International Standard

ISO 16961

Oil and gas industries including lower carbon energy — Internal coating and lining of steel storage tanks

Industries du pétrole et du gaz y compris les énergies à faible teneur en carbone — Revêtement intérieur et doublure interne des réservoirs de stockage en acier

Second edition
2024-05

Reference number
ISO 16961:2024(en)

© ISO 2024



COPYRIGHT PROTECTED DOCUMENT

© ISO 2024

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword ..... **v**

Introduction ..... **vi**

1 Scope **1**

2 Normative references **1**

3 Terms, definitions and abbreviated terms **3**
3.1 Terms and definitions 3
3.2 Abbreviated terms 5

4 Conformance **6**
4.1 Rounding 6
4.2 Conformance to this document 6

5 Pre-work requirements **6**
5.1 General 6
5.2 Safety precautions in flammable atmosphere 7
5.3 Qualification of coating/lining application and inspection personnel 7
5.4 Positive isolation and ventilation 7

6 Coating/lining materials **7**
6.1 General 7
6.2 Approvals 8
6.3 Prequalification of coating/lining system 8
6.4 Holding (blast) primer 9
6.5 Caulking (putty) and filler compounds 9
6.6 Fibreglass lining materials 9
6.6.1 Fibreglass resin compound 9
6.6.2 Glass fibre reinforcement 9
6.7 Glass flake filled coating/lining system 10
6.8 Epoxy coating/lining systems 10
6.9 Material approvals — Fibreglass lining system 11
6.10 Material approvals — Glass flake filled coating/lining system 14
6.11 Material approvals — Thin film epoxy coating/lining systems 14
6.12 Pre-production trial 14

7 Surface preparation **15**
7.1 General 15
7.2 Tank pre-cleaning and residue removal (for rehabilitation work) 15
7.3 Preparatory patching and grinding (for new and rehabilitation work) 16
7.4 Dry abrasive blast cleaning 16
7.5 Humidity control 17
7.6 After blast cleaning 18
7.7 Removal of existing laminate linings prior to abrasive blasting 18
7.8 Striker plates, steel legs, risers, down comers and supports 18
7.9 Safety precautions 19

8 Coating/lining application **19**
8.1 General requirements 19
8.2 Safety precautions 20
8.3 Fibreglass lining 20
8.4 Weather conditions 21
8.5 Primer application 21
8.6 Caulking (putty) application 21
8.7 Fibreglass laminate application 22
8.8 Coating/lining thickness 22
8.9 Glass flake filled coating application 23
8.10 Thin film coating application 24

© ISO 2024 – All rights reserved

9 Inspection and testing ... **25**
9.1 General requirements ... 25
9.2 Environmental conditions testing ... 26
9.3 Materials and equipment inspection ... 26
9.4 Compressed air and abrasive ... 26
9.5 Surface preparation inspection ... 26
9.6 Coating/lining inspection and testing ... 27
9.7 Coating/lining film thickness ... 27
9.8 Holiday detection test ... 27
9.9 Curing hardness test ... 27
9.10 Defects and pinhole repair ... 28
9.11 Adhesion test ... 28
10 Quality requirements ... **28**
11 Documentation ... **29**
11.1 General ... 29
11.2 Work proposal ... 29
11.3 Work records/reports ... 29
11.4 Inspection and testing reports and certificates of conformance ... 29
11.5 Final report ... 29
Annex A (informative) **Dew point calculation chart** ... **30**
Annex B (informative) **Caulking (putty) application** ... **31**
Annex C (informative) **Example of coating/lining work record/data sheet** ... **32**
Annex D (informative) **Example of coating/lining inspection and testing data sheet** ... **33**
Bibliography ... **34**

© ISO 2024 – All rights reserved

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 document 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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 12, *Oil and gas industries including lower carbon energy,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 16961:2015), which has been technically revised.

The main changes are as follows:

— inclusion of lining selection criteria (Clause 6);

— update of requirements for non-exposure and exposure tests (Clause 6);

— clarification of the requirements in a pre-production trial (Clause 6);

— update of the typical thicknesses based on industry standards (Clause 8);

— update of references throughout this document.

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.

© ISO 2024 – All rights reserved

Introduction

The objectives of this document are to define technical requirements for the corrosion protection by coating and lining of internal surfaces of steel storage tanks, to provide technical guidance for developing local standards and specifications, and to ensure conformance in coating and lining material selection and performance with contract requirements.

Where an alternative is proposed, the specification issuer needs to identify any deviations from this document and provide details.

© ISO 2024 – All rights reserved

Oil and gas industries including lower carbon energy — Internal coating and lining of steel storage tanks

1 Scope

This document specifies requirements for surface preparation, materials, application, inspection and testing of internal coating lining systems that are intended to be applied on internal surfaces of steel storage tanks of crude oil, hydrocarbons and water for corrosion protection.

It covers both new construction and maintenance works of tank internal coating and lining as well as the repair of defective and deteriorated coating/lining.

This document also provides requirements for shop performance testing of the coated/lined samples and the criteria for their approval.

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 2808, *Paints and varnishes — Determination of film thickness*

ISO 2812-1, *Paints and varnishes — Determination of resistance to liquids — Part 1: Immersion in liquids other than water*

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*

ISO 4628-3, *Paints and varnishes — Evaluation of degradation of coatings — Designation 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 degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 5: Assessment of degree of flaking*

ISO 7027 (all parts), *Water quality — Determination of turbidity*

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 8501-3, *Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 3: Preparation grades of welds, edges and other areas with surface imperfections*

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 2024 – All rights reserved

ISO 8502-6, *Preparation of steel substrates before application of paints and related products — Tests for the assessment of surface cleanliness — Part 6: Extraction of water soluble contaminants for analysis (Bresle 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 8503-2, *Preparation of steel substrates before application of paints and related products — Surface roughness characteristics of blast-cleaned steel substrates — Part 2: Method for the grading of surface profile of abrasive blast-cleaned steel — Comparator procedure*

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 8573-1, *Compressed air — Part 1: Contaminants and purity classes*

ISO 11124 (all parts), *Preparation of steel substrates before application of paints and related products — Specifications for metallic blast-cleaning abrasives*

ISO 11126 (all parts), *Preparation of steel substrates before application of paints and related products — Specifications for non-metallic blast-cleaning abrasives*

ISO 11127-7, *Preparation of steel substrates before application of paints and related products — Test methods for non-metallic blast-cleaning abrasives*

ISO 12944-3, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 3: Design considerations*

ISO 12944-9:2018, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 9: Protective paint systems and laboratory performance test methods for offshore and related structures*

ISO 15234, *Paints and varnishes — Testing of formaldehyde-emitting coatings and melamine foams — Determination of the steady-state concentration of formaldehyde in a small test chamber*

ISO 15711, *Paints and varnishes — Determination of resistance to cathodic disbonding of coatings exposed to sea water*

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*

ISO 29601, *Paints and varnishes — Corrosion protection by protective paint systems — Assessment of porosity in a dry film*

ISO 80000-1:2022, *Quantities and units — Part 1: General*

API RP 652, *Lining of Aboveground Petroleum Storage Tank Bottoms*

API Std 653, *Tank Inspection, Repair, Alteration and Reconstruction*

API Std 2015, *Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks*

ASTM A380, *Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems*

ASTM D522, *Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings*

ASTM D570, *Standard Test Method for Water Absorption of Plastics*

ASTM D790, *Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials*

ASTM D2240, *Standard Test Method for Rubber Property—Durometer Hardness*

ASTM D2583, *Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor*

© ISO 2024 – All rights reserved

ASTM D4060, *Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abrader*

ASTM D4285, *Standard Test Method for Indicating Oil or Water in Compressed Air*

ASTM D5402, *Standard Practice for Assessing the Solvent Resistance of Organic Coatings Using Solvent Rubs*

ASTM D6943, *Standard Practice for Immersion Testing of Industrial Protective Coatings and Linings*

ASTM F21, *Standard Test Method for Hydrophobic Surface Films by the Atomizer Test*

ASTM G42, *Standard Test Method for Cathodic Disbonding of Pipeline Coatings Subjected to Elevated Temperatures*

EN 14020 (all parts), *Reinforcements — Specification for textile glass roving's*

NACE TM0304, *Offshore Platform Atmospheric and Splash Zone Maintenance Coating System Evaluation*

NACE TM0404, *Offshore Platform Atmospheric and Splash Zone New C*

SSPC Guide 12, *Guide for Illumination of Industrial Painting Projects*

SSPC-Guide 15, *Field Methods for Retrieval and Analysis of Soluble Salts on Steel and Other Nonporous Substrates*

Painting Manual Vol SSPC, 1

SSPC-SP 1, *Steel Structure Painting Council Surface Preparation Specifications — Solvent Cleaning*

SSPC-SP 11, *Surface Preparation Standard, Power-Tool Cleaning to Bare Metal*

3 Terms, definitions and abbreviated terms

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

ISO and IEC maintain terminology 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 Terms and definitions

3.1.1
application procedure specification
document describing procedures, methods, equipment and tools used for *coating* (3.1.7) application

3.1.2
applicator
contractor (3.1.8) or subcontractor having the technical capability, knowledge, equipment and qualified personnel that is approved by the *client* (3.1.5) for the *coating* (3.1.7) processes according to specific requirements

Note 1 to entry: The requirements are given in this document.

3.1.3
C glass
glass fibre that provides greater resistance to chemicals and is used in advanced composites

Note 1 to entry: C glass is mainly used in the form of surface tissue in the outer layer of laminates used in chemical and water pipes and tanks.

© ISO 2024 – All rights reserved