Understanding ISO 21809-3

Premature failures of pipeline coatings and subsequent corrosion are often due to the lack of good specifications, including product selection and surface preparation standards, and/or poor workmanship and inspection. By M Roche

Closed cycle abrasive blast cleaning
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Field joint coatings are an integral part of the continuous corrosion protection coating system and must be specified and applied as such. In response to this requirement, ISO formed Technical Committee (TC) 67 to create value-added international standards for the oil, gas and petrochemical industries. To date more 150 standards have been published and 70 are currently in the work programme. The mission of TC 67 is to issue standards that could be adopted worldwide, nationally or regionally (e.g. EN, NACE, etc.), and to enable companies to rationalise their specifications. Within ISO TC 67, sub-committee (SC) 2 is devoted to pipelines and addresses all relevant topics, including corrosion. In terms of corrosion protection, several standards have already been published by the various work groups (WG), including;

- ISO 15589 Cathodic protection of pipeline transport systems - Part 1: On-land pipelines and Part 2: Offshore pipelines (WG11). This was also published by NACE as a modified adoption titled "ANSI/NACE SP0607-2007/ ISO 15589-2 (MOD)".
- ISO 21809 External coatings for buried or submerged pipelines used in pipeline

Typical onshore pipeline construction
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transportation systems. A series of task groups were formed to address the various generic types of external coatings (WG 14). These include:

- ISO 21809-1 Polyolefin Coatings (3-layer PE and 3-layer PP)
- ISO 21809-2 Single layer fusion bonded epoxy (FBE) coatings
- ISO 21809-3 Field joint coatings
- ISO 21809-4 Polyethylene Coatings
- ISO 21809-5 External concrete coatings
- ISO 21809-6 (In preparation) Multilayer FBE Coatings
- ISO 21809-X Multi-component polyolefin based powder coatings – at the project stage.

Work on ISO 21809-3 started in 2002. At that time the main standards and recommended practices in place were EN 12068 (Supply of tapes and shrinkable materials), EN 10329 (Field joint coatings), NACE RP 0402 (FBE at girth weld joints) and DNV RP F109 (Field joint coatings). After 9 meetings, the new standard was published in December 2008, and immediately after publication, work was started on an amendment (ISO 21809-3 Amd 1) to take into account the introduction of new families of field joint coatings and to correct some mistakes. This amendment was published in November 2011.

Following resolutions of WG3 of ISO TC67, SC2, a vote on a "New work proposal" for the complete revision of 21809-3 was approved and that work is currently underway.

There are a number of generic coating systems that are currently covered by ISO 21809-3:2008 and Amd 1:2011. These include:

- Bituminous tape coatings
- Petrolatum and wax tape coatings
- Polymeric tape coatings
- Coatings based on non-crystalline low-viscosity polyolefin tapes
- Heat shrinkable coatings
- Hot-applied microcrystalline wax coatings
- Elastomeric coatings
- Fusion bonded epoxy powder coatings
- Liquid applied coatings
- Polyolefin based coatings (hot applied)
- Thermal spray aluminium

USING ISO 21809-3

The standard as published also gives advice to users on various elements within the supply chain for field joint coatings and in this article, Marcel Roche, the Project Leader of ISO TC67 SG2 WG14-3 (the Task Group for Pipeline Field Joint Coatings), highlights some of the important points.

The standard contains a 'library' of field joint coating systems and materials. The standard is impartial and does not seek to directly contrast one system with another. It sets a minimum standard for each type of coating in isolation from the others. It does not address what cannot be used with what, i.e. parent coating compatibility is not discussed.

It requires those who use the standard to use it constructively and wisely, and requires that the purchaser, applicator and end-user act in unison to obtain the best results. In using the standard, it is not enough to simply state in a specification that field joint coatings must comply with ISO 21809-3. As stated in clause 6.1 *" ... designer needs to select the appropriate field joint coating from those available in the standard, based on parent coating compatibility, line pipe construction, location and operating conditions*". The goal should always be to create a field joint coating with equivalent performance (and with full compatibility) to the factory applied coating to avoid any compromise in pipeline integrity.

End-users must be active in defining the standard they require and must take responsibility to define the required standard and open up, or narrow down, the choice available as appropriate to the circumstances. If the objective is clearly set, then the contractor knows whether or not specialist materials, equipment and applicators are needed and can plan and schedule accordingly.

The standard also defines the following for users;

- Application Procedure Specification
- Pre-Qualification Trial
- Pre-Production Trial
- Inspection and Testing Plan
- Quality Assurance versus Quality Control

This allows the document to be further used as a tool, to ensure proper and standardised procedures are used on all projects. Looking at some of these points in more detail;

APPLICATION PROCEDURE SPECIFICATION (APS)

APS is defined in the standard as *"... document describing procedures, methods, equipment and tools to be used for coating application*". It should be prepared by the applicator and approved by the purchaser prior to the start of production or qualification trial. The APS covers all items associated with quality control and any agreed options for the specific field joint coating (FJC). Once approved the APS shall not be changed by the applicator without prior written authorisation of the purchaser. There is no requirement for the applicator to have to divulge specific and particular 'know how' that would benefit his competitors.

PROCEDURE QUALIFICATION TRIAL (PQT)

This is defined as *"... application of a field joint coating and subsequent inspection/testing of its properties to confirm that the APS is able to produce coating of specified properties, carried out at the premises of the applicator or any other agreed location*". This is used when required by the purchaser (end-user or contractor) to 'qualify' a FJC so it can be considered in projects. It is normally not project-specific and it maybe used to qualify an applicator so that he is eligible to apply a given FJC with a specific process, material, equipment and personnel. PQT's are usually carried out under factory conditions, even when it is a project-related PQT.

PRE-PRODUCTION TRIALS (PPT)

The definition of this is *"... application of a coating and inspection/testing of its properties to confirm that the APS is able to produce field joint coating of specified properties, carried out in the field immediately prior to start of production.*" When required by the purchaser (end-user or contractor), the PPT shall be carried out in his presence, or of his representative, on the first joints to be coated, or if agreed on a dummy pipe. The purpose of this is confirm that the application parameters established at the PQT are repeatable in the field and that specified properties as verified by lab testing are correct. It should be noted however, that laboratories are not generally readily available close to the project site.

INSPECTION AND TESTING PLAN (ITP)

Defined in the standard as *"... document providing an overview of the sequence of inspections and tests, including resources and procedures.*" The applicator shall perform inspection and testing during production in accordance with an ITP to verify the surface preparation, coating application, and the specified properties of the applied FJC. The ITP shall be prepared by the applicator and shall be approved by the purchaser prior to the start of the coating work, incorporating all agreed deviations, and thereby superseding the original specification.

The ITP should incorporate all installation and testing parameters that must be measured (that are known to deliver the required properties) and the frequency of measurement. The application parameters should be measured on every joint. The applicator has the duty to ensure that the applied coating complies with APS, but the applicator doesn't always carry out the formal inspection. If the contractor does the tests and fills in the Coating Record Sheets, a good dialogue with the Inspector(s) is essential. There is little to be gained by waiting to the end of the shift to point out defects. Inspectors should have appropriate qualifications and experience (to be given precedence).

QUALITY ASSURANCE VS QUALITY CONTROL

Quality assurance (QA) tests are more onerous in terms of time and their destructive nature. Typically they would be done for PQT's where coated joints can be cut up and sectioned for long term testing. The purpose is to confirm that measurable parameters used will deliver the required quality, so that those parameters can be monitored during the production Quality Control (QC) to give Assurance that the required quality is being achieved.

For example, if it is shown that a combination of easily measurable parameters such as surface profile, surface cleanliness, temperature and final thickness will produce an FBE coating that passes the DSC, CD and Hot Water Soak testing, then all that needs to be measured and recorded during the field application are these properties.

APPLICATION METHODS

A choice, in order of priority where appropriate should be presented, the onus is on the owner to stipulate which is preferred. The goal should be to maximise process control and uniformity under the given practical conditions.

For liquid coatings, automatic spray should be first choice, followed by manual spray and then brush or roller, in that order (all with abrasive blasting surface preparation)

For polyolefin-based coatings, abrasive blasting, induction heating and automated installation (preferred) should be used. This is to maximise process control for uniformity and control of surface conditions and installation temperatures wherever possible, to replicate factory conditions and parameters.

Automatic heat-shrink sleeve application
© Canusa

Table 1

Test / Property (Test method in brackets)	3LPP Factory Coating Requirement / Performance	Typical Project 3LPP Joint Coating Requirement for Major Projects
Surface Prep	Sa 2.5	Sa 2.5
Adhesion Strength (DIN 30678)	≥ 150N/cm @ 23°C ≥ 40N/cm @ 110°C	≥ 150N/cm @ 23°C ≥ 40N/cm @ 110°C
Impact Resistance (DIN 30678)	≥ 10J/mm	≥ 10J/mm
Indentation Resistance (DIN 30678)	Maximum Penetration ≤ 0.1mm @ 23°C ≤ 0.4mm @ 110°C	Maximum Penetration ≤ 0.1mm @ 23°C ≤ 0.4mm @ 90-110°C
Shore D Hardness (ASTM D2240)	≥ 60 Shore D	≥ 60 Shore D

CONSIDERATIONS FOR PSD

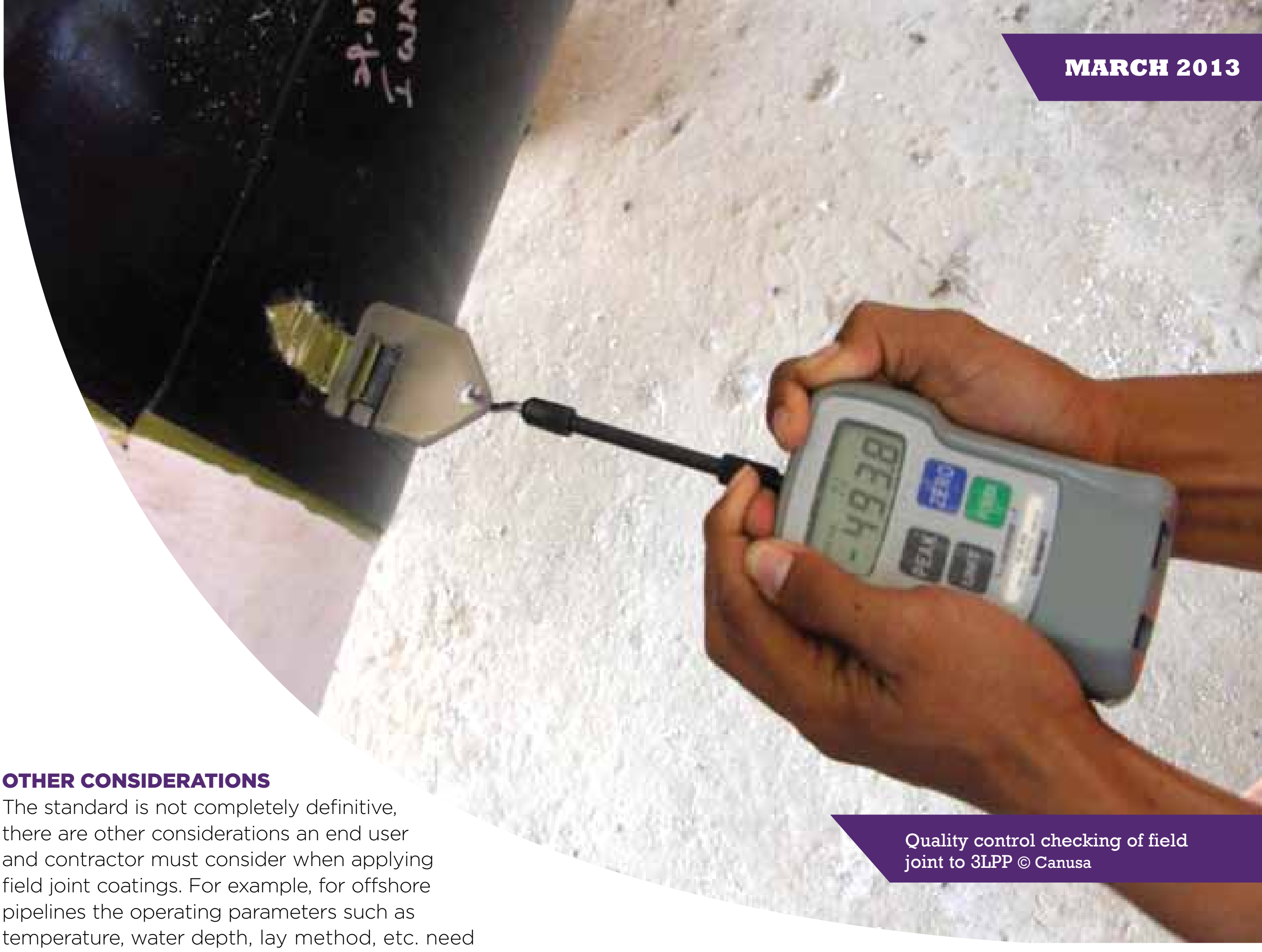
Real world examples help to demonstrate best practices in specification development. For example, in the case of 3LPP or 3LPE-coated pipelines, a review of numerous successful and representative major offshore and onshore projects completed over past decade where 3LPP or 3LPE coating was used, including, the Bluestream, MEDGAZ, Kashagan, Dolphin Sealines, NMPP in South Africa, In Salah in Algeria, among many others including numerous worldwide spoolbase projects, indicated that in all cases pipeline integrity was considered critical for these PP/PE-coated pipelines which had to deal with high temperature, deep water or unusually challenging environmental conditions.. Therefore the 3LPP or 3LPE joint coating performance on these projects was required to be essentially equal to, or exceeding, the performance of the factory applied 3LPP or 3LPE coating. For offshore pipelines, the choice of 3LPP as the factory coating was made in order to provide a certain key level of protection to the pipeline, given elevated operating temperature and/or offshore water depth, as well as the desire to ensure effective performance under these conditions for the entire lifetime of the pipeline. It was deemed too much of a risk to accept anything less on the joints for these pipelines, and only a small selection of joint coatings were considered as options to achieve this performance, as follows:

- 3LPP Extruded Systems:
  - Pre-Extruded Heat Shrinkable PP Wrap
  - Hot Applied PP Tape Wrap
- Injection Moulded 3LPP

All coatings considered generally matched the 3LPP factory-applied coating design and performance with the following components, which are common to each other and to those of the factory coating:

- ***Initial epoxy layer*** for corrosion protection.
- ***PP copolymer adhesive*** to provide effective bond of the non polar PP outer layer to the polar epoxy layer.
- ***PP outer layer*** to provide high temperature protection of the epoxy layer from moisture absorption and from external mechanical forces during operation.

The coatings considered offered equivalent performance to the 3LPP factory applied coating and this is exactly what was required in the joint coating specifications for the projects in question. Although specifications differ slightly, in general, the specifications for major successful 3LPP coated pipelines executed over the past decade have required the field joint coating performance to be as summarized in table 1.



Quality control checking of field joint to 3LPP © Canusa

OTHER CONSIDERATIONS

The standard is not completely definitive, there are other considerations an end user and contractor must consider when applying field joint coatings. For example, for offshore pipelines the operating parameters such as temperature, water depth, lay method, etc. need to be considered when selecting the optimum coating and application method. For on-shore pipelines, soil type and stress on pipeline, backfill methods, thermal cycling and ambient environment can also be important. The required design life is also another important consideration that can affect the coating required.

In summary, ISO 21809-3 contains a library of available field joint coatings. It sets a minimum standard for each type of coating, in isolation from the others, but does not address parent coating compatibility.

In all cases the ultimate goal should be for the joint coating to match the performance and design of the given factory applied coating and to have full compatibility with that coating.

If the objectives and requirements for coating performance and surface preparation are clearly set and the end-users take responsibility to ensure they are met through following the defined standardised procedures, then the contractor will understand his responsibilities and can plan construction accordingly. This will result in a FJC that is an integral and strong part of the continuous corrosion protection system.

This is an up-dated version of a presentation given at the BHR Group, Field Joint Coating Conference, Milton Keynes, UK, 2011. The author would like to thank, Ron Dunn, Canusa, David Jackson, Pipeline Induction Heat and David Norman for their help.

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