INTERNATIONAL STANDARD

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Petroleum, petrochemical and natural gas industries — Internal coating and lining of steel storage tanks

Industries du pétrole, de la pétrochimie et du gaz naturel — Revêtement de protection interne et doublure des réservoirs de stockage en acier

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Foreword

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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 on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries.*

Introduction

This International Standard is based on GSO 2057 – 2010 (E). The objectives of this International Standard are to define minimum 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 compliance in coating and lining material selection and performance with contract requirements.

Users of this International Standard should be aware that further or differing requirements can be needed for individual applications. This International Standard is not limiting the contractor and/or manufacturer from proposing or the company from accepting alternative engineering solutions for the individual application. This can be particularly applicable where there is innovative or developing technology. Where an alternative is proposed, the specification issuer should identify any deviations from this International Standard and provide details.

Annexes A, B, C and D of this International Standard are informative only.

Petroleum, petrochemical and natural gas industries — Internal coating and lining of steel storage tanks

1 Scope

This International Standard specifies the minimum 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 systems.

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

2 Conformance

2.1 Rounding

Unless otherwise stated in this International Standard, to determine conformance with the specified requirements, observed or calculated values shall be rounded to the nearest unit in the last right-hand place of figures used in expressing the limiting value, in accordance with ISO 80000-1:2009, Annex B, Rule A.

NOTE For the purpose of this provision, the rounding method of ASTM E29–08 is equivalent to ISO 80000-1:2009, Annex B, Rule A.

2.2 Compliance to this International Standard

A quality system should be applied to assist compliance with the requirements of this International Standard. ISO/TS 29001 gives sector-specific guidance on quality management systems.

The applicator shall comply with all of the applicable requirements of this International Standard. It shall be permissible for the client to make any investigations necessary in order to be ensured of compliance by the applicator and to reject any material that does not comply.

3 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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 C868-02 (2012), *Standard Test Method for Chemical Resistance of Protective Linings*

ASTM D412, *Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers — Tension*

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

ASTM D610, *Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces*

ASTM D714, *Standard Test Method for Evaluating Degree of Blistering of Paints*

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

ASTM D870, *Standard Practice for Testing Water Resistance of Coatings Using Water Immersion*

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

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

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

ASTM D4541, *Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers*

ASTM D4940, *Standard Test Method for Conductimetric Analysis of Water Soluble Ionic Contamination of Blasting Abrasives*

ASTM D5420, *Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Striker Impacted by a Falling Weight (Gardner Impact)*

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*

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 3233 (all parts), *Paints and varnishes — Determination of percentage volume of non-volatile matter by measuring the density of a dried coating*

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

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 7027, *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 8502-6, *Preparation of steel substrates before application of paints and related products — Tests for the assessment of surface cleanliness — Part 6: Extraction of soluble contaminants for analysis — The 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 10474, *Steel and steel products — Inspection documents*

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 — Part 7: Determination of water-soluble chlorides*

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

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 80000-1:2009, *Quantities and units — Part 1: General*

NACE SP0188, *Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates*

NACE/TM 0174, *Standard Test Method — Laboratory Methods for the Evaluation of Protective Coatings and Lining Materials on Metallic Substrates in Immersion Service*

SSPC-AB1, *Abrasive Specification No.1, Mineral and Slag Abrasive*

SSPC-AB2, *Abrasive Specification No.2, Cleanliness of Recycled Ferrous Metallic Abrasives*

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

SSPC-PA 2, *Steel Structure Painting Council Surface Preparation Specifications Measurement of Dry Coating Thickness with Magnetic Gages*

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

SSPC-SP 5/NACE No.1, *Joint Surface Preparation Standard-White Metal Blast* Cleaning

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

4 Terms, definitions and abbreviated terms

4.1 Terms and definitions

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

4.1.1
application procedure specification
APS
document describing procedures, methods, equipment and tools used for coating application

4.1.2
applicator
organization, contractor or subcontractor having the technical capability, knowledge, equipment and qualified personnel that is approved by the client for the coating processes as required by this International Standard

4.1.3
C glass
glass fibre that provides greater resistance to chemicals and is used in advanced composites, mainly used in the form of surface tissue in the outer layer of laminates used in chemical and water pipes and tanks

4.1.4
caulking
the process of applying a 98 % to 100 % solid catalysed epoxy material (caulking compound) on tank internal surfaces to fill pores/pits or to cover weld seams, lap joints, large projections, connections, etc.

Note 1 to entry: This is to provide a uniform gradual transition and smooth surfaces.

4.1.5
client
party or organization for which professional services are rendered or person that receives a product

4.1.6
coat
paint, varnish or lacquer applied to surface in a single application (one layer) to form an evenly distributed film when dry

4.1.7
contractor
vendor company or business that agrees to furnish materials and/or perform specific project/services to client

4.1.8
curing
chemical process of developing the intended properties of a coating/polymerized product in the lining system, generally due to a reaction between two or more chemicals (e.g. resin and curing compound)

4.1.9
dew point
temperature of a given air/water vapour mixture at which condensation starts, since, at that temperature, its maximum water content saturation is reached

4.1.10
dry abrasive blasting
surface preparation method that uses an abrasive propelled by air pressure, centrifugal force, to clean and provide a surface profile

4.1.11
dry film thickness
DFT
thickness of a coat or coating system in its fully cured and dry condition

Note 1 to entry: The dry film thickness of coating is measured by film thickness calibrated gauge and expressed in mils or microns (1 000 microns is equivalent to 40 mils).

4.1.12
E glass
glass containing not more than 1 % by mass of alkali (calculated as Na_2O) and used for the manufacture of glass fibre

4.1.13
epoxy
resin containing epoxide functional groups that allow for curing by polymerization with a variety of curing agents

4.1.14
fibreglass lining
cold curing resin linings to repair and/or add strength to tank bottoms with fibre mat

Note 1 to entry: Examples are pure epoxies, phenolic epoxies, polyesters, vinyl esters being chemically cured with curing agents.

4.1.15
fibreglass reinforced lining
resin linings, usually polyester, vinyl ester or epoxies, into which layers of fibreglass are incorporated to enhance the lining's structural capability, corrosion and chemical resistance performance

4.1.16
fibre mat
woven glass fibre that is used as reinforcement of the thermosetting resin (e.g. epoxy) lining to repair and/or add strength to tank bottoms

Note 1 to entry: Fibre mat is typically applied to a wet resin at about 450 g/m^2 area.

4.1.17
gel coat
final coat applied over the fibreglass lining laminate to seal the laminate surface and enhance water and hydrocarbon resistance

4.1.18
holiday
discontinuity in a lining (e.g. pinhole, void, crack, thin spot, and inclusion of foreign material) or contamination in the coating film that significantly lowers the dielectric strength of the coating

4.1.19
lining
material applied to the internal surfaces of a tank to serve as a barrier to corrosion and/or product contamination

Note 1 to entry: The term coating is also used for the purposes of this International Standard.

4.1.20
manufacturer
company responsible for the manufacture of coating material(s)

4.1.21
pinhole
small film defect characterized by small pore-like flaws in the lining that would permit corrosion of the substrate under the conditions for which the lining is designed

Note 1 to entry: A pinhole may extend entirely through the film to the substrate and lead to a holiday.

4.1.22
pre-production trial
PPT
application of coating and inspection/testing of its properties, to confirm that the APS is able to produce a coating with the specified properties

4.1.23
surface profile
micro-roughness of a surface, generally expressed as the average height of the major peaks relative to the major valleys, sometimes referred to as amplitude

Note 1 to entry: It is typically Ra/Ry/Rz value.

4.2 Abbreviated terms

ANSI	American National Standardization Institute
API	American Petroleum Institute
APS	Application Procedure Specification
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
BGAS	British Gas
CV	Curriculum Vitae
DFT	Dry Film Thickness
GRE	Glass Reinforced Epoxy
GRUP	Glass Reinforced Unsaturated Polyester
GRVE	Glass Reinforced Vinyl Ester
GSO	Gulf Standardization Organization
HBE	High Build Epoxy
HSE	Health, Safety and Environment
ITP	Inspection and Testing Plan
MSDS	Materials Safety Data Sheets
NACE	National Association of Corrosion Engineers
OSHA	Occupational Safety and Health Administration
PPE	Personal Protective Equipment
PPT	Pre-Production Trial
PQT	Procedure Qualification Trial
QA/QC	Quality Assurance/Quality Control
QP	Qualification Procedure
RH	Relative Humidity
RP	Recommended Practice
SOW	Scope of Work
SSPC	The Society for Protecting Coatings
WFT	Wet Film Thickness
WRAS	Water Regulations Advisory Scheme

5 Pre-work requirements

5.1 General

5.1.1 All necessary health, safety and environmental (HSE) procedures shall be employed to protect personnel and the surrounding environment during on-site/field works.

5.1.2 The contractor shall submit their HSE manual for client approval. The approved HSE procedures for the safe lining processes shall be strictly followed.

5.1.3 Adherence to all relevant international safety requirements, client safety regulations for contractors and lifting equipment regulations are required while performing coating and lining works.

5.1.4 Materials Safety Data Sheets (MSDS) for all chemicals to be used within operation areas shall be submitted for review and approval by client. Health and safety precautions shall be clearly described on each chemical container/package.

5.1.5 All wastes resulting from supply and application shall be contained, collected and properly disposed off in accordance with international/local environmental protection standards/regulations.

5.2 Safety precautions in flammable atmosphere

5.2.1 Where there is a risk of flammable atmosphere being present in a particular tank, the client may, with relevant safety authority, impose restrictions on methods of surface preparation.

5.2.2 The client shall advise on the hazardous area classification for plant design and construction/ maintenance projects.

5.2.3 The contractor shall provide the client with all necessary data for the proposed coating/lining systems, solvents and coating procedure in order to permit area classification to be determined for the duration of coating work. Special care shall be observed when mixing resins to avoid fire hazards.

5.2.4 All equipment used in surface preparation, coating/lining application and inspection, including floodlight or spotlights, shall be explosion-proof and spark-proof.

5.3 Safety precautions in confined space

The procedures for performing safe work in confined spaces shall be in accordance with OSHA 29 CFR 1910, API STD 2217A or according to national legislation.

5.4 Qualification of coating/lining application and inspection personnel

5.4.1 The coating/lining operatives shall be competent to undertake the coating application, inspection/ testing procedures and repair work. The qualification may be obtained as agreed with the client or by demonstration at a procedure qualification trial (PQT) during pre-production trial (PPT).

5.4.2 Inspectors and applicator personnel carrying out the coating inspection shall be competent to carry out the requirements of this International Standard. The applicator shall request the manufacturer of the coating/lining material(s) and equipment to provide technical assistance to the coating/lining operatives if necessary.