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Oil and gas industries including lower carbon energy - Qualification testing and acceptance criteria for protective coating systems under insulation - Part 1: Liquid applied coatings (ISO/DIS 19277-1:2026)

Öl- und Gasindustrie einschließlich kohlenstoffarmer Energieträger - Qualifikationsprüfung für Schutzbeschichtungssysteme unter Isolierungen - Teil 1: Flüssige Beschichtungen (ISO/DIS 19277-1:2026)

Industries du pétrole et du gaz, y compris les énergies à faible teneur en carbone - Essais de qualification des systèmes de revêtement protecteurs sous isolation - Partie 1: Revêtements appliqués sous forme liquide (ISO/DIS 19277-1:2026)

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75.200	Oprema za skladiščenje nafte, naftnih proizvodov in zemeljskega plina	Petroleum products and natural gas handling equipment
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DRAFT International Standard

ISO/DIS 19277-1

Oil and gas industries including lower carbon energ — Qualification testing and acceptance criteria for protective coating systems under insulation —

Part 1: Liquid applied coatings

Industries du pétrole et du gaz, y compris les énergies à faible teneur en carbone — Essais de qualification des systèmes de revêtement protecteurs sous isolation —

Partie 1: Revêtements appliqués sous forme liquide

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 67, *Oil and gas industries including lower carbon energy*.

This second edition cancels and replaces the first edition (ISO 19277:2018), which has been technically revised. The main changes are as follows:

- Document has now been split into two parts; this document is Part 1 dealing with liquid applied coatings only, and Part 2 is dealing with tape and sheet applied products.
- Cryogenic cyclic test has now been moved from the standard text and is included in the [Annex D](#) (Informative).
- An additional CUI simulation test has been added and option included to perform one of the three listed test methods
- Tests on stainless steel specimens have been deleted. Qualification testing of coating system shall be carried out on carbon steel. The system is then also qualified for use on stainless steel.

A list of all parts in the ISO 19277 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

Unprotected carbon steel in insulated service with the presence of water and concentrating contaminants from the atmosphere or surrounding sources can cause accelerated corrosion and lead to severe metal loss. Additionally, unprotected austenitic and duplex stainless steels can suffer external chloride-induced stress corrosion cracking if contaminants, such as chlorides from the atmosphere and or the insulation, are present at the steel surface. Therefore, steel structures under insulation are normally protected to prevent corrosion-related damage during the operational life required of the equipment.

There are different ways of protecting steel structures from corrosion under insulation. This document deals with protection by use of coating when used as part of a system, including insulation and cladding materials, which can work together to prevent corrosion under insulation (CUI). All components of the corrosion prevention system are important in achieving adequate corrosion protection. This document only deals with the coating part of the corrosion protection system with focus on typical CUI coating environments. Further, this document focuses on accelerated testing protocols and acceptance criteria, so that interested parties can make informed decisions.

To ensure effective corrosion protection of steel structures and equipment, it is necessary for owners of such structures, planners, consultants, companies carrying out corrosion protection work, inspectors of protective coatings and manufacturers of coating materials to have at their disposal state-of-the-art information in a concise form on corrosion protection by coating systems. Such information has to be as complete as possible, unambiguous and easily understandable to avoid difficulties and misunderstandings between the interested parties with the practical implementation of protection work.

This document is intended to give the abovementioned information to people who have some technical knowledge of coatings and the process operations of the equipment. It is assumed that the user of this document is familiar with other relevant International Standards, particularly those dealing with surface preparation, inspection/testing of coatings, and relevant regulations.

Future parts of this document are to be developed which are to include other subjects like higher temperature, cyclic and intermittent service, testing of coatings for maintenance and repair, tape-applied coating materials, etc.

Oil and gas industries including lower carbon energy — Qualification testing and acceptance criteria for protective coating systems under insulation —

Part 1: Liquid applied coatings

1 Scope

This document describes various corrosion under insulation (CUI) environments in refineries and other related industries and environments and establishes CUI environmental categories including operating temperature ranges from -45 °C to 204 °C for topside and aboveground service only. This document specifies both established and other test methods for the assessment of coatings used for prevention of CUI for each given environment. This document also provides acceptance criteria for each CUI environment.

NOTE The test results and acceptance criteria can be considered an aid in the selection of suitable coating systems. For service or peak temperatures over 204 °C testing acceptance criteria can be agreed between interested parties. Additional or other test and acceptance measures are possible but require particular agreement between the interested parties.

This document covers spray-applied coatings applied on new carbon steel for use in CUI service. The coatings can be used for new built structures and for existing structures where maintenance of the coating is needed. This document does not cover testing of sacrificial coatings, such as inorganic zinc, as these coatings can be consumed quickly in wet environments. Developing accelerated corrosion testing for what can be continuous wet service with sacrificial coatings is beyond the scope of this document.

“Non-through porosity” thermal spray aluminium coatings with greater than $250\text{ }\mu\text{m}$ dry film thickness can be tested and qualified in accordance with this document. This document does not cover tape and sheet applied products for use in preventing CUI.

This document does not deal with other aspects of coating degradation, such as those caused by abrasion, erosion, ultraviolet degradation or other methods that can exist given specific environment and construction methods.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 554, *Standard atmospheres for conditioning and/or testing — Specifications*

ISO 1513, *Paints and varnishes — Examination and preparation of test samples*

ISO 2409, *Paints and varnishes — Cross-cut test*

ISO 2812-2, *Paints and varnishes — Determination of resistance to liquids — Part 2: Water immersion method*

ISO 4624, *Paints and varnishes — Pull-off test for adhesion*

ISO 4628-2, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 2: Assessment of degree of blistering*

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ISO 4628-3, *Paints and varnishes — Evaluation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 3: Assessment of degree of rusting*

ISO 4628-4, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 4: Assessment of degree of cracking*

ISO 4628-5, *Paints and varnishes — Evaluation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 5: Assessment of degree of flaking*

ISO 4628-8, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 8: Assessment of degree of delamination and corrosion around a scribe or other artificial defect*

ISO 7384, *Corrosion tests in artificial atmosphere — General requirements*

ISO 9227, *Corrosion tests in artificial atmospheres — Salt spray tests*

ISO 12944-6, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 6: Laboratory performance test methods*

ISO 15528, *Paints, varnishes and raw materials for paints and varnishes — Sampling*

ISO 19840, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Measurement of, and acceptance criteria for, the thickness of dry films on rough surfaces*

AMPP TM 21442-2023, Test method for evaluation of protective coatings for use under insulation.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

artificial ageing

procedure designed to accelerate the ageing of a coating system, i.e. to reduce the corrosion-protective efficiency more rapidly than by natural weathering

[SOURCE: ISO 12944-6:2018, 3.1, modified — ‘paint system’ has been changed to ‘coating system’.]

3.2

corrosion under insulation

CUI

corrosion that is a result of the effect of moisture and contaminants, on the steel surfaces under thermal insulation

3.3

dry film thickness

DFT

thickness of a coating remaining over the peaks of a rough surface when the coating has hardened

3.4

durability

expected life of a protective coating system to the first major maintenance coating

[SOURCE: ISO 12944-8:2017, 3.3, modified — ‘paint system’ has been changed to ‘coating system’ and ‘maintenance painting’ has been changed to ‘maintenance coating’.]

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3.5

nominal dry film thickness

NDFT

dry film thickness specified for each coat or for the whole coating system

3.6

peak temperature

maximum temperature for the designed system, including possible upsets and temperature reached as a result of maintenance efforts such as steam cleaning

3.7

sacrificial coating

coating that provides corrosion protection by sacrificing or being consumed in the act of protecting the substrate

4 Performance testing design

4.1 Relationship between artificial testing and natural exposure

The selection of a coating system for specific conditions should preferably be based on experience from the use of the system in similar cases. The reason is that the durability of a CUI coating system depends on many external factors, such as the environment, the design of the structure, the insulation material, the weather proofing (cladding), the surface preparation, the application, drying procedures, service temperature, thermal shock, thermal cycling, peak temperature, amount of moisture, contaminants and other variables.

The durability is also linked to the chemical and physical characteristics of the system, e.g. the type of binder, the dry film thickness. These CUI related performance characteristics can be evaluated by artificial tests. Resistance to water or moisture, boiling water, steam interface, electrolytes in the system, thermal exposure, thermal shock, and thermal cycling are of primary interest.

Artificial tests and durations specified in this document have been selected to help ensure that potential coating systems will have the characteristics needed for the durability required in the intended service. Results from artificial tests should be used with caution, because artificial testing will not necessarily have the same effect as natural exposure. Many factors have an influence on the progress of degradation and, in the laboratory, it is not possible to accelerate all of them using the most effective method. It is therefore difficult to make a reliable ranking of coating systems of very different compositions from artificial tests in the laboratory. This can sometimes lead to efficient protective coating systems being rejected because they cannot pass these tests.

4.2 Laboratory tests

As CUI environments are very specific and have special requirements, several tests are included so that coating products can exhibit performance in harsh environments typical of CUI exposure. These include thermal performance, boiling water, thermal shock, thermal cycling, peak temperature performance, and long term isothermal conditions. In addition, these coating products shall provide corrosion protection for long periods of time at ambient conditions, and in possibly wet conditions related to initial coating application prior to process start up, time associated with process shutdowns, and short term mothballing of the facility.

Standard weathering testing procedures shall be used to establish ambient related corrosion control test procedures and acceptance criteria. Both air dried and conditioned test samples and heat conditions test samples shall be evaluated.

Additional CUI and high temperature related tests shall also be used in order to verify the ability of a coating to work under insulation at the prescribed conditions.

Inorganic zinc primers or other sacrificial coatings are no longer recommended in CUI environments due to the accelerated corrosion related to wet environments. If testing and acceptance is required, additional testing, as agreed between the interested parties, can be performed. However, long term wet environments

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are difficult to accelerate and as such the specifier/owner should be careful with any acceptance criteria for sacrificial coatings.

4.3 Additional laboratory tests

Other test methods may also be used by agreement between interested parties.

5 CUI classification environments

[Table 1](#) provides a list of CUI classification environments including the minimum and maximum temperatures for all environments. These descriptions include both isothermal and cyclic conditions.

Table 1 — CUI classification environments

Classification	Minimum temperature	Peak temperature
CUI-1	−45 °C	to 60 °C
CUI-2	−45 °C	60 °C to 150 °C
CUI-3	−45 °C	150 °C to 204 °C

Further, each coating should be qualified for each specific CUI classification where it is intended to be used. A coating that meets the requirements of a CUI-1 classification does not necessarily meet the requirements of a CUI-3 classification, and a coating that meets the requirements of a CUI-3 classification does not necessarily meet the requirements of a CUI-1 classification. By consolidating testing some tests can be used for more than one classification.

For insulated service for temperatures above 204 °C, additional testing may be performed as agreed by interested parties.

6 Test specimens

6.1 Test specimens' requirement

This document requires the use of test specimens and other testing surfaces that are available as standard shapes typically available on the marketplace. Both A-36 or S275 carbon steel test specimens shall be incorporated in testing and also shapes as described in [6.2.1](#) to [6.2.4](#).

6.2 Steel substrates

Test specimens will be as follows unless otherwise agreed to and documented.

6.2.1 Artificial Ageing and Thermal Cycling tests

Carbon steel test panels shall be made of A-36 or S275 carbon steel. The minimum panel size shall be 3 mm × 150 mm × 70 mm or as agreed and documented by the parties. The thickness of the test panels shall not allow for bending as a result of heating and quenching. Unless otherwise agreed, the panel surface shall be prepared by abrasive blast-cleaning to meet the requirements of the corresponding technical product data sheet as per the coating manufacturer's instructions. In all other respects, test panels shall comply with ISO 7384.

6.2.2 Method A- Multi-Phase CUI cyclic corrosion test

Square carbon steel tubing (A-36, ASTM A-500, or S275) ASIC standard shape HSS4X4X1/4 measuring approximately 101,4 mm by 101,4 mm, 406,3 mm long with a wall thickness of 6,35 mm shall be used for the multi-phase CUI cyclic test. Each coating sample area shall be a minimum of 101,4 mm long, on all four sides of the square tube with just the front face scribed with an X-cut. Each tube shall have an endcap welded on each end with a 25,4 mm pipe 101,5 mm long with a threaded connector. The two pipes shall be centred