENCE NO.: CPP-PROC-TZ-006-0206-24

China Petroleum Pipeline Engineering Co., Ltd. (hereinafter abbreviated as CPP) as Pipeline, Feederline & Above Ground Installation Contractor for the East African Crude Oil Pipeline (EACOP) Project invites experienced and reputable Contractors to express their interest in supplying kinds of equipment/materials for EACOP Project.

The EACOP Project involves the development, construction, operation and maintenance of a crude oil export pipeline that originates in Kabaale, Uganda and delivers oil for marine export on the East African coast in the Tanga area in Tanzania.

BRIEF DESCRIPTION OF THE SCOPE:

- **Supply of FIELD JOINT COATING-HDPE JACKETS FOR PIPLINE.**

MINIMUM REQUIREMENTS:

Companies expressing their interest are invited to document their request with:

1. **Proof of License/Registration Information and Profile of Supplier, including license and TIN certificate.**
2. **Proof of registration/application to Local Supplier Service Provider (LSSP) database at the time of submission of the response to this expression of interest is strongly recommended.**
3. **Fully filled Questionnaire, Key personnel list with CV(Appendix1)and Equipment list of production and inspection(Appendix2) in requested format. (Blank regards as unqualified item.)**
4. **Similar supplying experience within last three years(Appendix3) in requested format.**
5. **Compliance with Petroleum (Local Content) Regulations, 2017 and Local company definition for Tanzania.**
6. **Copy of certificates of ISO 9001, ISO 45001, ISO 14001 or equivalent of them.**
7. **Tax Clearance Certificate for the last three years and Audit report for the last three years.**
8. **The supplier must be manufacturer, Manufacturer's Commitment Letter shall be provided.**
9. **Technical requirements shall meet NO.24-FIELD JOINT COATING-HDPE JACKETS FOR PIPLINE.**

Interested companies which meet the minimum requirements and have the capacity to provide the WORK (GOODS/SERVICES) listed above should express their interest by sending together with the above listed documents an email to **supplierdata1@cpptz.com (Max. Email Size: 20 MBs, Wetransfer link is available for huge size documents.** & **All documents** must be submitted in the **English language**) on or before **24:00 hours East African Time (EAT),** on **DATE(6/2/2023). Subject of the email should be *"EOI for CPP-PROC-TZ-006-0206-24-COMPANY NAME"*. CPP reserves the right not to consider companies that submit an incorrect email subject and the incorrect format of Questionnaire, Appendix 1, 2 and 3.**

The **format** of the required documents and **relevant technical requirements (NO.24-FIELD JOINT COATING-HDPE JACKETS FOR PIPLINE)** which are mentioned in Minimum Requirements should be **downloaded from EACOP's website(https://eacop.com/opportunities-by-main-construction-contractors/china-petroleum-pipeline-engineering-co-ltd/)**. Companies satisfactorily meeting the above minimum requirements will receive, subject to the signature of a Non-Disclosure Agreement (NDA), a detailed pre-qualification questionnaire for further evaluation by Company.

CPP reserves the right not to consider companies that submit an incomplete dossier.

Note 1: Only pre-qualified companies will receive an invitation to submit their bid in furtherance of the Call for Tender process.

Questionnaire for the Pre-qualification of Procurement-AGI PPL

NOTE: Please provide documents named by serial number according to each item.
CPP reserves the right not to consider companies that submit Questionnaire filled by hand.

Item No.	Category / Question	
0	*NC/LC REQUIREMENTS	
0.1	General Requirements	
0.1.1	Is the Applicant fully aware of the local climatic and working conditions of country and the local applicable laws to carry out the project?（Yes or No）	
0.1.2	Applicant to confirm that the full Scope of the Project can be performed.（Yes or No）	
0.2	National Content Requirements for Uganda (Applicable for Uganda)	
0.2.1	Proof of business registration and business license for Uganda.	
0.2.2	Proof of registration with the PAU National Supplier Database (NSD) for Uganda.	
0.2.3	Compliance with the Petroleum Midstream National Content Regulation # 34,2016 for Uganda.	
0.3	Local Content Requirements for Tanzania (Applicable for Tanzania)	
0.3.1	Proof of business registration and business license for Tanzania.	
0.3.2	Proof of registration/application to EWURA Local Supplier Service Provider (LSSP) database.	
0.3.3	Compliance with Petroleum (Local Content) Regulations, 2017 and Local content requirements for Tanzania.	
1	GENERAL INFORMATION	
1.1	Company Data	
1.1.1	Name of Applicant	
1.1.2	Introduction of Applicant (establishing time,Copies of government issued IDs for all shareholders,main business scope,etc.)	
1.1.3	Applicant address	
1.1.4	Applicant phone number	
1.1.5	Applicant email address	
1.1.6	Applicant Website	

Questionnaire for the Pre-qualification of Procurement-AGI PPL

NOTE: Please provide documents named by serial number according to each item.
CPP reserves the right not to consider companies that submit Questionnaire filled by hand.

Item No.	Category / Question	
1.1.7	*Manufacturer's Commitment Letter The supplier must be manufacturer.	
1.2	Authorized contact person and contact details	
1.2.1	Name of authorized contact person	
1.2.2	Contact person's business address - phone number	
1.2.3	Contact person's business address - mobile phone number	
1.2.4	Contact person's business address - email address	
1.3	Organization Chart	
1.3.1	Applicant is requested to attach its organization chart.	
1.4	Language	
1.4.1	English shall be used as the Project language for all documents and correspondence - applicant to confirm	
2	**FINANCIAL ASPECTS**	
2.1	Bank information	
2.1.1	Name of Applicant's principal bank	
2.1.2	Address of Applicant's principal bank - street and number	
2.1.3	Address of Applicant's principal bank - post code and city	
2.1.4	Address of Applicant's principal bank - country (and state)	
2.2	*Registration with the Tax Revenue Authority	
2.2.1	Registration with the Uganda Tax Revenue Authority, including TIN Certificate.(Applicable for Uganda)	
2.2.2	Registration with the Tanzania Tax Revenue Authority, including TIN Certificate.(Applicable for Tanzania)	
2.3	*Proof of Tax Clearance Certificate	
2.3.1	Proof of Uganda Tax Clearance Certificate for the latest 3 years available.(Applicable for Uganda)	

Questionnaire for the Pre-qualification of Procurement-AGI PPL

NOTE: Please provide documents named by serial number according to each item.
CPP reserves the right not to consider companies that submit Questionnaire filled by hand.

Item No.	Category / Question	
2.3.2	Proof of Tanzania Tax Clearance Certificate for the latest 3 years available. (Applicable for Tanzania)	
2.4	Audited financial statements	
2.4.1	Applicant 's financial performance documents, Audited Balance sheets and Profit and Loss statements, Auditors Report and Notes to Accounts etc. for last 3 (three) years. Latest financial statement should not be older than 18 months on the date of submission of response to this Expression of Interest.	
2.5	Line of credit	
2.5.1	The line of credit shall not be less than USD 5 million, and the bid bond and performance bond shall only be issued by internationally renowned banks. （Yes or No）	
3	**LITIGATION HISTORY, RISK ASSESSMENT AND ELIGIBILITY**	
3.1	Litigation or arbitration history	
3.1.1	Provide information on any history of litigation or arbitration resulting from orders executed in the last (5) years or currently under execution, especially with CPP.（Yes or No）	
3.2	Eligibility	
3.2.1	Does Applicant appear on World Bank's common List of Ineligible Entities available under the following link http://www.worldbank.org/debarr or is Applicant subject to any sanction from World Bank and from UN? This must be similarly affirmed if the Applicant is an Affiliate or otherwise directly or indirectly controlled by such an ineligible entity.（Yes or No）	
4	**QA/QC, HSE, CERTIFICATES, KEY PERSONNEL**	
4.1	Please provide Applicant's ISO 9001:2015 Certificate.	
4.2	Please provide Applicant's ISO 45001:2018 Certificate (or equivalent).	
4.3	Please provide Applicant's ISO 14001:2015 Certificate (or equivalent).	
4.4	Please provide QA/QC manuals.	

Questionnaire for the Pre-qualification of Procurement-AGI PPL

NOTE: Please provide documents named by serial number according to each item.
CPP reserves the right not to consider companies that submit Questionnaire filled by hand.

Item No.	Category / Question	
4.5	Any other technical Certificates (API, etc.).	
4.6	Please provide key personnel list, Format refer to Appendix 1.	
4.6.1	Please provide QA Manager's CV	
4.6.2	Please provide QC Inspector's CV	
4.6.3	Please provide Production Manager's CV	
5	**FABRICATION AND DESIGN**	
5.1	Range of products for oil and gas industry the applicant produces.（Yes or No）	
5.2	Please give details of your manufacturing and design/engineering facilities (size, area, number, etc.).	
5.3	Do you have in house design facilities?（Yes or No）	
5.4	Please provide details of the assembly yard/facilities you would use for the various parts of the project.	
5.5	Please provide the equipment list of production and inspection, Format refer to Appendix 2.	
5.6	*Technical requirements shall meet our relevant technical requirements documents attached. (Yes or No)	
6	**PROJECT SPECIFIC OUTPUT, CAPACITY, ABILITY**	
6.1	Please specify estimated average capacity per month for manufacturing and delivery of the product.	
6.2	What is the available capacity (i.e. not yet booked) of the Applicant for the product in Year 2023?	
6.3	According to your present workload what is the approximate time period (in weeks) for the first dispatch after purchase order award (on EXW basis)?	
7	**EXPERIENCE RECORD AND REFERENCES**	
7.1	Please provide similar experience within last three years, Format refer to Appendix 3.	
7.2	Please provide scanned CONTRACT for completed project or LETTER of AWARD for ongoing projects, completion certificate (if any), appreciation letters (if any) etc.	
7.3	Please confirm whether there have been any product quality incidents in the past 5 years. （Yes or No）	
8	**RAW MATERIALS**	

Questionnaire for the Pre-qualification of Procurement-AGI PPL

NOTE: Please provide documents named by serial number according to each item.
CPP reserves the right not to consider companies that submit Questionnaire filled by hand.

Item No.	Category / Question	
8.1	Please list the Sub-suppliers of raw materials (Company Name, Country).	
9	**SPARE PARTS AND MAINTENANCE**	
9.1	Supply list of recommend spare part for the product. （If applicable）	
10	**DIVERSE DATA**	
10.1	Please confirm that you will provide on-site Services such as provision of re-assembly, supervision of site acceptance, assistance during quality warranty period. （If applicable, Yes or No）	

APPENDIX 1 List of the Key Personnel

No.	Title	Name	Years of Experience	Qualification Certificates		Location	Notes
				Name of the Certificate	Certificate No.		

Notes: pls attach the CV & scanned copies of certificates etc.

APPENDIX 2 List of Main Equipment

No.	Name of Main Equipment	Brand & Model	Qty.	Status of Equipment	Self-owned (Y/N)	Location of Equipment	Date of Production	Notes

Notes: This format includes equipment of production and inspection, pls attach photos and self-owned certificate etc.

APPENDIX 3 List of Similar Supplying Experience in Oil and Gas Field

Client	Contact Information of Client (Email/Phone number)	Location	Years	Name of the Project	Scope of Supply	Status of the Project (Completed / Ongoing)	Bidder's Contract Value	Notes

Notes:

1.Please attach following documents: scanned CONTRACT for completed project or LETTER of AWARD for ongoing projects, completion certificate (if any), appreciation letters (if any) etc.
2.The information of the PROJECT mentioned above may be confirmed by CPP with the assistance of EACOP COMPANY.

EAST AFRICAN CRUDE OIL PIPELINE	**EACOP Project**	Worley energy | chemicals | resources

Pipeline Field Joint Insulation & Coating Specification

05	AFC	29/Mar/2022	Approved for Construction	S. Westbury	K. Murray	J.Chohan
04	AFC	27/Jan/2022	Approved for Construction	S. Westbury	K. Murray	J.Chohan
03	AFC	10/Jan/2022	Approved for Construction	K. Murray	S. Westbury	J.Chohan
02	AFC	08/Oct/2021	Approved for Construction	K. Murray	S. Westbury	J.Chohan
01	IFA	19/Aug/2021	Issued for Approval	K. Murray	R. Doggett	J.Chohan
00	IFR	05/May/2021	Issued for Review	K.Murray	R.Doggett	J.Chohan
Rev.	**Step**	**Date**	**Revision Description**	**Issued by**	**Reviewed by**	**Approved by**

REVISION DESCRIPTION SHEET

Rev.	Page.	Description
05	various	Typos corrected. Table 1, appendix 4 and section 7.2 revised
04	various	Pre-qualification added where PQT is mentioned throughout document
04	28	Pre-qualification requirements added to appendix 4 & missing test frequencies added
04	15	LE overlap reduced to minimum 20mm at the raceway termination
04	8	High water table regions changed to swamps, wetland, and areas with a high probability of flooding
04	5/6	Pre-qualification, PQT and PPT requirements added
03	28	FBE coating corrected to Epoxy coating as per CPY comment.
02	22	Training and qualification requirements for inspection personnel added as new Section 9.2.
02	17	Raceway Bridge Installation
02	16/17	Audit requirement for HDPE casing system.
02	16	Documentation requirements for CPY approval of HDPE casing.
02	13	Paragraph amended to include preservation paint or PE film wrap as the temporary protective measure.
02	8	Mechanical Protection
02	7	Cable glanding requirement added for branched FJ.
02	6	Table 1 – Item c) LLHT component description amended to distinguish from Item b).
01	various	Revised in accordance with Company comments.
01	5	Reference to UT-MID-60-0120-200151 Rev01 added, in addition UT-MID-60-0120-200151 Rev01 is replaced by UT-MID-70-WPR2-210003.
01	6	Table 1 : Standard field joint length changed to 500 mm.
01	6	Table 1 : Minor amendments to wording to improve clarity.

TABLE OF CONTENTS

1 SCOPE

This specification details the qualification and testing requirements for the field joint insulation and coating system for the jointing of the onshore pipeline as outlined in Section 4 of Company document UG-BUL-00-0100-100016. This document defines the requirements to be followed for:

- The Pre-Qualification and PQT of the complete field joint insulation system comprising the anti-corrosion coating, the PU foam insulation and the PE100 casing jacket.
- The application requirements of the field joint insulation system onto the pre-insulated pipeline joints.
- The testing requirements of the field joint insulation system for both pre-production tests (PPT) and Production.

This specification incorporates all the qualification and testing requirements detailed in UT-MID-60-0120-200151 Rev01 and replaces UT-MID-60-0120-200151.

The pre-insulated pipelines covered by this specification will have an external anti-corrosion coating comprising of fusion bonded epoxy (FBE), a thermally insulating layer of rigid polyurethane foam (PUF) and an outer high density polyethylene (HDPE) jacket. Refer to UG-BUL-00-0100-100016.

The field joints shall be protected with a coating system that is fully compatible with the line pipe coating and allows satisfactory application under the predicted field conditions. The field joints shall be suitable for a continuous operating temperature of 0°C up to +85°C.

The field joint coating system shall consist of the following elements :

- Anti-corrosion coating: 100% solids liquid epoxy
- Thermal insulation: Injected PU Foam
- Outer jacket: Black PE100 type polyethylene material

The field joint coating system shall be qualified in accordance with EN 489:2009 and the amendments and additional requirements of this specification. This specification is divided into sections dealing with the liquid epoxy requirements, the PE100 polyethylene casing requirements (including welding) and the PU foam requirements. Each section includes requirements for PPT and Production.

1.1 Qualification & PPT

The qualification and testing requirements of this specification apply to all FJC materials and casing types. All inspections and tests specified in this document shall be performed. The same equipment, materials and procedures used during qualification shall be used for PPT and production. If multiple materials are proposed, only the tests relating to that specific layer, shall be repeated.

CONTRACTOR shall provide a minimum of 2 weeks' notice prior to commencing pre-qualification, PQT and PPT. CONTRACTOR shall video stream the application and testing, this may be done via mobile phone through Microsoft Teams or similar application. COMPANY may, at its discretion, choose to send a representative to witness.

Each casing type shall use the same anti-corrosion coating, thermal insulation, and HDPE materials and each of these materials shall be sourced from the same MANUFACTURER. If a different material is used, or a material is sourced from a different MANUFACTURER, then it shall also be subject to all qualification and testing requirements applicable to that material.

1.1.1 Pre-Qualification

In the event the MANUFACTURER, APPLICATOR or raw materials proposed for the FJC are <u>not</u> listed as pre-qualified in Tender Bulletin No 30, a pre-qualification shall be performed by CONTRACTOR prior to PQT.

The purpose of the pre-qualification is for CONTRACTOR to demonstrate the field joint coating concept at the earliest opportunity.

The pre-qualification shall consist of coating a minimum of two simulated field joints using the proposed raw materials, equipment and system applicators that will be used for PQT and production. All the inspection and test requirements listed in appendix 4 shall be successfully completed and a pre-qualification report shall be compiled and issued to company for review and approval before PQT may commence.

The FJC shall be applied to TIS coated pipe consisting of FBE anti-corrosion layer, PU foam insulation and HDPE outer sheath, representative of the project TIS coating. However, for the pre-qualification the TIS coated pipe does not need to have been applied by the project TIS contractor.

1.1.2 PQT

A PQT shall be performed after pre-qualification and prior to PPT. The purpose of the PQT is to demonstrate the materials, equipment and application method can produce a field joint coating that meets the project requirements.

All the inspection and testing listed in appendix 4 shall be performed on TIS coated pipe applied by the project TIS contractor. CONTRACTOR shall advise the quantity of pipe and simulated field joints needed to perform the PQT. CONTRACTOR shall add a circumferential cap weld at the centre of each of the test zones to simulate the field weld.

FJC repairs, TIS repairs and stripping of defective FJC shall all be included in PQT.

A PQT report shall be compiled by CONTRACTOR and submitted to COMPANY for review and acceptance prior to PPT commencement.

1.1.3 PPT

A PPT is to be performed at the actual site of application using the equipment and personnel mobilised for coating work in the field. The PPT shall demonstrate the inspection and testing requirements listed in tables 3,4,5 can be achieved when taking into account the environmental and other site-specific effects on the coating application.

1.2 Casing Configurations and Sizes

Different field joint (FJ) casing sizes and configurations shall be necessary to take account of the complete LLHT system which consists of the LLHT cables, various inline cable connections, the penetration of the FJ casing to permit connection of the LLHT cables to above ground junction boxes and the penetration of the FJ casing for earthing purposes. See the schematic figure given in Appendix 3.

Refer to document UT-MID-60-WPR2-150027 for electrical details of the LLHT system.

Three types of FJ casing have been identified to accommodate the different field jointing requirements for the LLHT system. The different casing types are standard, extended and branched and these are summarised in Table 1 and described below. The CONTRACTOR may propose additional casing types as necessary.

The standard FJ casing shall be installed at 18 metre intervals at each pipeline field weld joint. At each field weld joint one of the LLHT components listed as Items a), b) or c) in Table 1 shall be installed within the HDPE casing. These components will be located under the insulation and shall not penetrate through the HDPE casing.

Table 1 : Field Joint Casing Types

FJ Casing Type	Component	Pipe Type	Installation Interval	Field Joint Length Note 1	Casing Penetration
Standard Type A [Note 9]	3x LLHT aluminium raceways with Bridge connectors [Note 4]	*WT ≤18.24 mm Straight Pipe Bends MLBV Connection*	Every 18 metres	500 mm	No
Extended Type B [Note 10]	3x LLHT aluminium raceways with Bridge connectors	*WT 23.83 mm Straight Pipe Bends MLBV Connection*	Every 18 metres	700 mm TBC by LLHT Vendor	No
	3x LLHT splice kits (HV coupling) [Note 5]	*All WT Straight Pipe*	Approx. 1 km		
	Cross-bonding of cable screens [Note 6]		Approx. 2 – 3 km		
Extended Type C [Note 10]	Star end connectors for LLHT [Note 2]	*All WT Straight Pipe*	Not exceeding 60km [Note 2]	1200mm TBC by LLHT Vendor	No
Branched Type D [Note 10 &12]	Cable Connections • LLHT power ≤6 cables [Note 3 & 7] • Earth Connection [Note 8] • Instrument Connection [Note 13] • Telluric Mitigation • AC Mitigation [Note11]	*All WT Straight Pipe*	Approx. 10 km [Note 3]	Tee-joint or saddle joint configuration required. CONTRACTOR to determine cutback length	Yes
Branched Type E [Note 10 &12]	8” MLBV PT Branch	*All WT Straight Pipe*	1 per MLBV. Approx. 82 MLBV’s total	Tee-joint or saddle joint configuration required. CONTRACTOR to determine cutback length.	Yes

Notes to Table 1

1. The field joint length is twice the TIS coating cutback length for the individual pipe ends (i.e. 2 x 250 mm). The field joint length does not include for the necessary overlap between the FJ casing and the pipeline jacket. (The minimum overlap length is 75 mm.)
2. Two separate star connectors are required at each location, one for each consecutive LLHT sections.
3. Junction boxes or service junction boxes will be located at each of the AGIs, the MLBVs and additional substations. The total number of AGIs, MLBVs and substations is approximately 99.
4. The nominal internal dimensions of the raceways are approximately 30 x 30 mm, final dimensions TBC.
5. The splice kits may not require the bridge connectors between the aluminium raceways.
6. The 3 LLHT splice kits will require the cable screens to be cross connected as per the LLHT Suppliers requirements.
7. Two sets of 3 LLHT cables shall penetrate through the PE casing.
8. One flexible earth wire at each location shall penetrate through the PE casing.
9. Full PQT required performing all testing listed in appendix 4
10. Reduced PQT required as detailed in appendix 4
11. Locations TBC on completion of survey and subsequent design.
12. Branched type casings shall be supplied by a COMPANY approved vendor.
13. Located at each of the MLBV’s

The standard field joint length (i.e. distance between the exposed ends of the PUF insulation either side of the weld joint) is nominally 500 mm. Linepipe and hot induction bends with WT ≤18.24 mm will be supplied with a coating cutback length of 250 mm at each end. Linepipe and hot induction bends with WT ≤23.83 mm will be supplied with a coating cutback length of 350 mm at each end.

Extended FJ casings (Type C), shall be required for the star end connectors located at the end of each LLHT section. Two separate star end connectors are placed end to end at the interface between two consecutive LLHT sections and therefore require an extended coating cutback length. The star end connections shall be located under the insulation and shall not penetrate through the HDPE casing.

Branched LLHT power connection FJ casings (Type D), shall be installed at the start of each LLHT section to allow connection of the LLHT cables to the aboveground junction boxes located at each of the pipeline AGIs, MLBVs and at additional (trace heating) substations. Two sets of 3 LLHT cables shall penetrate through the HDPE casing and terminate in the aboveground junction boxes located close to the pipeline.

Branched earthing connection FJ casings (Type D), shall be installed at approximately 10 km intervals to enable connection of the LLHT system to earthing electrodes located adjacent to the pipeline. A single flexible cable shall penetrate through the HDPE casing and terminate in aboveground junction boxes or directly in earthing pits.

For the branched FJ casings the casing configuration shall be of the Tee-type or saddle joint type. The casing configuration and length shall allow for the cable numbers, size and cable flexibility which is limited for the LLHT cables. The CONTRACTOR may propose the same FJ casing for both Items e) and f) if suitable for both.

Branched FJ casings shall ensure water tightness at the point of cable entry/exit; cable glands shall be installed to provide a water seal and in areas with a high water table or susceptible to flooding, two cable glands shall be installed to provide the water seal.

1.3 Wetland Regions

Where there is higher risk of water ingress such as swamps, wetlands and areas with a high probability of flooding, a visco-elastic tape system applied to the interface between the pipeline jacket and the FJ casing as an additional barrier against water penetration.

The tape wrap system shall be applied as two layers: an inner layer of a visco-elastic tape to prevent water ingress and an outer PE/PVC layer to provide mechanical protection to the inner layer.

As per ISO 21809-3, the inner visco-elastic tape shall be a non-crystalline (fully amorphous) low-viscosity (non-crosslinked) non-reactive polyolefin (e.g. polyisobutylene, other polybutenes, or atactic polypropylene) based compound layer with a direct bond to the substrate.

As per ISO 21809-3 the outer layer shall be a polymeric outer wrap tape (FJC type 13A).

The CONTRACTOR shall submit an application procedure for review by the COMPANY. The application procedure shall ensure good bonding durability and resistance to soil stress effects.

The tape system shall be applied in accordance with the approved procedure to all circumferential and longitudinal PE joints. The overlap distance on the FJ casing and the pipeline jacket shall be 250 mm minimum or in accordance with the tape manufacturer's instructions, whichever is the greater value.

The tape system shall be compatible with the pipeline PE jacket and the PE casing and suitable for the maximum temperature at the surface of the pipeline jacket (Tmax).

The CONTRACTOR shall submit an independent test report confirming compliance to all the properties and requirements listed in ISO 21809-Part 3 2016 at Tmax. The CONTRACTOR shall carry out PQT of the tape system in accordance with Table A.1 of ISO 21809-Part 3 2016.

The coating operatives shall be qualified to carry out the coating application procedure and repair work. Proof of successful qualification shall be documented.

1.4 Mechanical Protection

In case, due to installation methods such as horizontal directional drilling, thrust boring, etc., the field joint coating is subjected to excessive mechanical stresses such as abrasion, gouging, impacts that may puncture, tear or compromise the coating integrity, CONTRACTOR shall propose an additional layer of mechanical protection. The proposed mechanical protection shall be subject to COMPANY approval.

1.5 Holds

None.

1.6 Units of Measure

All technical data shall be presented in the International System of Units (SI) with the exception of pipe diameters which shall be in inches (NPS).

1.7 Language

All documentation and communications shall be in the English Language.

2 PROJECT DESCRIPTION, ABBREVIATIONS & DEFINITIONS

Refer to UT-MID-60-WPR2-100015 – EACOP Project Description, Abbreviations and Definitions List for the project description and the general nomenclature for the Project.

Table 2 lists the acronyms frequently used in this document.

Table 2: Abbreviations and Acronyms

Acronym	Description
AGI	Above Ground Installation
DFT	Dry Film Thickness
EF	Electro-Fusion
FBE	Fusion Bonded Epoxy
FJ	Field Joint
HDPE	High Density Polyethylene
ITP	Inspection Test Plan
LLHT	Long Line Heat Tracing
MLBV	Main Line Block Valve
OIT	Oxidation Induction Time
PE	Polyethylene
PPS	Project Particular Specification
PPT	Pre-Production Tests
PQT	Procedure Qualification Testing
PUF	Polyurethane Foam
TIS	Thermal Insulation System
TBC	To Be Confirmed

2.1 Definitions

The following terms are used in this document.

CONTRACTOR : Party responsible for construction of the pipeline.

MANUFACTURER : Manufacturer or supplier of the field joint coating materials.

APPLICATOR : Party responsible for the application of the complete field joint coating system.

INSPECTOR : Inspection company or representatives appointed by the Pipeline Project Team.

COMPANY: EACOP

3 APPLICABLE DOCUMENTS

3.1 Project and COMPANY Specification and Documentations

The latest revision of the Project or COMPANY documents shall apply, unless otherwise stated.

Document Number	Document Title
UG-BUL-00-0100-100016	Polyurethane thermal insulation and outer casing of polyethylene for onshore pipeline - Optimum Requirements
UT-MID-60-WPR2-100015	EACOP Project Description, Definitions and Abbreviations List
UT-MID-60-WPR2-150027	EACOP Long Line Heat Tracing (LLHT) Specification
UT-MID-60-0120-200151	EACOP Field Joint Insulation & Coating PPS
UT-MID-70-ISF1-210014	Raceway Bridge Installation Procedure

3.2 Codes and Standards

Document Number	Document Title
ASTM D968	Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D4285	Standard Test Method for Indicating Oil or Water in Compressed Air
ASTM D4940	Standard Test Method for Conductimetric Analysis of Water Soluble Ionic Contamination of Blast Cleaning Abrasives
EN 253:2009	District heating pipes – Bonded single pipe systems for directly buried hot water networks – Factory made pipe assembly of steel service pipe, polyurethane thermal insulation and a casing of polyethylene
EN 489:2009	District heating pipes — Preinsulated bonded pipe systems for directly buried hot water networks — Joint assembly for steel service pipes, polyurethane thermal insulation and outer casing of polyethylene.
EN ISO 11124 -1	Preparation of steel substrates before application of paints and related products — Specifications for metallic blast-cleaning abrasives —Part 1:General introduction and classification
EN ISO 11124 -2	Preparation of steel substrates before application of paints and related products — Specifications for metallic blast-cleaning abrasives — Part 2: Chilled-iron grit
ISO 179-2	Plastics - Determination of Charpy Impact Properties - Part 2: Instrumented Impact Test
ISO 844	Rigid cellular plastics — Determination of compression properties
ISO 845	Cellular plastics and rubbers — Determination of apparent density
ISO 868	Plastics and ebonite - Determination of indentation hardness by means of a durometer (Shore hardness)

ISO 1133-1	Plastics — Determination of the melt mass-flow rate (MFR) and melt volume flow rate (MVR) of thermoplastics — Part 1: Standard method
ISO 1183	Plastics - Methods for determining the density and relative density of non-cellular plastics
ISO 2808	Paints and varnishes — Determination of film thickness
ISO 3104	Petroleum products — Transparent and opaque liquids — Determination of kinematic viscosity and calculation of dynamic viscosity
ISO 4590	Rigid cellular plastics — Determination of the volume percentage of open cells and of closed cells
ISO 4624	Paints and Varnishes – Pull off test for Adhesion
ISO 6964	Polyolefin pipes and fittings—Determination of carbon black content by calcination and pyrolysis— Test method and basic specification
ISO 8497	Thermal insulation - Determination of steady-state thermal transmission properties of thermal insulation for circular pipes
ISO 8501-1	Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness
ISO 8502-3	Preparation of steel substrates before application of paints and related products — Tests for the assessment of surface cleanliness — Part 3: Assessment of dust on steel surfaces prepared for painting (pressure sensitive tape method)
ISO 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
ISO 8503-4	Preparation of steel substrates before application of paints and related products — Surface roughness characteristics of blast-cleaned steel substrates — Part 4: Method for the calibration of ISO surface profile comparators and for the determination of surface profile — Stylus instrument procedure
ISO 8503-5	Preparation of steel substrates before application of paints and related products — Surface roughness characteristics of blast-cleaned steel substrates — Part 5: Replica tape method for the determination of the surface profile
ISO 11357-6	Plastics. Differential scanning calorimetry (DSC). Part 6: Determination of oxidation induction time (isothermal OIT) and oxidation induction temperature (dynamic OIT)
ISO 12162	Thermoplastics materials for pipes and fittings for pressure applications - Classification, designation and design coefficient
ISO 14896	Plastics - Polyurethane raw materials - Determination of isocyanate content
ISO 18488	Polyethylene (PE) materials for piping systems — Determination of Strain Hardening Modulus in relation to slow crack growth —Test method

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)
IS0 21809-2	Petroleum and natural gas industries — External coatings for buried or submerged pipelines used in pipeline transportation systems — Part 2: Single layer fusion-bonded epoxy coatings
IS0 21809-3	Petroleum and natural gas industries — External coatings for buried or submerged pipelines used in pipeline transportation systems — Part 3: Field joint coatings
NACE SP 0274	High-Voltage Electrical Inspection of Pipeline Coatings
SSPC SP1	Steel Structures Painting Council. Surface Preparation Specification. Solvent Cleaning.

3.3 Other Referenced Documentation

None.

4 HEALTH AND SAFETY REQUIREMENTS FOR INSTALLATION

During the field joint coating operations, all APPLICATOR operators responsible for installation of the field joint coating systems shall be subject to the following health and safety requirements.

All operators shall adhere to Project safety requirements as well as to local regulations related to Health and Safety.

- All operators involved in the application of the joint coating shall be properly trained prior to the commencement of the Project.
- During application of the field joint coating each of the operators working in the field joint coating area shall be aware and mindful of those working directly around them. The operators shall follow the installation procedures learned during training and qualification and shall remain in complete control of their installation tools at all times. Complete understanding of the installation procedure shall be gained as a key component of operator training.
- APPLICATOR shall complete a site-specific risk assessment of the coating activities for CONTRACTOR approval a minimum of 2 weeks prior to PQT, PPT and Production phases.

In addition to following the CONTRACTOR guidelines, all APPLICATOR operators shall wear the following personal protective equipment at all times:

- Hard Hat
- Safety Glasses / Goggles
- Safety Work Boots
- Long Sleeve Flame Retardant Overalls
- Heat Resistant Gloves
- Ear Plugs / Hearing Protection

5 RECEIPT, STORAGE AND HANDLING OF FJC MATERIAL

Upon the receipt of the field joint coating material by the CONTRACTOR/APPLICATOR, the supplied documentation and the material packages shall be examined in order to verify that the material complies with the requirements specified in the Purchase Order.

The field joint coating material packages shall contain, as a minimum, the following information:

- SUPPLIER /MANUFACTURER's name;
- Product's trade name;
- Product's expiry date;
- Product's identification including factory of origin;
- Product's batch number and date of production;
- Product's batch test certificates

The field joint coating materials shall be stored and handled in accordance with the Material Safety Data Sheets and the MANUFACTURER storage recommendations which shall include temperature limits for storage. As a minimum, the materials shall be kept under cover in a dry, ventilated area, enclosed in the original packaging and shall be raised from the ground in order to avoid contamination with any foreign substances present on the ground or in the atmosphere. Materials shall be protected from direct exposure to sunlight, rain, dust and other adverse environmental elements.

Prior to using the field joint coating materials, the material packages shall be visually inspected in order to verify that the field joint coating materials have not been damaged. The coating material packaging shall only be opened immediately prior to use for product installation. Coating material packaging that is damaged, including damage by internal leakage or external contamination, shall be quarantined for further inspection to assess the damage to the actual field joint coating materials.

PE100 casing shall be stored at all times at a temperature below the minimum temperature for natural shrinkage demonstrated by the casing supplier during qualification.

6 LIQUID EPOXY RESIN REQUIREMENTS

The anti-corrosion coating of joints is mandatory and shall consist of a 100% solids, high build liquid epoxy resin that is spray applied to the blasted steel surface at the coating cut back area.

6.1 Surface Preparation

A visual inspection shall be performed on the field joint cut back area in order to verify that there are no steel defects or contamination with oil, grease, salts, or other loosely adhering materials. Any steel defects shall be reported to the CONTRACTOR supervisor and/or repaired according to CONTRACTOR procedures and specifications.

The exposed PUF face shall be prepared for field jointing. This shall include removal of preservation paint or polyethylene film wrap applied at the coating mill as a temporary protection measure to the coated pipe ends. If required, the exposed PUF face shall be prepared to provide a fresh interface to ensure good adhesion to the FJ polyurethane foam. Care shall be taken to prevent damage to the FBE tail and the heat tracing raceways. Loose surface contamination shall be removed from the field joint area and the adjacent HDPE casing to ensure it does not affect the electro-fusion process.

Air humidity, metal temperature, and dew point shall be measured. The dew point temperature shall be 3ºC above the metal temperature. No abrasive blasting shall be done during rain or sand storms.

Detergent or suitable solvents as per SSPC-SP-1 shall be used to clean the metal surface prior to blasting. Additional methods, such as power tool brushes or equivalent shall be used if needed to remove any defects or contaminant still present after solvent cleaning. In case soil, dirt or similar loose contaminant is detected, it shall be removed with a clean cloth or with clean, compressed air, depending on the convenience of the method.

The compressed air supply shall be tested in accordance with ASTM D4285 to verify it is free from oil and water contamination. The compressed air shall be tested at the start of each work shift and then at 4 hour intervals.

The salt level on the bare steel pipe surface shall be measured with SCM130/400 equipment and the NaCl concentration shall not exceed 2 µg/cm^2. Should the chloride contamination exceed the maximum allowable value, the contaminated area shall be washed with fresh, high pressure water containing less than 50 ppm soluble chloride concentration. After drying of the steel surface is complete, the area shall be retested for chloride contamination to ensure the values are within the acceptable limits.

The exposed steel surface on the field joint coating area shall then be grit blast cleaned in order to achieve a steel surface cleanliness grade of Sa 2½ as per the ISO 8501-1 standard, and a surface roughness (Ry5) of 50 to 100 microns as per ISO 8503-1. In case the specified cleanliness grade or surface roughness has not been achieved, the steel surface shall be re-blasted.

The abrasive blasting materials shall be angular particles supplied in accordance with the requirements of the applicable part of ISO 11126 except the conductivity of the aqueous extract shall not exceed 15 milliSiemens/m (equivalent to 150 microSiemens/cm). (This conductivity value is more stringent than the value permitted in the ISO standards). Each batch of abrasives shall be supplied with a test report detailing the material, particle sizing, conductivity of aqueous extract, the water soluble chloride content and the maximum content of free crystalline silica (not to exceed 1% m/m).

During qualification (PQT), only stylus equipment providing Ry5 readings (cut off 2.5mm) shall be used to determine the surface roughness measurements. Surface roughness measurements during Production can use the replica tape method or press-o-film tape only if calibrated against the stylus equipment at both PQT and PPT stages, and the steel temperature is within the temperature range permitted by the press-o-film supplier. The press-o-film range shall then be selected to suit the specified roughness range of 50-100 microns as measured by the stylus instrument method. Visual-tactile comparators are not allowed.

The FBE factory applied coating shall be lightly abraded for a minimum distance of 75 mm from the cutback edge using either abrasive paper or by sweep blasting (depending on the convenience) around the entire circumference. The adjacent mainline coating HDPE jacket, rigid PUF insulation and heat tracing system shall be protected during abrasive blasting processes.

All traces of dust contamination shall be removed with clean, compressed air.

After surface preparation is completed, the dust contamination on the pipe surface shall be measured according to ISO 8502-3. The resultant dust contamination shall be of a rating 2 or better (quantity and size), as per ISO 8502-3.

The surface preparation inspection requirements and test frequencies shall be in accordance with Table 3.

6.2 Epoxy Application

The 2-part liquid epoxy resin shall be applied via spray method in accordance with MANUFACTURER's recommendation. The liquid epoxy shall overlap the FBE factory applied coating by a minimum of 50 mm with the exception of the raceway terminations and gaps between raceways which shall have a minimum 20mm overlap. Application of the coating in conjunction with the heat tracing system shall be demonstrated during the qualification process.

Liquid epoxy shall be capable of being applied in temperatures ranging from +10C to +55C and MANUFACTURER shall provide gel time, pot life, and curing time across the entire temperature range to the APPLICATOR. MANUFACTURER shall indicate any special provisions for storage/handling (if any) and any additional hold points/quality control points to ensure application suitability during production.

APPLICATOR shall develop a liquid epoxy repair procedure and inspection test plan with assistance of the MANUFACTURER and submit it to COMPANY for approval. The repair procedure and inspection test plan shall be qualified as part of the PQT and PPT.

The applied liquid epoxy resin shall meet the technical performance and test requirements listed in Table 3 for PPT and Production. Refer to Appendix 4 for the technical performance and test requirements necessary for Pre-Qualification and PQT.

Table 3: Epoxy Coating Testing Requirements (PPT / Production)

Property	Test Method	Test Temperature	Requirement	Test Frequency	
				PPT	**Prodn**
Visual Inspection			No grease, defects, debris or clean with solvent and brushes	3 Joints	Each Joint
Compressed air quality check	ASTM D4285	Ambient Temp	Free of oil and water contamination	1 per Shift	1 per Shift
Abrasive material conductivity check	ASTM D4940		< 15 milliSiemens/m (< 150 microSiemens/cm)	1 per Shift	1 per Shift
Surface Cleanliness	ISO 8501-1		Sa 2.5	3 Joints	Each Joint
Surface Roughness Stylus instrument method	ISO 8503-4 Note 1		50-100 microns (Ry5, cut off 2.5 mm)	3 Joints	Each Joint Note 1
Surface Roughness Replica tape method	ISO 8503-5 Note 1		50-100 microns	3 Joints	Each Joint Note 1
Salt Contamination	SCM 130/400		2 µg/cm^2	1 Joint	1 per Shift
Dust Level	ISO 8502-3		Quantity <2 Size <2	1 Joints	Each Joint
Abrasion of Overlap	Sand paper grit 50		>75 mm	3 Joints	Each Joint
Surface Temp Prior to Coating	Pyrometer		≥ 3°C above dew point and as per qualified range during PQT	3 Joints	Each Joint
Mix Ratio	Cup shot		As per qualified range during PQT	3 Joints	1 per Shift
Wet Film Thickness	ISO 2808-1A		As per qualified range during PQT	3 Joints	Each Joint
Dry Film Thickness	ISO 21809-3	Ambient Temp	As per qualified range during PQT	3 Joints	Each Joint
Forced Cure Temperature (if applicable)	Thermometer		As per qualified range during PQT	3 Joints	Each Joint
Holiday Detection	ISO 21809-3	Ambient Temp	2 kV/mm --no holidays	3 Joints	Each Joint
Impact Resistance	ISO 21809-3	23ºC	≥ 3 J/mm	1 Joint	NR
Adhesion to Steel	ISO 4624	23ºC	>10 MPa	3 Joints	NR
Adhesion to Steel	ISO 21809-Clause A4	23ºC	Rating 1 max	3 Joints	Twice per Shift
Adhesion to FBE	ISO 4624	23ºC	>10 MPa	3 Joints	NR
Hardness	ISO 868	23ºC	>80 Shore D	3 Joints	Twice per Shift
Overlap onto FBE	Tape measure	23ºC	≥50 mm	3 Joints	Each Joint

Cathodic Disbondment (28 days)	ISO 21809-3	23ºC	≤5 mm	NR	NR
Cathodic Disbondment (48 hours)	ISO 21809-3	65ºC	≤3 mm	3 Joints	NR

Notes to Table 3 :

1. Replica tape method permitted for surface roughness measurement during Production if calibrated against the stylus method (ISO 8503-4) during the PQT and PPT. See Section 6.1 of this Specification. If the replica tape method is successfully calibrated, then the surface roughness by stylus instrument is not required for Production testing.
2. NR = Not Required

7 HIGH DENSITY POLYETHYLENE CASING REQUIREMENTS

7.1 General

Considering the remote nature, limited infrastructure, extreme terrain and local climate of the pipeline construction, the casing jacket is required to provide a highly efficient seal over the joint to resist long term effects and stresses. As such, an engineered system taking in to account ease of installation, material composition and in-process testing requirements is mandatory to achieve a robust solution suitable for the pipeline design life and to mitigate risks related to corrosion and degradation of insulation effectiveness.

The field joint casing system shall provide a water tight seal against water penetration and in addition shall exhibit good resistance to the following factors :

- Forces initiated by axial movements of the pipe on/in the ground
- Radial forces and movements caused by overhead traffic loads, thermal expansion, soil movement and construction activities
- Chemical and physical effects of the soil surrounding the pipe
- Penetration of water from the surrounding soil when wet.

Selection of the HDPE casing/sleeve and casing supplier shall be subject to COMPANY approval. The CONTRACTOR shall submit the following documentation for review :

- Detailed data sheet.
- Test reports demonstrating compliance with the requirements of this specification.
- A full track record of the casing manufacturer for the supply of the proposed product.
- QA/QC certificates of the HDPE casing manufacturing plant.

Before production of the HDPE casing system the CONTRACTOR shall employ an independent third party inspector to audit the manufacturing plant for the HDPE casing system. Note that the HDPE casing system includes the HDPE casing/sleeve and all associated welding materials necessary to complete the electrofusion welding to the pipeline casing, as outlined in Sections 7.3 and 7.4. During production the in-house quality checks and testing shall be witnessed and validated by an independent third party inspector. The independent third party inspector shall be located at the manufacturing plant throughout production.

7.2 Installation of LLHT Components

LLHT cables and cable splices shall be installed after LE application and curing, and before raceway bridges, casing and PUF are applied.

The aluminium raceways or other LLHT components (refer to Table 1) shall be installed as per the approved Project procedures. The CONTRACTOR shall develop a schedule identifying the LLHT components and FJ casing type required at each pipeline field weld joint.

The raceway bridges shall be installed in accordance with the Raceway Bridge Installation Procedure UT-MID-70-ISF1-210014.

7.3 Requirements and Compatibility with Pipeline Casing

All proposed HDPE joint casing solutions shall meet the minimum requirements of EN 489:2009 and Clause 4.3 of EN 253:2009 and shall be of PE100 type. Furthermore, the HDPE joint casing composition shall be able to resist premature shrinkage / recovery in the African climate and to adapt/conform to out-of-round jacket pipe. To that effect, the MANUFACTURER shall provide the maximum range for ovality and out of roundness to which its casing will accommodate.

During PQT the MANUFACTURER shall carry out specific thermal testing to demonstrate the HDPE casing will not undergo premature shrinkage when exposed to the high ambient temperatures on site.

The HDPE used for field joint casing shall be compatible for welding with the HDPE used on the pipeline jacket/casing. As such, the melt index of the field joint casing shall not differ by more than 0.5g/10min (5kg/190°C) from the pipeline jacket in order to be considered compatible. If outside this range, requirements of Clause 4.3.1.2 of EN 253:2009 shall apply.

PE coated welding wire, or any other PE materials used in the fusion welding of the pipeline jacket to the field joint casing, shall also be HDPE grade and meet the same melt index compatibility requirement given above. (The compatibility of the melt indexes shall be demonstrated between the three types of HDPE i.e. outer pipe jacket, field joint casing, PE coated welding wire.)

When PE coated welding wires are used a minimum of two welding wires shall be applied in parallel along the circumferential joint of the casing to the linepipe jacket to mitigate water ingress and disbondment. The PE welding shall ensure there are no unwelded areas at the circumferential joint. Special attention shall be applied to the inlet location of the welding wires on the casing to avoid unwelded areas at this location. In addition, during the PQT a roller box test shall be performed to simulate the installation process and make sure that the roller box will not tear apart the casing.

The field joint casing shall be surface treated on its internal surface via an oxidative flame treatment or equivalent to provide good bonding to the PU foam. This shall be demonstrated during Pre-Qualification and PQT.

7.4 Installation and Electro-fusion Welding

Installation of the casing shall follow MANUFACTURERs recommendations and shall as a minimum employ electro-fusion welding of the joint casing to the pipeline HDPE jacket. The HDPE casing is the main component in preventing external water penetration into the pipeline insulation; as such the application is critical and paramount.

The EF welding of the casing shall not negatively impact the long term performance of the pipeline HDPE jacket. To provide performance assurance the electro-fusion welding system shall provide digital access and traceability to all quality control parameters including continuous monitoring and recording of the electro-fusion temperature. Tolerances in temperature and time for the electro-fusion process shall be demonstrated during PQT.

Dimensions of the PE100 casing shall be as follow:

- Overlap to HDPE pipeline jacket/casing: 75 mm minimum supported by PU foam.
- The HDPE pipeline jacket/casing shall be abraded over 100 mm minimum
- Width of EF zone after fusion: 20 mm minimum
- Distance of the EF zone from the external edge of the casing: 20 mm minimum
- Thickness of the casing shall be 5 mm minimum

The use of an extrusion welding gun (with an integral air heater unit) may be proposed for the welding of the joint casing provided the process can fulfil the requirements of this specification in full.

Continuous close contact of HDPE casing to the HDPE jacket of the pipeline is critical to good welding. The procedure to control the contact between the 2 casings before welding shall be demonstrated during PQT and PPT and shall be easily inspected on site during production (torque records/visual/gap assessment...) Tolerances on contact (gap), if any, shall be demonstrated during PQT. If shrinkable casings are employed, the clearance or gap between the casing and the pipe before shrinkage shall be defined with an acceptable range during PQT and PPT for inspection during production. The time during which the straps or equivalent need to be left on the casing for full welding shall be defined at PQT and PPT stage together with acceptance criteria for inspection during Production.

Following installation, and prior to foaming, the applied casing shall be air pressure tested at 0.2 bar for 3 minutes, in accordance with EN 489:2009. A soapy water/liquid shall be applied around the casing edges to aid leakage detection. Any leakage failure of the EF weld shall result in stripping and re-application of a new casing, repair by local welding is not allowed at that stage.

APPLICATOR shall develop casing repair procedure and inspection test plan with assistance of the MANUFACTURER and submit for approval. The repair procedure and inspection test plan shall be qualified during the PQT and PPT. SUPPLIER shall also provide a detailed procedure and inspection test plan for plugging/sealing the casing after rigid polyurethane application. For the PQT, water propagation test is to be done in accordance with Appendix 1.

The HDPE casing shall meet the technical performance and test requirements listed in Table 4 for PPT and Production. Refer to Appendix 4 for the technical performance and test requirements necessary for Pre-Qualification and PQT.

Table 4: – HDPE Casing Testing Requirements (PPT / Production)

Property	Test Method	Test Temperature	Requirement	Test Frequency	
				PPT	**Prodn**
Density	ISO 1183	23ºC	>0.94 g/cm^3 Note 1	Each batch	Each batch
Thermal Stability (OIT)	ISO 11357-6	210ºC	≥30 min Note 1	Each batch	Each batch
Melt mass-flow rate (MFR)	ISO 1133-1		As per agreed procedure during PQT Note 1	Each batch	Each batch
Carbon Black Content	ISO 6964		2% minimum Note 1	Each batch	Each batch
Carbon Black Particle Size			Type P Note 1	Each batch	Each batch
Hardness	ISO 868	23ºC	>55 Shore D	3 samples	1 per Shift
Surface Preparation of HDPE Jacket	Sand paper with grit 50		As per PQT procedure	3 Joints	Each Joint
PE Welding Rods/Coils			Certificate of analysis and certificate of conformity as per PQT	Each batch	Each batch
Welding Parameters (temperature and time profiles)			As per qualified range during PQT	3 Joints	Each Joint
PE Welding Rods/Coils Installation			As per agreed procedure during PQT	3 Joints	Each Joint
Dimensional Checks of the Overlap / Distance of the Weld from the Edges / Width of Welded Area			As per qualified range during PQT	3 Joints	Each Joint

Casing Gap Before Shrinkage (when applicable)			As per qualified range during PQT	3 Joints	Each Joint
Shrinkage Time and Temperature			As per qualified range during PQT	3 Joints	Each Joint
Torque Control of Strapping System			As per qualified range during PQT	3 Joints	Each Joint
Time Before Release of Strapping System			As per qualified range during PQT	3 Joints	Each Joint
Air Pressure Test	EN 489:2009	≤ 70ºC	Apply air pressure at 0.2 bar for 3 minutes - no leaks Note 2	3 Joints	Each Joint

Notes to Table 4

1. Values reported on Manufacturer's batch certificate.
2. Soapy water applied to the casing edge to aid detection of air leaks.

8 POLYURETHANE FOAM INFILL REQUIREMENTS

Once the HDPE casing is installed and following a successful pressure test to verify the seal integrity, the casing shall be injected with PUF ensuring that the casing (which acts as a mold) is completely filled around the entire pipeline joint. This section defines the minimum technical requirements for materials and application of polyurethane foam insulation for the field joint area. The MANUFACTURER of the PUF materials shall provide test data showing full compliance to Clause 5.4 of EN 489:2009 and the below specification requirements.

The CONTRACTOR / APPLICATOR shall use closed-cell polyurethane foam where the closed-cell content is not less than 88% per ISO 4590.

Foam density shall be project nominal +/-10% when measured in accordance with ISO 845 and shall have a maximum thermal conductivity of 0.03 W/mK (ISO 8497). Compressive strength of the PUF shall be greater than 0.4 MPa as per ISO 844.

Once the PUF has been injected into the HDPE casing and has passed required testing check points, the casing vents shall be suitably plugged/sealed via electro-fusion process. The MANUFACTURER shall provide written guidance on the PUF injection procedure, calculated quantity of PU to be injected into the field joint in order to obtain the final expected properties of the PUF, mix ratio, special safety/handling precautions, mixing/reaction/curing times and foaming temperature limits (i.e. substrate temperature range at which the PUF can be injected).

The injection process shall be done via an automated plural pump equipment recording the following minimum information:

- Joint ID
- Temperature of components
- Mix ratio
- Injection time
- Quantity injected

During the Pre-Qualification, PQT and PP each test joint shall be destructively tested to assess voids. 5 circumferential cuts each spaced 100 mm apart shall be taken from the field joint. The four 100 mm wide rings of casing and insulation shall be removed one by one and the cross-section surface inspected for voids and bubbles. All voids larger than 2 mm in any direction shall be measured in 2 directions perpendicular to each other, and the product of the 2 measurements shall be defined as the area of the void. Total amount of voids shall be <5% of the cross-sectional area. Voids smaller than 2 mm shall be ignored. A retest shall be performed for any failures. There shall be good bonding at the interface between the two PUF at cut back areas.

The PUF shall meet the technical performance and test requirements listed in Table 5 for PPT and Production. Refer to Appendix 4 for the technical performance and test requirements necessary for Pre-Qualification and PQT.

Table 5: PUF Testing Requirements (PPT and Production)

Property	Unit	Test Method	Requirement	Test Frequency	
				PPT	**Prodn**
Density (Polyol)	Relative to water	Manufacturer	Within Manufacturer's certificate of conformity range	Each batch	Each batch

Viscosity (Polyol)	cPs	ISO 3104	Within Manufacturer's certificate of conformity range	Each batch	Each batch
Density (isocyanate)	Relative to water	Manufacturer	Within Manufacturer's certificate of conformity range	Each batch	Each batch
Viscosity (isocyanate)	cPs	ISO 3104	Within Manufacturer's certificate of conformity range	Each batch	Each batch
Cream and String Time	Seconds	Manufacturer	Within Manufacturer's certificate of conformity range	Each batch	Each batch
Isocyanate Content	%	ISO 14896	Within Manufacturer's certificate of conformity range	Each batch	Each batch
Free Rise Density			Within Manufacturer's certificate of conformity range	Each batch	Each batch
Isocyanate Injection Temperature			As per qualified range during PQT	3 Joints	Each Joint
Polyol Injection Temperature			As per qualified range during PQT	3 Joints	Each Joint
Mix Ratio	Ratio by weight	Weight measure	Manufacturer's nominal value +/-2%	3 Joints	Once per shift
Steel Substrate Temperature Before Injection		thermometer	As per qualified range during PQT	3 Joints	Each Joint
Injection time			As per qualified range during PQT	3 Joints	Each Joint
Quantity Injected			As per qualified range during PQT	3 Joints	Each Joint
Foam Density	kg/m^3	ISO 845	Project nominal value +/-10% (for free rise)	3 Joints	Once per shift
Voids and Bubbles	%	ISO 845 Clause 7	As per Clause 7	3 Joints	-
Closed Cell Content	%	ISO 4590	> 88% (for free rise)	3 Joints	Once per shift
Cell Size	mm	Clause 5.4.5.1 of EN 489:2009	< 0.5 mm	3 Joints	NR
Compressive Strength	MPa	ISO 844	> 0.4	NR	NR

Notes to Table 5 :

1. NR = Not Required.

9 TRAINING REQUIREMENTS

9.1 Coating Operators

All operators involved in the installation and inspection of the field joint system shall be trained by the MANUFACTURER and the APPLICATOR. Only trained operators shall be permitted to work on the Project.

A specific training scheme shall be developed for each component of the field joint system (anti-corrosion coating, PE100 casing and welding, PU foam injection). Each operator shall be trained for the component he will be involved with.

All operators shall be trained before qualification. For Production, all operators shall be trained before PPT.

The training scheme shall be provided to the Company for review and approval as part of the qualification of the system (Appendix 4). Each successfully trained operator shall receive a certificate detailing for which component he is trained. The certificate shall have the operator's name and a photograph for ease of identification.

9.2 Coating Inspectors

For the inspection personnel, the training shall be performed exclusively by the system MANUFACTURER and the APPLICATOR. Inspection personnel shall receive full training for all steps of the field joint installation from application of the anti-corrosion coating, to welding of the HDPE casing, the PU foam injection and all related testing steps. The training shall be validated by both written and practical examination and proof of training issued with photographic identification.

Inspection personnel shall hold current certification as a coating inspector prior to receiving the additional project specific training above. Certification shall be in accordance with one of the following national standards :

- NACE – Coating Inspector Level 2.
- FROSIO – Coating Inspector Level 2.
- Institute of Corrosion – Painting Inspector Level 2.
- Institute of Corrosion – Pipeline Coating Inspector Level 2.
- BGAS-CSWIP – Site Coating Inspector.
- BGAS-CSWIP – Mill Coating Inspector
- BGAS-CSWIP – Painting Inspector Grade 2.

APPENDIX 1. WATER PROPAGATION TEST FOR PQT

On a full field joint system with anti-corrosion coating and a foam thickness identical to the design of the pipe:

1. Drill a hole of 50 mm diameter down to the anti-corrosion coating (no PU foam residue shall be apparent on the anti-corrosion coating surface.
2. Glue a Plexiglas pipe of 100 to 200 mm diameter and 3.5 m high on top of the hole.
3. Fill the Plexiglas pipe with deionized water mixed with blue dye at 3 m height of water column.
4. Heat the inside of the pipe at 90ºC.
5. Duration of the test: 3 months with intermediate inspection at 1 and 2 months to be done in order to estimate the evolution with time of any potential defects.
6. After three months, dismantle and remove the PU foam away from the hole.
7. Record any disbondment of the foam at the hole.
8. Record any disbondment of the anti-corrosion coating from the steel and any sign of corrosion of the steel.
9. Record the extent of the foam degradation and water propagation.

APPENDIX 2. WELDING QUALIFICATION TESTS

These tests have the objective of qualification of the HDPE casing welding process. It shall be done each time a new welding system is proposed and each time there is a change in the nature of the following:

- HDPE grade used for the casing
- Type of wires for electro-fusion
- Electro-fusion box
- Thickness of HDPE casing
- Changes in the welding parameters outside of the agreed ranges during qualification samples

10 full weld joints shall be performed with an agreed procedure and with full traceability for HDPE casing, the HDPE pipeline casing, diameter, thickness, welding parameters, welding box used, etc. The welds can be done without filling PU foam as this appendix concerns only HDPE welding.

Testing Procedures

Peel Test

Each weld shall be treated separately. A test-strip of 25 mm width shall be cut across the weld (perpendicular to the weld) over the entire width of the welded area, being careful not to cut the HDPE casing of the pipe, but only the HDPE casing of the field joint. Portable tensile machine on a A-frame with a constant tensile speed of 10 mm/min shall be used to peel off the strip from the inside of the joint. The peel force vs time shall be recorded. The test is complete when either of the following occurs :

- The test-strip is peeled off the pipeline casing entirely
- The test-strip has broken in a ductile manner

The above test is repeated on each of the 10 weld joints at the 12 / 3 / 6 / 9 o'clock positions.

At start of each peel test, if deemed necessary, a thin cutter blade shall be used to carefully initiate the peel at the interface between the two casings and make it peel through the full weld width.

Acceptance Criteria:

- The test-strip has peeled off the welded area with a full ductile failure (no brittle area) at the weld interface, the ductile failure zone shall occur on both sides of the weld interface (between the joint casing and the pipeline casing).
- For ductile failure of the test-strip (by elongation) without being fully removed from the welded area, there shall be visible ductile behaviour in front of the peeled test-strip and no more than one visible welding/heating wire after the break.

Visual Examination

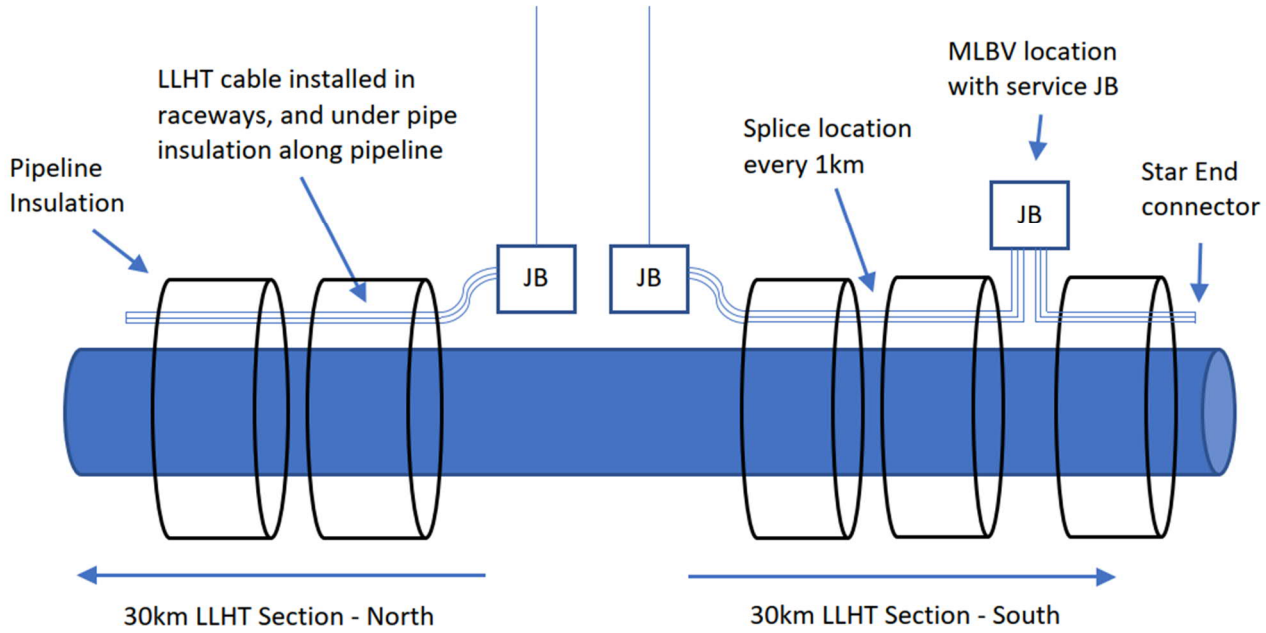
On a sample taken across the welded area and polished to a smooth mirror finish, no voids around the welding/heating wires and clear welded zone on both sides of the weld interface, when inspected with optical microscope at a x40 magnification minimum.

Oxidation Induction Time Measurement

Samples shall be taken at the interface between the field joint casing and the pipe HDPE outer jacket within the ductile failure zone of the peel test for OIT measurements on 5 samples from 5 different welded joints.

OIT results shall be no less than 30 minutes at 210°C.

APPENDIX 3. SCHEMATIC ARRANGEMENT FOR LLHT EQUIPMENT



APPENDIX 4. PRE-QUALIFICATION & PQT TESTS

	Data / Properties	Test Method	Test Conditions	Requirements	Frequency		
					Pre- Qualification	PQT	
						FJ Type A	FJ Type B, C, D, E
FBE Anti-corrosion coating							
General Data							
	Data Sheet/Safety Data Sheet			To be provided for review	Each Product	Each Product	Each Product
	Certificate of analysis			To be provided	Each Batch	Each Batch	Each Batch
	Track records/tests data as per existing standards			To be provided for review	Each Product	Each Product	Each Product
	Gel time/cure time as function of temperature			Manufacturer to provide curves	Each Product	Each Product	Each Product
Steel Surface Preparation							
	Pipe surface condition before blasting	Visual inspection and clean in accordance with Section 6.1 of this Specification.		Free of oil, grease, defects, loose debris.	2 joints	3 joints	1 joint for each FJ type
	Compressed air quality check	ASTM D4285	Ambient Temp	Free of oil and water contamination	1 per Shift	1 per Shift	1 per Shift
	Abrasive material conductivity check	ASTM D4940		< 15 milliSiemens/m (< 150 microSiemens/cm)	1 per Shift	1 per Shift	1 per Shift
	Surface cleanliness	ISO 8501-1		Sa 2.5	2 joints	3 joints	1 joint for each FJ type

	Data / Properties	Test Method	Test Conditions	Requirements	Frequency		
					Pre- Qualification	PQT	
						FJ Type A	FJ Type B, C, D, E
	Surface roughness Stylus instrument procedure.	ISO 8503-4 Stylus equipment Ry5 (cut off 2.5mm). Note 2		50-100 microns Ry5 (stylus)	2 joints	3 joints	1 joint for each FJ type
	Surface Roughness Replica tape method	ISO 8503-5 Note 2		50-100 microns	2 joints	3 joints	1 joint for each FJ type
	Salt contamination	SCM130/400		2 micrograms/cm^2 max	1 joint	1 joint	1 joint for each FJ type
	Dust level	ISO 8502-3		Quantity <=2 Size <=2	1 joint	1 joint	1 joint for each FJ type
	Abrasion of overlap to FBE	Sand paper grit 50 minimum		>75mm overlap. 100% surface	2 joints	3 joints	1 joint for each FJ type
	Surface temperature before coating	thermometer		3°C above dew point and as per Manufacturer recommendation	2 joints	3 joints	1 joint for each FJ type
Coating Application							
	Surface temperature prior to application	thermometer		As per Manufacturer recommendation	2 joints	3 joints	1 joint for each FJ type
	Mix ratio	Cup shot calibration		As per Manufacturer recommendation with a maximum of 5%	2 joints	3 joints	1 joint for each FJ type
	Overlap onto FBE			50 mm minimum	2 joints	3 joints	1 joint for each FJ type
	Wet film thickness	ISO 2808-1A		As per Manufacturer recommendation with a minimum of 500 microns	2 joints	3 joints	1 joint for each FJ type

	Data / Properties	Test Method	Test Conditions	Requirements	Frequency		
					Pre- Qualification	PQT	
						FJ Type A	FJ Type B, C, D, E
	Dry film thickness	ISO 21809-3		As per manufacturer recommendation with a minimum of 500 microns	2 joints	3 joints	1 joint for each FJ type
	Forced cure	thermometer		Manufacturer's recommendation and no foaming or bubbles. Temperature compatible with PU Foam application.	2 joints	3 joints	1 joint for each FJ type
	Holiday detection	ISO 21809-3	Ambient	2 kV/mm – No holidays	2 joints	3 joints	1 joint for each FJ type
Epoxy coating – Off-line Testing							
	Water Absorption	ASTM D570	24hrs at 23°C	<0.1%	3 Samples	3 Samples	3 Samples (Note 5)
	Impact resistance	ISO 21809-3	Ambient	3 J/mm - No holidays	1 joint	1 joint	1 joint (Note 5)
	Adhesion to steel	ISO 4624	Ambient	> 10 MPa	2 joints (Note 4)	3 joints	3 joints for each FJ type (Note 5)
	Adhesion to FBE overlap	ISO 4624	Ambient	> 10 MPa	2 joints (Note 4)	3 joints	3 joints for each FJ type (Note 5)
	Adhesion to steel after Hot Water Immersion Testing	ISO 21809-3 (HWI) ISO 4624 (Adhesion)	Ageing: 28 days at 80°C. Testing at ambient	23°C > 7 MPa	2 joints (Note 4)	3 joints	3 joints for each FJ type (Note 5)

	Data / Properties	Test Method	Test Conditions	Requirements	Frequency		
					Pre- Qualification	PQT	
						FJ Type A	FJ Type B, C, D, E
	Adhesion to FBE after Hot Water Immersion Testing	ISO 21809-3 (HWI) ISO 4624 (Adhesion)	Ageing: 28 days at 80°C. Testing at ambient	23°C > 7 MPa	2 joints (Note 4)	3 joints	3 joints for each FJ type (Note 5)
	Adhesion to steel after Hot Water Immersion Testing	ISO 21809-3 (HWI) ISO 4624 (Adhesion)	Ageing: 28 days at 85°C. Testing at ambient	For Information	2 joints (Note 4)	3 joints	3 joints for each FJ type (Note 5)
	Adhesion to FBE after Hot Water Immersion Testing	ISO 21809-3 (HWI) ISO 4624 (Adhesion)	Ageing: 28 days at 85°C. Testing at ambient	For Information	2 joints (Note 4)	3 joints	3 joints for each FJ type (Note 5)
	Cross cut	ISO 21809-2-Clause A4	Ambient	Rating 1 max	2 joints	3 joints	3 joints for each FJ type (Note 5)
	Hardness	ISO 868	Ambient	> 80 Shore D	2 joints	3 joints	3 joints for each FJ type (Note 5)
	Cathodic disbondment at 28 days	ISO 21809-3	23°C	< 5mm	2 joints (Note 4)	3 joints	3 joints for each FJ type (Note 5)
	Cathodic disbondment at 48 hours	ISO 21809-3	65°C	< 3mm	2 joints (Note 4)	3 joints	3 joints for each FJ type (Note 5)
	Glass transition temperature of cured product	DSC (inflection point)		90°C minimum	1 joint	1 joint	1 joint for each FJ type
PE100 Casing and Welding							
General Information							

	Data / Properties	Test Method	Test Conditions	Requirements	Frequency		
					Pre- Qualification	PQT	
						FJ Type A	FJ Type B, C, D, E
	Data sheet / Safety Data sheet / CoA / CoC			To be provided for review	Each batch	Each batch	Each batch
	Description and composition of the casing if multi-layer system			To be provided for review	Each Product	Each Product	Each Product
	PE100 certification	ISO 12162		To be provided for review	Each Product	Each Product	Each Product
	Track record and test data as per existing standards	EN 253:2009 and EN 489:2009		To be provided for review	Each Product	Each Product	Each Product
	Welding compatibility with outer casing of pipeline	ISO 1133-1	5 kg/190°C	Both MFR do not differ by more than 0.5 g/10 min	Each Product	Each Product	Each Product
	Climatic compatibility: minimum natural shrinkage temperature			The minimum natural shrinkage temperature shall be demonstrated via specific test report. To be provided for review	Each Product	Each Product	Each Product
	Welding process description and track record			To be provided for review	Each Product	Each Product	Each Product
	Surface treatment description of internal face of casing.			Manufacturer to provide corresponding information for review.	Each Product	Each Product	Each Product

	Data / Properties	Test Method	Test Conditions	Requirements	Frequency		
					Pre- Qualification	PQT	
						FJ Type A	FJ Type B, C, D, E
PE100 Casing Properties							
	MFR (Melt mass flow rate)	ISO 1133-1	5 kg/10min	As per Manufacturer range and compatible with outer casing of pipeline	Each batch (CoA)	Each batch (CoA)	Each batch (CoA)
	Density (black compound)	ISO 1183	23°C	> 940 and as per Manufacturer range	Each batch (CoA)	Each batch (CoA)	Each batch (CoA)
	Carbon black content	ISO 6964	23°C	> 2% and as per Manufacturer range	Each batch (CoA)	Each batch (CoA)	Each batch (CoA)
	OIT	ISO 11357-6	210°C	> 30 minutes	Each batch (CoA)	Each batch (CoA)	Each batch (CoA)
	Carbon black particle size content			Type P	Each batch (CoA)	Each batch (CoA)	Each batch (CoA)
	Hardness	ISO 868	23°C	> 55 Shore D	2 joints	3 joints	1 joint for each FJ type
Welding Process							
	Welding wires certificate of analysis			To be provided for review	Each batch	Each batch	Each batch
	HDPE compatibility (in case of HDPE coated wires)			MFR do not differ by more than 0.5 g/10min between wires, field joint casing and HDPE pipe casing	Each batch	Each batch	Each batch
	PE100 certificate (in case of PE coated wires)	ISO 12162		To be provided by wire manufacturer for review	Each batch	Each batch	Each batch

	Data / Properties	Test Method	Test Conditions	Requirements	Frequency		
					Pre- Qualification	PQT	
						FJ Type A	FJ Type B, C, D, E
	Welding parameters (temperature profile and time)			To be defined by material supplier and demonstrated during PQT with acceptable range for each parameter. The PQT shall define the acceptance values to be used for the PPT and Production.	Each Product	Each Product	Each Product
	Welding parameters recording			Full tractability of each weld parameters shall be provided, with weld identification	2 joints	3 joints	3 joints for each FJ type
	Surface preparation of the HDPE outer pipe overlap	Sand paper grit 50 minimum		150 mm overlap length minimum. 100% surface	2 joints	3 joints	3 joints for each FJ type
	Overlap of casing			75 mm over PU foam minimum	2 joints	3 joints	3 joints for each FJ type
	Electro-fused zone			20 mm minimum	2 joints	3 joints	3 joints for each FJ type
	Distance of EF zone from casing external edges			20 mm minimum	2 joints	3 joints	3 joints for each FJ type
	Casing installation - gap measurement between casing and pipe before shrinkage (when applicable)			Gap as per manufacturer recommendation. To be used as process control for PPT and Production	2 joints	3 joints	3 joints for each FJ type

	Data / Properties	Test Method	Test Conditions	Requirements	Frequency		
					Pre- Qualification	PQT	
						FJ Type A	FJ Type B, C, D, E
	Shrinkage temperature and time (when applicable)			Gap as per manufacturer recommendation. To be used as process control for PPT and Production	2 joints	3 joints	3 joints for each FJ type
	Torque control of strapping system			As per manufacturer recommendation and providing full surface contact between field joint casing and outer pipe casing during the welding process. To be used as process control during PPT and Production.	2 joints	3 joints	3 joints for each FJ type
	Time before release of strapping system			To be defined during PQT and used during PPT and production as process control	2 joints	3 joints	3 joints for each FJ type
	Pressure test	Pressure of 0.2 bars for 3 minutes. Soapy water around the casing edges or weld locations.		No leak. In the event of a leak failure the entire casing shall be removed. Repairs are not permitted at this stage.	2 joints	3 joints	3 joints for each FJ type
Welding Process – Off-line Testing							
	Welding process qualification	Appendix 2		Appendix 2	10 welds	10 welds	10 welds
	Weld joint stress crack resistance*	EN 489:2009 Clause 4.2.4	80°C	>300hrs	One joint	One joint	One joint

	Data / Properties	Test Method	Test Conditions	Requirements	Frequency		
					Pre- Qualification	PQT	
						FJ Type A	FJ Type B, C, D, E
PU Foam							
General Information	Data sheet / Safety data sheet			To be provided for review.	Each Product	Each Product	Each Product
	Track records/test results as per existing standards	EN 253:2009 and EN 489:2009		To be provided for review	Each Product	Each Product	Each Product
	PU type			Polyether polyol. Foaming via water reaction with isocyanate. No CFC.	Each Product	Each Product	Each Product
	Recommendation for PU foam process and quantity injected to get the expected final properties			Manufacturer recommendation and calculation sheet report for review	Each Product	Each Product	Each Product
	Maximum temperature of steel substrate for PU foam injection.			Manufacturer to provide test data demonstrating the maximum allowable temperature of the steel substrate for PU foam injection.	Each Product	Each Product	Each Product
PU Foam Properties							
	Viscosity (polyol)	manufacturer	20°C	Within range of manufacturer. Certificate of Analysis	Each batch	Each batch	Each batch
	Density (polyol)	manufacturer	20°C	Within range of manufacturer. Certificate of Analysis	Each batch	Each batch	Each batch

	Data / Properties	Test Method	Test Conditions	Requirements	Frequency		
					Pre- Qualification	PQT	
						FJ Type A	FJ Type B, C, D, E
	Viscosity (isocyanate)	manufacturer	20°C	Within range of manufacturer. Certificate of Analysis	Each batch	Each batch	Each batch
	Density (isocyanate)	manufacturer	20°C	Within range of manufacturer. Certificate of Analysis	Each batch	Each batch	Each batch
	Isocyanate content	ISO 14896	23°C	Within range of manufacturer. Certificate of Analysis	Each batch	Each batch	Each batch
	Cream and string time	manufacturer		Within range of manufacturer. Certificate of Analysis	Each batch	Each batch	Each batch
	Free rise density	manufacturer		Within range of manufacturer. Certificate of Analysis	Each batch	Each batch	Each batch
PU Foam Injection Process							
	Polyol injection temperature			Within range of manufacturer	Continuous check and record	Continuous check and record	Continuous check and record
	Isocyanate injection temperature			Within range of manufacturer	Each Product	Each Product	Each Product
	Mix ratio	Ratio by weight (cup shot)	Ambient	Nominal +/- 2%	Each pour	Each pour	Each pour

	Data / Properties	Test Method	Test Conditions	Requirements	Frequency		
					Pre- Qualification	PQT	
						FJ Type A	FJ Type B, C, D, E
	Steel substrate temperature before injection	thermometer		Within manufacturer recommendation and below the maximum allowable temperature for the PU foam. To be used as process control during PPT and Production.	2 joints	3 joints	1 joint for each FJ type
	Injection time	Record time		Within range of manufacturer	Each pour	Each pour	Each pour
	Quantity of material injected	Kg		Within range of manufacturer	Each pour	Each pour	Each pour
PU Foam - Off-line Tests							
	Foam density	EN 253:2009		Project nominal +/- 10%	2 joints	3 joints	1 joint for each FJ type (Note 6)
	Voids and bubbles	As per Section 8 of this Specification.		Total void area < 5% Measured as per Section 8 of this Specification.	2 joints	3 joints	3 joint for each FJ type
	Closed cell content	EN 253:2009		> 88%	2 joints	3 joints	1 joint for each FJ type (Note 6)
	Cell size	EN 253:2009		< 0.5 mm	2 joints	3 joints	1 joint for each FJ type (Note 6)
	Thermal conductivity	ISO 8497		< 0.03 W/m.k	1 joint	1 joint	1 joint for each FJ type (Note 6)

	Data / Properties	Test Method	Test Conditions	Requirements	Frequency		
					Pre- Qualification	PQT	
						FJ Type A	FJ Type B, C, D, E
	Compressive strength	ISO 844		> 0.4 MPa	1 joint	1 joint	1 joint for each FJ type (Note 6)
	Water absorption	EN 489:2009 Clause 4.2.3.4		< 10% after 90 min boiling water	1 joint	1 joint	1 joint for each FJ type (Note 6)
Full Field Joint Testing							
	Soil stress test and water ingress	EN 489:2009 Clause 5.1	80°C	No water ingress as per Clause 5.2 of EN 489	-	One joint	-
	Water tightness Note 1	EN 489:2009 Clause 4.2.1	23°C	No water ingress	-	One joint Note 1	-
	PU Foam Shrinkage - after ageing Note 1	EN 489:2009 Clause 4.2.3.1		Shrink < 2 mm	-	One joint Note 1	-
	Water ingress	As per Appendix 1		Report degradation and disbondment.	-	One joint	-
Documentation							
	Report detailing the test results shall be submitted to COMPANY for review and acceptance.				1 report	1 report	

	Data / Properties	Test Method	Test Conditions	Requirements	Frequency		
					Pre- Qualification	PQT	
						FJ Type A	FJ Type B, C, D, E

Notes:

1. Historical data can be provided if system is identical to the one under qualification.
2. Replica tape method (Press-o-film) permitted for use in PPT and Production only if calibrated against stylus instrument during PQT. Refer to Section 6.1 of this Specification.
3. CoA = Certificate of Analysis. CoC = Certificate of Conformity
4. May be performed on representative test plates, on the condition they are coated at the same time as the FJC, using the same equipment, materials and procedure
5. Not required if the LE product has been previously qualified on any other FJ type.
6. Not required if the PUF product has been previously qualified on any other FJ type.

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