

Group Instruction for Supply



GIS 06-404

External Field Joint Coating

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Engineering Technical Practice
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Foreword

The latest draft of the European standard, EN 10329, “Steel tubes and fittings for onshore and offshore pipelines - External field joint coatings”, is used as the basis for this Group Instruction for Supply (GIS).

This is the first issue of Engineering Technical Practice (ETP) GIS 06-404. This GIS is newly created and is not based on any heritage documents from the merged BP companies.

1. Scope

- a. This GIS provides minimum requirements for application and related testing of corrosion protection coatings applied to steel surfaces that remain bare after coated line pipe and/or coated fittings (components) have been joined by welding.
- b. This GIS applies to both seamless and welded pipe.
- c. This GIS describes:
 1. Responsibilities of the coating applicator.
 2. Different types of field joint coatings for both buried and immersed pipelines.
- d. This GIS refers to field joint coatings for pipelines that are to be cathodically protected.

2. Normative references

The following referenced documents may, to the extent specified in subsequent clauses and normative annexes, be required for full compliance with this GP:

- For dated references, only the edition cited applies.
- For undated references, the latest edition (including any amendments) applies.

BP

GIS 06-401	Cold Applied Tape Wrap.
GIS 06-402	Fusion Bonded Epoxy Powder External Pipeline Coatings.

American Society for Testing and Materials (ASTM)

ASTM G14	Standard Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test).
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European Standards (EN)

EN 10289	Steel tubes and fittings for onshore and offshore pipelines. External liquid applied epoxy and epoxy-modified coatings.
EN 10290	Steel tubes and fittings for onshore and offshore pipelines. External liquid applied polyurethane and polyurethane-modified coatings.
EN 12068	Cathodic protection. External organic coatings for the corrosion protection of buried or immersed steel pipelines used in conjunction with cathodic protection. Tapes and shrinkable materials.

International Organisation for Standardisation (ISO)

ISO 868	Plastics and ebonite - Determination of indentation hardness by means of a durometer (Shore hardness).
ISO 2808	Paints and varnishes - Determination of film thickness.
ISO 8501-1	Preparation of steel substrates before application of paints and related products - Visual assessment of surface cleanliness - Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.
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 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.
ISO 8503	Preparation of steel substrates before application of paints and related products - Surface roughness characteristics of blast-cleaned steel substrates.
ISO 9001	Quality management systems - Requirements.
ISO 9002	Quality systems - Model for quality assurance in production, installation and servicing.
ISO 11357-2	Plastics - Differential scanning calorimetry (DSC) - Part 2: Determination of glass transition temperature.

NACE International (NACE)

NACE RP0274	High Voltage Electrical Inspection of Pipeline Coatings Prior to Installation.
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Society for Protective Coatings (SSPC)

SSPC SP 1	Solvent Cleaning.
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3. Symbols and abbreviations

For the purpose of this GIS, the following symbols and abbreviations apply:

EP	Epoxy.
FBE	Fusion bonded epoxy.
HSS	Heat Shrink Sleeve
ITP	Inspection and test plan.
PUR	Polyurethane.
PVC	Polyvinyl chloride.

4. Quality assurance

- a. Field joint coating operation shall be governed by a documented quality system, which ensures that requirements of the specification are met in every respect.
- b. Quality system shall be based upon recognised quality standards, of which ISO 9001 and ISO 9002 are suitable examples. Quality assurance systems in accordance with other equivalent standards may be used, subject to approval by the BP responsible engineer.
- c. A quality assurance group shall be established that is responsible for reviewing the quality system and ensuring its implementation.
- d. Application and test procedures that make up the quality system and ITP shall be subject to agreement with the BP responsible engineer.

Quality systems designed according to the requirements of national or international standards other than those quoted may provide fit for purpose alternatives.

The application and test procedures should be specific to the project and should be produced on a project by project basis.

- e. Quality system shall:
 - 1. Include control of material and equipment suppliers and subcontractors.
 - 2. Ensure that requirements of this GIS are satisfied by vendors and subcontractors operating quality systems in their own organisations.
- f. A quality plan and ITP for activities necessary to satisfy specification requirements shall be prepared and be subject to agreement with the BP responsible engineer before commencement of work as follows:

The quality plan and ITP should be specific to the project and should be produced on a project by project basis.

 - 1. Quality plan and ITP shall include any subcontracted work. Subcontractor quality plans shall be submitted.
 - 2. Quality plan shall be sufficiently detailed to indicate sequentially and, for each discipline, the requisite quality control, inspection, testing and certification activities, and appropriate frequencies for the same with reference to relevant procedures and acceptance standards.
- g. Quality system and associated procedures may, with due notice, be subject to BP formal audits. Application of quality control will be monitored by BP inspectors, who will witness and accept, on behalf of BP, inspection, testing, and associated work required by the specification.
- h. The provision for inspection services to report directly to BP shall in no way relieve the responsibility to ensure that the full scope of work is performed entirely in accordance with the specification and the agreed quality plan and ITP.

5. Field joint coating selection

5.1. Field joint coating and factory coating matrix

- a. Permissible field joint coating and line pipe coating combinations are provided in Table 1.
- b. In each case, field joint coatings that are used shall:
 - 1. Be comparable in physical and mechanical properties to line pipe coating.
 - 2. Provide a satisfactory level of adhesion to factory coating and steel substrate.
 - 3. Be suitable for the full operating temperature range of the pipeline in the specific environment.
- c. The most appropriate field joint coating shall be selected in accordance with Table 1.

5.2. Manufacturer data

- a. The latest manufacturer product data sheets and batch certificates for materials to be used shall be obtained from manufacturer and retained.
- b. The minimum amount of information that shall be obtained from coating materials manufacturer is provided in respective clauses of this GIS, which cover each specific field joint coating material (see 8.1 to 8.5). This information shall be provided either in manufacturer product data sheets or supplementary documentation before any work commences.
- c. Measures shall be taken to ensure that:
 - 1. Raw materials, including cleaners, abrasives, and coating materials, comply fully with this GIS.
 - 2. Manufacturer recommended storage instructions are followed.

3. Manufacturer recommended shelf life has not been exceeded.
4. Raw materials are stored in accordance with manufacturer instructions and remain in acceptable condition at all times.

Table 1 - Types of field joint coating(s) depending on the factory applied coating

Factory applied line pipe coating	Field joint coating †						
	1	2	3	4	5	6	7
Cold applied laminate tapes	√	x	x	x	x	x	x
Coal tar and asphalt enamel	√	√	√	√	x	x	x
Epoxy powder	x	x	√	√	√	x	x
Three layer FBE powder/polyethylene	x	√	√	√	x	x	x
Three layer FBE powder/polypropylene	x	√*	x	x	x	√	√
Liquid epoxy and epoxy modified coatings (bends and fittings)	x	x	√	x	x	x	x
Liquid polyurethane and polyurethane modified coatings (bends and fittings)	x	x	x	√	x	x	x

√ = Suitable coating x = Unsuitable coating

† Field joint coating key

	Clause
1. Cold applied laminate tape	8.1
2. Heat shrinkable materials	8.2
3. Liquid applied epoxy	8.3
4. Liquid applied polyurethane	8.3
5. FBE	8.5
6. FBE/flame sprayed polypropylene	8.4
7. FBE/tape applied polypropylene	8.4

* Polypropylene heat shrink sleeves only (e.g., Canusa GTS-PP)

6. General requirements for surface preparation and coating application

6.1. Preparation of field joint area before coating

6.1.1. Surface cleaning

- a. During inclement weather, such as wind and rain, cleaning operations shall only be performed if suitable protective awnings or shelters are provided that prevent contamination of the surface being prepared.
- b. The entire field joint area, including, as a minimum, the first 100 mm (4 in) of adjacent line pipe coating, shall be cleaned in accordance with SSPC SP 1 to remove any dirt, grease, or salt contamination.
- c. Filing or grinding shall be used to remove any weld spatter, slag, rough weld capping, burrs, etc., that would otherwise be detrimental to the quality of the finished coating.

6.1.2. Steel surfaces

6.1.2.1. Surface preparation

- a. Surface preparation shall only take place if relative humidity is less than 85% and steel temperature is more than 3°C (5°F) above dewpoint.
- b. Rust and scale shall be removed by blast cleaning with a suitable abrasive to produce a surface that corresponds to Grade Sa 2-1/2 or better, as defined in ISO 8501-1.
- c. Choice of abrasive shall be such that it produces an angular surface profile with amplitude of 50 μ to 100 μ (2 mil to 4 mil). Surface profile shall be measured in accordance with one or more of the methods described in ISO 8503.

- d. Steel shot should not be used for abrasive blasting.

This produces a rounded profile, resulting in less efficient coating adhesion.

6.1.2.2. Surface imperfections

- a. Slivers, laminations, or other imperfections exposed by the cleaning process shall be removed, and the steel surface shall be reblast cleaned.
- b. After removal of these imperfections, residual pipe wall thickness shall comply with minimum tolerance requirements of pipe manufacturing specification.

6.1.2.3. Salt contamination

- a. A salt meter approved by the BP responsible engineer shall be used to perform salt tests on the field joint to determine whether further surface cleaning is required. Alternatively, a conductometric method may be used in accordance with ISO 8502-9.
- b. In each case, at least one test shall be performed on each side of each field joint.
- c. Salt meter shall be calibrated in accordance with equipment manufacturer recommendations.
- d. Alternatively, a standard and/or proprietary volumetric procedure may be used to determine level of salt contamination.
- e. Acceptance criteria shall be $3 \mu\text{g}/\text{cm}^2$ ($0,7 \mu\text{oz}/\text{in}^2$), maximum.
- f. Initially, frequency of salt tests shall be one test for each hr of production. If, over a period of time, acceptable values are consistently achieved, frequency of salt test measurements may be reduced at the discretion of the BP responsible engineer.

Salt contamination testing frequency may be relaxed once the results obtained demonstrate that the risk of surface salt contamination is being successfully managed.

6.1.3. Preparation of adjoining factory applied coating

- a. A minimum of the first 50 mm (2 in) of factory coating adjacent to the field joint area shall also be prepared to provide a suitable surface to which the field joint coating can adhere.
- b. Methods for preparing the area described in a. are dependent upon factory applied coating and described in more detail throughout this clause. In all cases, the first stage shall be the complete removal of dirt, grease, and other forms of contamination in accordance with 6.1.1.b as follows:
 - 1. For coal tar and asphalt enamel surfaces, ragged edges shall be removed, and the surface shall be roughened or abraded using abrasive paper or a file.
 - 2. Disbonded and ragged cold applied tapes shall be cut back to a firmly adherent edge and square end. The outer surface shall be lightly roughened with abrasive paper.
 - 3. FBE shall be lightly sweep abrasive blast clean or hand abraded for a roughened finish with no loosely bonded coating remaining.
 - 4. Three layer FBE polyethylene
 - a) A toe of FBE, if provided beyond the polyethylene layer termination, shall be treated as described in 3.
 - b) Polyethylene outer coating shall be either abrasive blast cleaned, scraped with a surform or similar tool, or abraded with a coarse flexible sanding disc (P60) to provide a firm key.
 - c) If it can be demonstrated to be beneficial, controlled flame treatment with an appropriate oxidising flame shall be performed. Measurements of surface energy

may be taken before and after flame treatment using surface tension pens to determine effectiveness of the treatment.

5. Three layer FBE polypropylene
 - a) A toe of FBE, if provided beyond the polypropylene layer termination, shall be treated as described in 3.
 - b) Polypropylene outer coating shall be scraped clean using a surform or equivalent tool.
 - c) If polypropylene field joint coating is to be applied, external heat shall be applied until outer surface of the polypropylene is soft if prodded with a blunt instrument. Heating of polypropylene at the overlap areas shall be performed immediately before application of polypropylene field joint coating component.
6. For liquid applied epoxy and urethane coatings, area to be overlapped shall be lightly abrasive blast cleaned or hand abraded to provide a roughened surface on which subsequent coatings may be overlapped.

6.1.4. Contamination of prepared surfaces

- a. Before field joint coating is applied, residual abrasive dust and debris shall be removed from surface of the joint by blowing with clean compressed air or another method, subject to approval by the BP responsible engineer.

The efficacy of the chosen method of removal of dust and debris should be demonstrated.

- b. A prepared field joint that becomes contaminated in any way before coating application can be performed shall be subject to further cleaning in accordance with a.

6.1.5. Quality control of surface preparation

- a. Relative humidity, dewpoint, and steel temperature shall be measured at the start of each shift and at least every 4 hr thereafter.
- b. Visual inspection of each field joint shall be performed over 100% of the surface to determine compliance with 6.1.2.1 and 6.1.2.2.
- c. Surface profile measurements shall be performed, at a minimum, as follows:
 1. Two measurements per field joint.
 2. One field joint at the start of each shift and one field joint every 4 hr thereafter.
- d. Level of dust contamination shall be determined in accordance with ISO 8502-3 at start of each shift and every 4 hr thereafter. Degree of cleanliness shall be rating 2 or better.
- e. Quality control requirements during surface preparation shall comply with Table 2, unless agreed otherwise with BP.

Quality control requirements should be assessed on a project by project basis.

6.2. Coating application

- a. Coatings shall not be applied if relative humidity is greater than 85% or steel temperature is less than 3°C (5°F) above dewpoint.
- b. Field joint shall be coated within 4 hr of surface preparation or before any visual deterioration of the surface, whichever is sooner.

Table 2 - Quality control of surface preparation

Item	Requirement	Clause reference	Frequency	
			Prequalification	Production
Abrasive	Present batch certificate	5.2.a	Each batch.	Each batch.
	Check storage conditions	5.2.c	Each batch.	Each batch.
Environmental conditions		6.1.2.1.a/6.2.a	Beginning of each shift and every 4 hr thereafter.	Beginning of each shift and every 4 hr thereafter.
Pipe surface condition		6.1.5.b	100% each field joint.	100% each field joint.
Surface cleanliness		6.1.2.1.b	100% each field joint.	100% each field joint.
Surface contamination		6.1.5.d	Two locations, minimum, per field joint.	Two locations on one field joint. Start of each shift and every 4 hr thereafter.
Surface profile		6.1.5.c.	Two locations, minimum, per field joint.	Two locations on one field joint. Start of each shift and every 4 hr thereafter.
Salt contamination		6.1.2.3	One location, minimum, per field joint.	Once per field joint per hr.
Preparation of line pipe coating		6.1.3	100% each field joint.	100% each field joint.

- c. Immediately before application, surface temperature of the joint shall be within temperature range specified by coating manufacturer. Temperature monitoring shall be performed as follows:
 1. Temperature of the joint shall be monitored using a reliable temperature measurement technique to ensure that application conditions on the steel substrate and factory applied coating are correct.
 2. Instruments used for this purpose shall be fully calibrated.
- d. Coating shall be applied in accordance with manufacturer recommendations by trained personnel. If preheat is required to raise temperature of steel substrate, induction heating shall be used.

Heating with an open flame cannot provide uniform heat input to the field joint area and often results in damage to existing line pipe coating.

- e. Induction heating coils used to heat pipe at any stage in surface preparation and coating process shall undergo a heat profile test during field joint coating prequalification as follows:
 1. Heat profile test shall involve fixing at least six thermocouples to the steel substrate and recording the temperature profile across and around the circumference of the field joint during rise and decay in temperature.
 2. A permanent record of heat rise and decay for each induction coil used shall be retained for duration of production work scope.
 3. Temperature variation across the field joint shall not exceed 15°C (27°F).
- f. If coating is applied using automated equipment, a documented maintenance routine shall be developed to ensure reliability of the equipment as follows:
 1. Sufficient spare parts shall be available at site to fully support maintenance activities and prevent prolonged equipment outages.
 2. Documented maintenance routine shall form part of inspection and test plan.

If used continuously over extended periods, hot twin airless spray equipment used to apply solvent free, two pack epoxy and polyurethane coatings is particularly prone to off specification mixing due to equipment malfunction.



6.3. Appearance of applied coating

Applied coating shall be of uniform appearance over the entire surface, with no foreign matter inclusions (grit, dust, etc.) and no wrinkles, blisters, runs, or sags.

6.4. Testing

Throughout production, regular inspection of surface cleaning, surface preparation, and coating application shall be performed at each stage as follows:

- a. Table 2 covers inspection requirements during surface preparation.
- b. Inspection requirements during and after coating application are provided under each generic coating type in 8.
- c. Relevant inspection and test procedures are given in Annex A through Annex I.
- d. Activities listed in inspection and test procedures shall be the minimum acceptable to BP.

6.5. Coating repairs

For each line pipe coating and field joint coating combination to be used, a coating defect acceptance criteria and repair procedure shall be subject to review and approval by the BP responsible engineer before procedure prequalification.

The coating defect acceptance criteria should be defined before starting the coating procedure prequalification.

7. Coating application - procedure prequalification

7.1. General

- a. Proposed procedures to be used for field application of the specified field joint coating system shall fully comply with this GIS and shall be subject to approval by the BP responsible engineer.

The procedures covering the application in the field of the field joint coating should be agreed before coating work starts.

- b. Before start of production coating, proposed procedures for field joint coating shall be qualified to the project specification requirements. Where no applicable project specification exists the procedures shall be qualified to the requirements of this GIS.

7.2. Coating procedures

Coating procedures shall incorporate full details of the following:

- a. Full descriptions of raw materials, their manufacturer(s), and grades to be used, including current data sheets that provide values for basic properties of each material.
- b. Raw material verification test methods and results.
- c. Preliminary pipe inspection.
- d. Pipe cleaning/dirt and grease removal.
- e. Blast cleaning abrasives and techniques.
- f. Testing for soluble salts.
- g. Abrasive blast cleaning quality, standard, and surface profiles.
- h. Method of dust removal.
- i. Measurement of residual dust contamination.

- j. Pipe preheat method and pipe temperature at point of coating.
- k. Coating application procedures.
- l. Coating inspection procedures, testing methods, and acceptance criteria.
- m. Coating repair procedures.
- n. ITP.

7.3. Coating procedure approval tests/prequalification

- a. Before commencement of coating procedure approval tests, documented coating procedures shall be subject to approval by the BP responsible engineer (see 7.2). These procedures shall include test methods and acceptance criteria as detailed in the annexes of this GIS.

Detailed procedures for the field joint coating work should be produced and agreed prior to the start of the coating procedure approval testing.

- b. Coating procedure approval tests will be witnessed by BP. BP shall have notice of at least 7 working days to witness procedures and tests.
- c. At least three field joints shall be prepared and coated during coating procedure approval tests in accordance with the approved coating procedure.
- d. As a minimum, tests shall be performed on raw materials used and on final coating on all three test field joints in accordance with relevant inspection and test requirements in 8 for formal approval of the overall coating application procedure.
- e. Proposed coating repair procedures shall be qualified during coating procedure approval tests.
- f. Within 4 days of completion of coating procedure approval tests, a written test report, complete with a full set of records covering properties of raw materials and applied field joint coating, shall be submitted to the BP responsible engineer for approval.

Timely submission of the test reports will allow proper consideration of the suitability of the field joint coating.

8. Field joint coatings, coating application, and quality

8.1. Cold applied laminate tapes

8.1.1. Coating description

- a. Cold applied laminate tape systems shall consist of:
 - 1. Quick drying primer, suitable for either brush or spray application.
 - 2. Anticorrosion tape, consisting of a PVC or polyethylene carrier with a minimum thickness of 0,75 mm (0,030 in) that is firmly adhered to an inner layer of a self adhesive bituminous rubber compound with a minimum thickness of 0,8 mm (0,031 in).
 - 3. Optional (if specified) mechanical protection outer wrap with minimum thickness of 0,75 mm (0,030 in) and in accordance with GIS 06-402. Tape shall be suitable for application by hand or machine.
- b. Cold laminate tape wrap coatings shall comply with GIS 06-401.

8.1.2. Technical information

- a. General technical data on cold applied laminate tape system, as described in 7.2.a and 7.2.b, shall be obtained from tape manufacturer.

- b. Specific technical data listed in Table 3 shall also be obtained.

Table 3 - Technical data sheet for cold applied laminate tapes

Name of manufacturer.
Commercial name of product(s).
Generic description of product(s).
Recommended storage conditions.
Structure of coating system.
Number of layers.
Primer.
Solids content.
Density.
Method of application.
Colour.
Dry film thickness range.
Solvent required for thinning/cleaning.
Recommended ambient conditions during application.
Time to overwrapping with tape system versus temperature.
Tape system(s).
Composition.
Tolerance on thickness of component.
Method of application.
Impact resistance.
Tensile strength.
Maximum operating temperature.

8.1.3. Surface preparation

Surface preparation shall be performed in accordance with 6.1.

8.1.4. Application of coating

- a. Coating shall be applied in accordance with the coating application clause in GIS 06-401. Cold applied tape shall overlap adjacent intact factory coating by at least 100 mm (4 in).
- b. If height of line pipe seam weld or butt weld exceeds 2 mm (0,08 in), weld seam cover tape shall be used.
- c. Weld seam cover tape shall:
 1. Have a width that is at least three times the maximum width of the weld seam.
 2. Be identical in composition to that used to wrap body of pipe.
 3. Be applied before application of circumferential tape wrap.

8.1.5. Quality control of surface preparation and coating application

8.1.5.1. General

- a. General requirements for inspection and testing during surface preparation are specified in Table 2 and 6.1.5.
- b. Specific requirements for cold applied tape application are described in 8.1.5.2 through 8.1.5.3 and summarised in Table 4.

8.1.5.2. Surface preparation

Quality control during surface preparation shall, as a minimum, comply with 6.1.5.