CSA GROUP™

# Z245.30-18

# Field-applied external coatings for steel pipeline systems

REVISED DECEMBER 2019

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# *Revision History*

## Z245.30-18, Field-applied external coatings for steel pipeline systems

| Update No. 1 — December 2019 | Revision symbol (in margin) |
|---|---|
| Clauses 3, 6.2.1, 7.1, 7.5, 7.5.1, 7.5.2.2, 9.3, and 11<br>Tables 1, 4, 6, 7, and 8 | ① |

# *Standards Update Service*

## *Z245.30-18*
## *September 2018*

**Title:** *Field-applied external coatings for steel pipeline systems*

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# *Z245.30-18*

# *Field-applied external coatings for steel pipeline systems*



*Published in September 2018 by CSA Group*
*A not-for-profit private sector organization*
*178 Rexdale Boulevard, Toronto, Ontario, Canada M9W 1R3*

*To purchase standards and related publications, visit our Online Store at* ***store.csagroup.org***
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*ISBN 978-1-4883-1407-0*

# Contents



  

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# Preface

This is the second edition of CSA Z245.30, *Field-applied external coatings for steel pipeline systems*. It supersedes the previous edition published in 2014.

The major changes to this edition are the following:

a) the competency requirements have been extensively revised (Clause 6.1);
b) the inspection and testing requirements have been revised (Clause 7);
c) the markings requirements have been revised (Clause 9);
d) the test procedures have been revised (Clause 12); and
e) all tables have been extensively revised.

In this 2018 edition, where a major change or addition to the previous edition of this Standard has been made, the clause, table, or figure affected is identified by the symbol Ⓟ in the margin. Users of this Standard are advised that the change markers in the text are not intended to be all-inclusive and are provided as a convenience only; such markers cannot constitute a comprehensive guide to the revisions made to this Standard. Care must therefore be taken not to rely on the change markers to determine the current requirements of this Standard. As always, users of this Standard must consider the entire Standard.

This Standard was prepared by the Subcommittee on Coatings, under the jurisdiction of the Technical Committee on Petroleum and Natural Gas Industry Pipeline Systems and Materials and the Strategic Steering Committee on Petroleum and Natural Gas Industry Systems, and has been formally approved by the Technical Committee.

**Notes:**

1) *Use of the singular does not exclude the plural (and vice versa) when the sense allows.*
2) *Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.*
3) *This Standard was developed by consensus, which is defined by* CSA Policy governing standardization — Code of good practice for standardization *as "substantial agreement. Consensus implies much more than a simple majority, but not necessarily unanimity". It is consistent with this definition that a member may be included in the Technical Committee list and yet not be in full agreement with all clauses of this Standard.*
4) *To submit a request for interpretation of this Standard, please send the following information to inquiries@csagroup.org and include "Request for interpretation" in the subject line:*
   a) *define the problem, making reference to the specific clause, and, where appropriate, include an illustrative sketch;*
   b) *provide an explanation of circumstances surrounding the actual field condition; and*
   c) *where possible, phrase the request in such a way that a specific "yes" or "no" answer will address the issue.*

   *Committee interpretations are processed in accordance with the* CSA Directives and guidelines governing standardization *and are available on the* Current Standards Activities *page at standardsactivities.csa.ca.*
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   a) *Standard designation (number);*
   b) *relevant clause, table, and/or figure number;*
   c) *wording of the proposed change; and*
   d) *rationale for the change.*

  

# Z245.30-18
# Field-applied external coatings for steel pipeline systems

## 1 Scope

### 1.1
This Standard covers the qualification, application, inspection, testing, handling, and storage of materials required for coatings applied externally to steel piping in the field or a shop. Coated piping addressed by this Standard is intended primarily for buried or submerged service in oil or gas pipeline systems.

Ⓟ **1.2**

This Standard covers the following coating systems:

a) System FC1: liquid-applied epoxy or fusion bond epoxy (FBE) with a glass transition temperature of 115 °C or less;
b) System FC2: liquid-applied epoxy or FBE with a glass transition temperature greater than 115 °C;
c) System FC3: liquid-applied epoxy or FBE intended for abrasion service;
d) System FC4: adhesive and a polymeric backing (e.g., tape, heat shrinkable sleeve);
e) System FC5: epoxy primer, adhesive, and a polymeric backing (e.g., tape, heat shrinkable sleeve);
f) System FC6: anti-corrosion coating, if applicable [see Items a), b), d), and e)], polyurethane foam insulation, and a polymeric backing with or without adhesive (e.g., tape, heat shrinkable sleeve); and
g) System FC7: fibre-reinforced petrolatum, paraffin-filled, or visco-elastic systems.

### 1.3
In this Standard, “shall” is used to express a requirement, i.e., a provision that the user is obliged to satisfy in order to comply with the Standard; “should” is used to express a recommendation or that which is advised but not required; and “may” is used to express an option or that which is permissible within the limits of the Standard.

Notes accompanying clauses do not include requirements or alternative requirements; the purpose of a note accompanying a clause is to separate from the text explanatory or informative material.

Notes to tables and figures are considered part of the table or figure and may be written as requirements.

Annexes are designated normative (mandatory) or informative (non-mandatory) to define their application.

## Ⓟ 2 Reference publications

This Standard refers to the following publications, and where such reference is made, it shall be to the editions listed below, unless the user finds it more appropriate to use newer or amended editions of such publications.

  

**CSA Group**

CAN/CSA-ISO 9001:16
*Quality management systems — Requirements*

Z245.20 Series-18
*Plant-applied external coatings for steel pipe*

Z245.20-18
*Plant-applied external fusion bond epoxy coating for steel pipe*

Z245.21-18
*Plant-applied external polyethylene coating for steel pipe*

Z245.22-18
*Plant-applied external polyurethane foam insulation coating for steel pipe*

CAN/CSA-Z662-15
*Oil and gas pipeline systems*

**ASTM International**

C518-17
*Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus*

D638-14
*Standard Test Method for Tensile Properties of Plastics*

D1002-10
*Standard Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal)*

D1525-17e1
*Standard Test Method for Vicat Softening Temperature of Plastics*

D1621-16
*Standard Test Method for Compressive Properties of Rigid Cellular Plastics*

D1622/D1622M-14
*Standard Test Method for Apparent Density of Rigid Cellular Plastics*

D2240-15e1
*Standard Test Method for Rubber Property—Durometer Hardness*

D2842-12
*Standard Test Method for Water Absorption of Rigid Cellular Plastics*

D4414-95 (2013)
*Standard Practice for Measurement of Wet Film Thickness by Notch Gages*

  

D4417-14
*Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel*

D6226-15
*Standard Test Method for Open Cell Content of Rigid Cellular Plastics*

E28-14
*Standard Test Methods for Softening Point of Resins Derived from Pine Chemicals and Hydrocarbons, by Ring-and-Ball Apparatus*

E29-13
*Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications*

**ISO (International Organization for Standardization)**

9001:2015
*Quality management systems — Requirements*

21809-3:2016
*Petroleum and natural gas industries — External coatings for buried or submerged pipelines used in pipeline transportation systems — Part 3: Field joint coatings*

**NACE International — The Corrosion Society**

SP0188-2006
*Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates*

SP0274–2011
*High-Voltage Electrical Inspection of Pipeline Coatings*

**SSPC (The Society for Protective Coatings)**

SSPC-Guide 15-2013
*Field Methods for Extraction and Analysis of Soluble Salts on Steel and Other Nonporous Substrates*

SSPC-PA 2-2017
*Procedure for Determining Conformance to Dry Coating Thickness Requirements*

SSPC-VIS 1-2004
*Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning*

SSPC-VIS 3-2004
*Guide and Reference Photographs for Steel Surfaces Prepared by Hand and Power Tool Cleaning*

## Ⓟ ① 3 Definitions

The following definitions shall apply in this Standard:

**Anti-corrosion coating** — a coating applied directly on steel for the purpose of corrosion protection.

**Application company** — the company responsible for the application of the coating and the applicator applying the coating.

**Applicator** — the person applying the selected coating product.

  

**Batch** — a specified quantity of material produced under the same uniform conditions during a continuous production run by one manufacturer.

① **Certificate of application compliance** — a document provided by the application company stating that the coating is in compliance with the requirements of this Standard.

**Certificate of material qualification** — a document provided by the manufacturer stating that the coating material has been qualified in compliance with the requirements of this Standard.

**Company** — the individual, partnership, corporation, or other entity that is in charge of design, materials, operations, maintenance, or construction, whichever is applicable.
**Note:** *The company can act through an authorized representative.*

**Competent** — qualified, trained, and experienced in performing the required duties.

**Field-applied coatings** — anti-corrosion coatings applied either at a pipeline system site or at another location not covered by the CSA Z245.20 Series.

**Glass transition temperature** — the approximate midpoint of the temperature range over which the glass transition takes place.

① **Holiday** — a discontinuity in the coating that exhibits electrical conductivity when exposed to a specific voltage.

**Imperfection** — a material discontinuity or irregularity that is detectable by inspection in accordance with the requirements of this Standard.

**Laboratory-coated test specimen** — a specimen taken from a laboratory-prepared panel.

**Manufacturer** — the company responsible for the manufacture of the coating product to be applied.

**Overlap length** — the minimum length measured from the end of the existing coating to the end of the field-applied coating.

**Record of applicator qualification** — a document provided by the application company stating that the applicator has met the applicator qualification requirements of this Standard.

**Test report** — a document that provides the quantitative test results for tests conducted in accordance with the requirements of this Standard.

# 4 General

## 4.1 Rounding procedure

Except as otherwise required by this 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 the rounding method of ASTM E29.

## Ⓟ 4.2 Requirements for quality

The manufacturer and the application company shall have a documented quality management system.

  

The manufacturer shall be responsible for the quality of the materials and the application procedure.

The application company shall be responsible for the quality of the application of the coating system.
**Note:** *CAN/CSA-ISO 9001 or ISO 9001 may be used for quality management systems.*

### 4.3 Compliance
The application company shall be responsible for complying with all of the applicable requirements of this Standard. The company may make any investigation necessary in order to be assured of compliance by the application company and may reject any material or work that does not comply.

## 5 Materials

### 5.1 Product ordering

#### 5.1.1 Piping
The piping to be coated shall conform to the standard or specification that is specified in the purchase order.

#### 5.1.2 Coating systems
The following information shall be considered for inclusion in purchase orders for coating systems for pipeline systems:
a) the manufacturer;
b) the product name;
c) the product sizing or product quantity, if applicable (e.g., length, kit size, coating thickness range);
d) the operating temperature range;
e) the CSA Standard designation, including the year of publication (i.e., CSA Z245.30-18);
f) the coating system (FC1, FC2, FC3, FC4, FC5, FC6, or FC7);
g) the cutback length for ends of pipe or piping components;
h) the overlap to existing coatings;
i) the maximum preheat temperature (taking into consideration the integrity of the steel and of the existing coating); and
j) special requirements.

### 5.2 General
Coating materials shall be
a) qualified by the manufacturer to be in accordance with the requirements of Clause 5.3. The certificate of material qualification shall be available from the manufacturer upon request by the company or application company;
b) identified by the manufacturer either on the product or on the shipping containers with the following:
   i) the manufacturer's name;
   ii) the product description (e.g., material name, quantity, kit size, dimensions, colour, as applicable);
   iii) the batch number;
   iv) the requirements for handling, transportation, and storage (e.g., "Do not freeze.");
   v) either the year and month of manufacture and the shelf life or the expiration date, where applicable; and

  

c) handled, transported, and stored in accordance with the manufacturer's requirements.

## 5.3 Qualification

### 5.3.1

The coating system properties and application procedure shall be qualified by the manufacturer by testing laboratory-coated test specimens for compliance with the acceptance criteria specified in

a) Table 1 for Systems FC1, FC2, and FC3;
b) Table 2 for System FC4;
c) Table 3 for System FC5;
d) Table 4 for System FC6; and
e) Table 5 for System FC7.

Test samples shall be made of pipe or pipeline components that approximate, as closely as possible, the situations and conditions that will be found during construction, maintenance or repair. The coating of flat panels shall not be acceptable for Systems FC4, FC5, FC6, and FC7.

The manufacturer shall conduct tests for each coating system and provide the application company and the company with a test report on the properties specified in Tables 1 to 5, as applicable.

The manufacturer shall have a method of correlating the coating system identifier to the manufacturer's qualified application procedure (MQAP).

### 5.3.2

The MQAP shall address the following, as applicable:

a) tools, consumables, and equipment required to apply the coating system;
b) approved solvents or other cleaning agents to be used to clean the steel and adjacent anti-corrosion coating prior to surface preparation;
c) surface preparation of the steel (including final surface profile, materials and surface contamination mitigation);
d) surface preparation of adjacent anti-corrosion coatings (e.g., cutback, repairs);
e) compatibility with other anti-corrosion coatings;
f) preheat methods;
g) substrate temperature range for surface preparation, application and cure;
h) ambient conditions considering dew point temperature;
i) coating mixing and thinning procedures;
j) coating thickness range;
k) coating application method;
l) coating curing or cooling schedule and conditions;
m) recoat and repair method;
n) time to backfill; and
o) handling and storage requirements for coating materials, including the following, as applicable:
    i) temperature limitations (e.g., freezing, excessive heat);
    ii) humidity;
    iii) protection from the elements (e.g., snow, rain, sunlight);
    iv) protection from contaminants (e.g., dust, water, chemicals);
    v) expiration date; and
    vi) protection from physical damage.

  

### 5.3.3
The company, in consultation with the manufacturer, may approve any modification of the MQAP provided that it has ensured that the modification will not have any deleterious effects on the performance of the new or existing anti-corrosion coatings.

### 5.3.4
Except as permitted by Clause 5.3.3, the coating shall be requalified by the manufacturer when there is a change in one or more of the following:
a) the coating chemical formulation;
b) the location of manufacture;
c) the manufacturing process; and
d) the application procedure

### 5.3.5
The manufacturer shall assign a unique identifier to each version of the MQAP and reference the applicable MQAP in documentation/marking with the supplied materials.
**Note:** *the unique identifier should include revision date.*

### 5.4 Packaging
The coating shall be delivered in containers or packaging that is clearly labelled with the information specified in Clause 5.2 b).

## 6 Coating application

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### 6.1 Competency

### 6.1.1 General
The application company shall ensure that the applicator is competent to apply the coating.

### 6.1.2 Qualification of applicators

### 6.1.2.1
The application company shall be responsible to ensure the applicators are trained prior to the start of work. The training shall cover the appropriate MQAP for the applicable coating systems.

At a minimum, training shall include, but not be limited to,
a) storage and handling of coating materials;
b) surface cleanliness and surface profile;
c) preheat methods;
d) coating application procedures;
e) inspection methods;
f) coating repair methods; and
g) cold or adverse weather techniques.
**Note:** *The manufacturer should be involved in coating application training.*

  

### 6.1.2.2
The application company shall ensure that all personnel involved in assisting the applicators are trained in the specific tasks that have been assigned to them (e.g., surface preparation, preheat, mixing).

### 6.1.2.3
The application company or its designated representative shall qualify its applicators by
a) ensuring that test samples are prepared in accordance with the MQAP;
b) witnessing the procedures used by the applicator to prepare test samples; and
c) evaluating test samples.

Test samples shall meet the requirements of Clause 6.1.2.4.

Test samples shall be made of pipe or pipeline components that approximate, as closely as practical, the situations and conditions that will be found during construction, maintenance, or repair. The coating of flat panels shall not be acceptable.

The company may witness any or all aspects of the applicator training and qualification testing process.

### 6.1.2.4 Qualification testing requirements
The tests to be conducted, the test methods to be used, and the acceptance criteria shall be as specified in
a) Table 6 for Systems FC1, FC2, and FC3;
b) Table 7 for Systems FC4, FC5, and FC7; and
c) Table 8 for System FC6.

### 6.1.2.5 Record of applicator qualification

### 6.1.2.5.1
Upon successful completion of the qualification testing, the application company or designated representative shall create a record of the applicator's qualification that includes
a) the applicator's name;
b) the unique number for the applicator qualification record;
c) the MQAP used to qualify the applicator;
d) the date of successful qualification testing;
e) results of the testing performed in accordance with Tables 6, 7, or 8; and
f) the name of the application company's representative or designated representative that can attest to the successful qualification.

### 6.1.2.5.2
This required evidence of qualification shall be referred to as a record of applicator qualification.

### 6.1.2.5.3
Records of applicator qualification shall be retained by the application company.

### 6.1.2.5.4
Copies of records of applicator qualification shall be provided by the application company if requested by the company or its designated representative.

  

#### 6.1.2.5.5

If requested by the applicator, evidence of the applicator's qualification shall be issued by the application company or designated representative. The evidence shall be in the form of a qualification certificate. The qualification certificate may be an electronic or paper document. It shall include

a) the applicator's name;
b) the unique number for the applicator qualification traceable to the record of applicator qualification;
c) the MQAP used to qualify the applicator;
d) the date of successful qualification testing; and
e) the name of the application company's representative or designated representative that can attest to the successful qualification.

### 6.1.2.6 Requalification

An applicator applying a particular coating system shall be requalified when

a) there is a non-editorial change in the MQAP;
b) there are repeated non-conformances as specified in Tables 6 to 8; or
c) the applicator has not applied the selected coating system for a period of more than one year.

The application company shall assess the applicator to determine if training in accordance with Clause 6.1.2 is required for re-qualification.

## 6.1.3 Applicator competency

### 6.1.3.1 General

The applicator shall be competent to apply the coating.

### 6.1.3.2 Experience logs

#### 6.1.3.2.1

When required by the company or application company, experience logs shall be provided by the applicator that include the following:

a) the applicator's name and contact information;
b) the unique number for the applicator qualification record;
c) the application company and contact information;
d) the project or job number and contact information;
e) the application date;
f) the type of coating system applied (e.g., the product name);
g) the MQAP version number;
h) the number of coating applications (e.g., girth welds, repairs); and
i) the pipe diameter.

#### 6.1.3.2.2

The application company shall determine the format and media of the experience logs (e.g., books, forms, electronic media, databases, spreadsheets).

#### 6.1.3.2.3

The application company shall ensure that the experience logs indicate that the applicator has applied the selected coating system within the previous year.

  

The application company shall determine the number of experience log entries that are necessary to determine competency in accordance with Clause 6.1.3.3.1 for each selected coating system.

The applicator shall be responsible for the information contained within the experience log.

Experience logs shall be retained by the applicator and be provided to the company or application company upon request.

#### 6.1.3.2.4

Information on experience logs shall be recorded by the applicator or an alternate person on behalf of the applicator.

#### 6.1.3.2.5

The application company shall verify the accuracy of the information within the experience log.

#### 6.1.3.2.6

Requalification in accordance with Clause 6.1.2.6 may be used in lieu of experience logs.

### 6.1.3.3 Competency determination

#### 6.1.3.3.1

Competency shall be determined by

a) reviewing the applicator's qualification record for appropriateness for the coating system and the version of the MQAP to be applied;
b) reviewing the applicator's experience logs to determine that the applicator has
   i) applied the selected coating system using the MQAP; and
   ii) applied the selected coating system within the previous year; and
c) witnessing the applicator
   i) applying the selected coating system to the piping in accordance with the MQAP; and
   ii) meeting the acceptance criteria for the selected samples as specified in Clause 6.1.2.4.

#### 6.1.3.3.2

The company may waive the requirements of Clause 6.1.3.3.1 c) if the application company demonstrates that the applicator's qualification record, training, and experience are sufficient to ensure competency.

#### 6.1.3.3.3

The company may review the application company's competency determination and make its own determination based on the requirements of Clause 6.1.3.3.1.

### 6.1.3.4 Competency records

Records of competency determination and retests shall be retained by the application company and provided to the company.

## 6.2 Application practices and equipment

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### 6.2.1 General

The coating shall be qualified for production in accordance with the requirements of Clause 5.3.

  

The application company shall provide sufficient applicators and assistance to the applicator to ensure that the quality of the selected coating system is in accordance with the MQAP (see Clause 5.3.2).

The application company shall verify that the qualification of the applicators is based on the MQAP appropriate for the coating system being applied.

Applicators shall use tools, consumables, and equipment in accordance with the MQAP (see Clause 5.3.2).

### 6.2.2 Surface preparation

The surface preparation of the steel and the existing coating shall be in accordance with the MQAP (see Clause 5.3.2).

Imperfections in the steel and existing coating that might cause holidays shall be removed in a manner that results in a surface finish suitable for the subsequent application of coating.

**Note:** *See the applicable piping standard and Clause 6.3 of CAN/CSA-Z662 for more information on surface requirements applicable to steel piping.*

During and after its preparation, the surface shall be protected from contact with the environment, materials, and equipment that could contaminate or affect the prepared surface.

Immediately prior to the coating application, the cleaned surface shall be inspected to ensure compliance with the MQAP.

### 6.2.3 Surface temperatures

#### 6.2.3.1

Substrate temperature and curing temperatures of the entire surface to be coated shall be in accordance with the MQAP (see Clause 5.3.2). The substrate temperature shall not exceed the temperature capability of the existing coating or affect the steel properties.

**Note:** *Protection may be used to prevent thermal damage to the existing coating.*

The heating method(s) and procedure(s) shall not contaminate the surfaces to be coated, affect the property requirements specified in Tables 6, 7, and 8, as applicable, exceed the temperature capability of the existing coating, or affect the steel properties [see Clause 5.1.2 i)].

#### 6.2.3.2

The substrate temperatures of the entire surface to be coated shall be measured and recorded using a calibrated surface contact thermometer.

The applicator shall measure temperatures in a manner that verifies that the entire surface to be coated is within the application temperature range as specified in the MQAP (see Clause 5.3.2).

#### 6.2.3.3

The method and heating equipment shall be in accordance with the MQAP (see Clause 5.3.2).

### 6.2.4 Applying the coating system

The application of the coating shall be in accordance with the MQAP (see Clause 5.3.2).

  

### 6.3 Records

In addition to the requirements listed in Clause 5.3.2, application records shall include the following information:

a) the coating system;
b) the job name used by the company;
c) the applicator;
d) the joint number or location identifier;
e) the MQAP version number; and
f) inspection records, if applicable.

## 7 Inspection and testing

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### 7.1 Inspection and test plan

If requested by the company, an inspection and test plan (ITP) shall be prepared by the application company prior to the coating application. The ITP shall be approved by the company and shall include, at a minimum, the following information:

a) the organization or individuals responsible for performing the inspection activity;
b) the coating test requirements specified in Tables 6 to 8;
c) the supplemental coating test requirements (e.g., acceptance criteria, frequency, method) specified by the manufacturer or the company;
d) the ambient condition limitations (air temperature, dew point, wind speed, and other relevant environmental conditions);
e) the requirements (e.g., acceptance criteria, frequency, method) for inspection and testing of repairs or recoating;
f) the method of identification of applicators;
g) the method for recording the location of the coating;
h) the records requirements; and
i) witness and hold points.

### 7.2 Notice

The application company shall give the company reasonable notice of the coating schedule.

### 7.3 Access

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#### 7.3.1

When agreed between the manufacturer and company and/or the application company, the inspector representing the company shall have reasonable access to the manufacturer's locations during manufacturing, storage, application, testing, and handling of the coating as appropriate.

#### 7.3.2

The inspector representing the company shall have reasonable access to the application company's work site during storage, application, testing, and handling of the coating.

#### 7.3.3

All inspections shall be made at the place of manufacture, transport, storage, and application and shall be conducted without undue interference with the activities of the work site.

  

## 7.4 Inspector competency

The inspector representing the company for the purposes of inspecting the application of the selected coating system in accordance with Clause 7.3.2 shall be qualified as determined by the company. The competency determination shall include training on the MQAP, an understanding of the test methods specified in Tables 6, 7, and 8, and the assessment of test results.

## ① 7.5 Coating quality testing

### ① 7.5.1 General

Testing of coating systems shall include

a) physical testing;
b) visual inspection; and
c) holiday inspection.

**Note:** *When a test does not satisfy the required acceptance criteria, the application company should attempt to determine the cause of the unsuccessful test result.*

### 7.5.2 Physical testing

#### Ⓟ 7.5.2.1 Acceptance criteria

Testing frequency for each applicator and acceptance criteria shall be as specified in

a) Table 6 for Systems FC1, FC2, and FC3;
b) Table 7 for Systems FC4, FC5, and FC7; and
c) Table 8 for System FC6.

#### ① 7.5.2.2 Imperfections

Where there is adhesion and peel test failure for Systems FC1, FC2, FC3, FC4, FC5, and FC7, two additional tests shall be performed on the coating which failed to conform to the test requirements. Where one or both of the retests also fails to conform to the test requirements, the defective coating shall be completely removed, reapplied and retested.

**Note:** *Where there is repeated peel or adhesion test failures, consideration should be given to the evaluation of the quality of previously applied coating, including a means of assessing adhesion quality and measures to improve the adhesion.*

### 7.5.3 Visual inspection

#### 7.5.3.1 General

The coated surface shall be visually inspected. Visual inspection shall include checking for the imperfections described in Clause 7.5.2. Inspection shall be performed when the coating is free of contaminants (e.g., water, frost, snow, ice, mud).

#### 7.5.3.2 Acceptance criteria

The application company and the manufacturer shall establish the acceptance criteria for each of the visual imperfections referenced in

a) Table 6 for Systems FC1, FC2, and FC3;
b) Table 7 for Systems FC4, FC5, and FC7; and
c) Table 8 for System FC6.

These criteria shall be provided to the company for review and acceptance.

  

#### 7.5.3.3 Imperfections

Where imperfections identified during the visual inspection exceed the applicable limits specified by Clause 7.5.3.2, the affected area shall be repaired in accordance with the requirements of Clause 8.

### 7.5.4 Holiday inspection

#### 7.5.4.1 General

For new construction, the coated surface shall be inspected with a holiday detector where possible.

For coatings on existing piping, the company shall determine when holiday inspection is required.

For System FC6 coatings, holiday testing in accordance with Tables 6 and 7 shall be conducted only on the anti-corrosion coating, not on the outer jacket.

Holiday inspection shall be performed when the coating is free of contaminants (e.g., water, frost, snow, ice, mud). If water cannot be eliminated from the coating surface, wet sponge holiday detection may be used if approved by the company.

#### 7.5.4.2 Procedure

The holiday test procedure shall be conducted in accordance with the specifications in

a) Table 6 for Systems FC1, FC2, and FC3;
b) Table 7 for Systems FC4, FC5, and FC7; and
c) Table 8 for System FC6.

The detector shall be calibrated at least once in a 12 month period.

The detector shall be verified and tested at the beginning of each day of use and not less than once every 12 h against a volt meter that has been calibrated to recognized standards within the previous 6 months.

Where applicable, coating temperature and degree of cure during holiday detection shall be specified by the manufacturer.

#### 7.5.4.3 Acceptance criteria

There shall be no holidays in finished coating.

#### 7.5.4.4 Imperfections

Where imperfections identified during the holiday inspection exceed the applicable limits specified by Clause 7.5.4.3, the affected area shall be repaired in accordance with the requirements of Clause 8.

## 8 Repairs

Where required by Clause 7, coated piping shall be repaired in accordance with the applicable MQAP.

## Ⓟ 9 Markings

### 9.1

The application company shall assign each applicator a unique identifier and shall maintain a record of the assigned unique identifiers.

  

### 9.2
The applicator shall mark the date of application and the assigned unique identifier on all coating applications they have performed.

① ### 9.3
The marking shall be placed on or near the coating as soon as possible.

### 9.4
The company may waive the requirement for marking by the applicator if only a single applicator is performing the application.

### 9.5
This record of unique identifiers shall be made available upon request by the company.

## 10 Handling and storage of coating materials
Coating materials shall be transported, handled, and stored in accordance with the MQAP.

Handling and storage considerations shall include the following:
a) temperature limitations (e.g., freezing, excessive heat);
b) humidity;
c) protection from the elements (e.g., snow, rain, sunlight);
d) protection from contaminants (e.g., dust, water, chemicals);
e) expiration date; and
f) protection from physical damage.

## ① 11 Coating test reports and certificates of application compliance

### 11.1 Test reports
The application company shall ensure that reports are prepared to document the results of the tests required by this Standard.

Test reports shall be provided to the company on a schedule agreed to between the company and the application company.

### 11.2 Certificates of application compliance
If requested by the company, the application company shall furnish certificates of application compliance stating that
a) the application company has transported, handled, stored, applied, inspected, and tested the coating in accordance with the requirements of this Standard and any other requirements specified by the company; and
b) the results of the coating tests and other required tests have been found to conform to such requirements.

  

# 12 Test procedures — Hardness and peel adhesion

## 12.1 Shore D hardness test

For Systems FC1, FC2, FC3, and FC5 (epoxy primer only), Shore D hardness testing shall be conducted in accordance with ASTM D2240 and supplemented by the following:

a) A clearly identified area shall be built up to the thickness required by ASTM D2240.

**Note:** *This built-up area is commonly referred to as the button. The button should be placed on top of the overlap with the existing coating at the 12 o'clock position.*

b) The coating shall reach a thumbnail hard state.

c) Testing shall occur when the button is within a temperature range of 10 to 25 °C.

**Note:** *Shore D meters can give inaccurate readings if the indenter is pushed too fast or too slowly. It is recommended that the gauge be held in a near-vertical position and the foot of the gauge then be pressed firmly against the coating, but not so firmly as to imbed the foot into the coating surface. Consistency in the test method is essential.*

## Ⓟ 12.2 Peel adhesion test

Peel tests are a subjective test used on Systems FC4 and FC5 to assess proper adhesion to the substrate. Peel tests shall be performed as follows:

a) Select the area most prone to failure (e.g., overlap onto existing coating, bottom of the pipe that is difficult to preheat).

b) Conduct peel tests at a coating and substrate temperature range of 20 ± 3 °C. The substrate and coating shall be at the same temperature throughout the test location with tolerance of ± 1 °C. Direct heating of the coating shall be done in a manner that prevents damage to the coating.

c) Using a felt pen, mark a 25 mm × 150 mm rectangle on the coating.

d) Mark a tick every 10 mm along the sides of the rectangle.

**Note:** *This rectangle is referred to as the peel strip.*

e) Using a sharp utility knife, cut the rectangle through the coating. Care shall be taken in overlap areas not to cut through the existing coating.

f) Peel the strip back just enough to allow a peel gauge, pliers, or vise grips to be attached. Pull to the next tick and designate it as zero. The next 100 mm of the peel strip shall be the testing area used for determination.

g) Pull the strip at a steady rate of approximately 100 mm/min (10 mm/6 s) at a 90° angle to the pipe.

h) Continue to pull the peel strip until the entire strip is removed.

i) If required by the company, provide a measurement of the force needed to pull off the peel strip. Measure the peel force by attaching a spring scale or force gauge to the peel strip and averaging the readings obtained for each 10 mm increment.

j) Record the temperature of the coating, the ambient temperature, the failure mode, the percentage of surface area that remains bonded to the pipe, and, where required, the peel force value.

**Note:** *Photographs should be used to document peel tests.*

  

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## Table 1
## Manufacturer qualification coating test requirements for Systems FC1, FC2, and FC3
(See Clause 5.3.1 and Table 4.)

| Test | Acceptance criteria | | | Number of test specimens | Test method | Remarks |
|---|---|---|---|---|---|---|
| | FC1 | FC2 | FC3 | | | |
| Thickness | * | * | * | 3 | SSPC-PA 2 | — |
| Shore D hardness | * | * | * | 3 | Clause 12.1 of this Standard | Applies to liquids only Measured at >80% cure |
| Thermal characteristics | Meets manufacturer's specification | Meets manufacturer's specification | Meets manufacturer's specification | 3 | CSA Z245.20, Clause 12.7 | Applies to FBE only |
| Cure — Δ*Tg* (change in glass transition temperature) | ≤ 5 °C | ≤ 5 °C | ≤ 5 °C | 3 | CSA Z245.20, Clause 12.7 | Applies to FBE only |
| 24 h cathodic disbondment at 65 °C | 6.5 mm maximum radius | 6.5 mm maximum radius | 6.5 mm maximum radius | 3 | CSA Z245.20, Clause 12.8 | — |
| 28 day cathodic disbondment at 20 °C | 8.5 mm maximum radius | 8.5 mm maximum radius | 8.5 mm maximum radius | 3 | CSA Z245.20, Clause 12.8 | — |
| 28 d cathodic disbondment at maximum rated service temperature | 10 mm maximum radius | 10 mm maximum radius | 10 mm maximum radius | 3 | CSA Z245.20, Clause 12.8 | — |
| Cross-section porosity | Rating of 1–3 | Rating of 1–3 | Rating of 1–3† | 3 | CSA Z245.20, Clause 12.10 | Applies to FBE only |
| Interface porosity | Rating of 1–3 | Rating of 1–3 | Rating of 1–3‡ | 3 | CSA Z245.20, Clause 12.10 | Applies to FBE only |
| 3.0° flexibility | No cracking | n/a | n/a | 5 | CSA Z245.20, Clause 12.11 | Applies to FBE only |
| 2.0° flexibility | n/a | No cracking | No cracking | 5 | CSA Z245.20, Clause 12.11 | Applies to FBE only |
| 0.75° flexibility | No cracking | No cracking | No cracking | 5 | CSA Z245.20, Clause 12.11 | Applies to liquids only |
| 1.5 J impact resistance | No holidays | No holidays | n/a | 3 | CSA Z245.20, Clause 12.12** | — |
| 3.0 J impact resistance | n/a | n/a | No holidays§ | 3 | CSA Z245.20, Clause 12.12** | — |

*(Continued)*

## Table 1 (Concluded)

| Test | Acceptance criteria | | | Number of test specimens | Test method | Remarks |
|---|---|---|---|---|---|---|
| | FC1 | FC2 | FC3 | | | |
| Adhesion to steel substrate | Rating of 1 or 2 | Rating of 1 or 2 | Rating of 1 or 2 | 3 | ISO 21809-3, Annex Q modified†† | — |
| Adhesion to existing coating | Rating of 1–3 | Rating of 1–3 | Rating of 1–3 | 3 | ISO 21809-3, Annex Q modified†† | — |
| 28 d adhesion to steel at 75 °C | Rating of 1–3 | n/a | Rating of 1–3 | 3 | CSA Z245.20, Clause 12.14 | — |
| 28 d adhesion to existing coating at 75 °C | Rating of 1–3 | n/a | Rating of 1–3 | 3 | CSA Z245.20, Clause 12.14 | — |
| 28 d adhesion to steel at 95 °C | n/a | Rating of 1–3 | n/a | 3 | CSA Z245.20, Clause 12.14 | |
| 28 d adhesion to existing coating at 95 °C | n/a | Rating of 1–3 | n/a | 3 | CSA Z245.20, Clause 12.14 | — |
| Gouge resistance | n/a | n/a | Record value | | CSA Z245.20, Clause 12.15 | — |

* *There are no acceptance criteria for this test. The test result shall be used as a reference value for the applicator qualification and coating quality tests.*
† *This rating applies to individual layers of multi-layer coating systems except anti-slip overcoats.*
‡ *Cure and interface porosity tests shall be completed on the inner layer of the coating system.*
§ *For all multi-layer coatings, except for anti-corrosion coatings with an anti-slip overcoat, use 1.5 J.*
** *The voltage setting for the DC holiday detector shall be a maximum of 5 V/µm of thickness.*
†† *Modified to allow thicknesses in excess of 0.5 mm up to 2.0 mm.*

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## Table 2
## Manufacturer qualification coating test requirements for System FC4
(See Clause 5.3.1 and Table 4.)

| Test | Acceptance criteria | Number of test specimens | Test method | Remarks |
|---|---|---|---|---|
| Thickness* | MQAP | 3 | SSPC-PA 2 | — |
| 28 d cathodic disbondment at 20 °C | 12 mm maximum radius | 3 | CSA Z245.21, Clause 12.3 | — |
| 28 d cathodic disbondment at maximum design temperature | Meets company specification | 3 | CSA Z245.21, Clause 12.3 | — |
| Tensile strength of backing | 17 MPa | 3 | ASTM D638, Type IV sample; crosshead speed 50 mm/min | — |
| Elongation | 300% minimum | 3 | ASTM D638, Type IV sample; crosshead speed 50 mm/min | — |
| Hardness | Meets manufacturer's specification | 3 | ASTM D2240 | — |
| Peel adhesion to steel | ≥ 10 N† | 3 | CSA Z245.21, Clause 12.4 or 12.5 | — |
| Peel adhesion to existing coating | ≥ 10 N† | 3 | CSA Z245.21, Clause 12.4 or 12.5 | |
| Flexibility | No cracking of polyethylene or tape | 3 | CSA Z245.20, Clause 12.11 | — |
| Lap shear at 20 °C | ≥ 0.175 MPa | 3 | ASTM D1002 modified; 2.54 cm/min | — |
| Lap shear at maximum rated service temperature | ≥ 0.005 MPa | 3 | ASTM D1002 modified; 2.54 cm/min | — |
| Impact resistance | Specified by company | 3 | CSA Z245.20, Clause 12.12* | — |

* *The voltage setting for the DC holiday detector shall be 10 V/μm of thickness, up to a maximum of 15 000 V [see also Clause 12.2.3 d) and e) of CSA Z245.20].*
† *Equal to 0.4 N/mm.*

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## Table 3
## Manufacturer qualification coating test requirements for System FC5
(See Clause 5.3.1 and Table 4.)

| Test | Acceptance criteria | Number of test specimens | Test method | Remarks |
|---|---|---|---|---|
| Thickness* | MQAP | 3 | SSPC-PA 2 | — |
| 28 d cathodic disbondment at 20 °C | 12 mm maximum radius | 3 | CSA Z245.21, Clause 12.3 | — |
| 28 d cathodic disbondment at maximum design temperature | Meets company specification | 3 | CSA Z245.21, Clause 12.3 | — |
| Tensile strength of backing | 17 MPa | 3 | ASTM D638, Type IV sample; crosshead speed 50 mm/min | — |
| Elongation | 300% minimum | 3 | ASTM D638, Type IV sample; crosshead speed 50 mm/min | — |
| Hardness | Meets manufacturer's specification | 3 | ASTM D2240 | — |
| Adhesion of epoxy primer | Rating of 1 or 2 | 3 | ISO 21809-3, Annex Q modified‡ | — |
| Peel adhesion to steel | ≥ 150 N† | 3 | CSA Z245.21, Clause 12.4 or 12.5 | — |
| Peel adhesion to existing coating | ≥ 150 N† | 3 | CSA Z245.21, Clause 12.4 or 12.5 | |
| Flexibility | No cracking of polyethylene or tape | 3 | CSA Z245.20, Clause 12.11 | — |
| Lap shear at 20 °C | ≥ 2.000 MPa | 3 | ASTM D1002 modified; 2.54 cm/min | — |
| Lap shear at maximum rated service temperature | ≥ 0.200 MPa | 3 | ASTM D1002 modified; 2.54 cm/min | — |
| Impact resistance | Specified by company | 3 | CSA Z245.20, Clause 12.12* | — |

* *The voltage setting for the DC holiday detector shall be 10 V/μm of thickness, up to a maximum of 15 000 V [see also Clause 12.2.3 d) and e) of CSA Z245.20].*

† *Equal to 6 N/mm.*

‡ *Modified to allow thicknesses in excess of 0.5 mm up to 2.0 mm.*

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## Table 4
## Manufacturer qualification coating test requirements for System FC6
(See Clause 5.3.1.)

| Test | Acceptance criteria | Test method | Remarks |
|---|---|---|---|
| **Anti-corrosion coating (if specified)** | | | |
| Systems FC1 and FC2 | See Table 1 | See Table 1 | — |
| Systems FC4 and FC5† | See Tables 2 and 3 | See Tables 2 and 3 | — |
| System FC4 | At least 20 °C above maximum design temperature | ASTM E28 | |
| System FC5 | At least 10 °C above maximum design temperature | ASTM D1525 | |
| **Polyurethane foam insulation** | | | |
| Open cell content | ≤ 12% volume | ASTM D6226 | — |
| Water absorption | Record value (volume %) | ASTM D2842 | — |
| Creep at maximum design temperature ±3 °C | Record value (radial displacement, mm) | CSA Z245.22, Clause 12.2 | — |
| Density | Record value (kg/m³) | ASTM D1622/D1622M | |
| **Compressive strength at 20 ± 3 °C** | | | |
| Spray foam | ≥ 0.3 MPa | ASTM D1621 | — |
| Mould foam | ≥ 0.2 MPa | ASTM D1621 | — |
| **Compressive strength at maximum design temperature ± 3 °C** | | | |
| Spray foam | ≥ 0.15 MPa | ASTM D1621 | — |
| Mould foam | ≥ 0.1 MPa | ASTM D1621 | — |
| **k-factor** | | | |
| Initial | ≤ 0.03 W/m·K | ASTM C518 | — |
| After 100 d at maximum design temperature ± 3 °C | ≤ 0.03 W/m·K | ASTM C518 | — |
| **Outer jacket** | | | |
| Peel adhesion at overlap onto outer jacket | ≥ 10 N* | Clause 12.2 of this Standard | — |
| Flexibility | No cracking of polyethylene or tape | CSA Z245.20, Clause 12.11 | |

*(Continued)*

## Table 4 (Concluded)

| Test | Acceptance criteria | Test method | Remarks |
|---|---|---|---|
| Impact resistance | Minimum of 3.0 J/mm of actual total coating thickness | CSA Z245.20, Clause 12.12 | Modified to an applied sleeve and specimen cut in accordance with CSA Z245.20, Clause 12.12. |
| Tensile strength of backing | 17 MPa | ASTM D638, Type IV sample; crosshead speed 50 mm/min | — |
| Elongation | 300% minimum | ASTM D638, Type IV sample; crosshead speed 50 mm/min | — |
| Hardness | Shore D > 40 | ASTM D2240 | — |
| **Lap shear** | | | |
| System FC4 | ≥ 0.175 MPa | ASTM D1002 modified; 2.54 cm/min | — |
| Electrofusion | ≥ 17 MPa | ASTM D1002 | System with no anti-corrosion coating |

* *Equal to 0.4 N/mm*

† *For System FC4 and System FC5, lap shear testing is not required at either 20 °C or at maximum design temperature. For System FC4, the test shall be of the adhesive and a ring and ball softening point shall be used in accordance with CSA Z245.21, Table 2, System A. For System FC5, the test shall be of the adhesive and a vicat softening point shall be used in accordance with CSA Z245.21, Table 2, Systems B1 and B2.*

**Note:** *Heat aging of samples for compressive strength, k-factor, and axial shear strength tests shall be carried out in accordance with Clause 12.1 of CSA Z245.22.*

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## Table 5
## Manufacturer qualification coating test requirements for System FC7
(See Clause 5.3.1.)

| Test | Acceptance criteria | Number of test specimens | Test method | Remarks |
|---|---|---|---|---|
| 28 d cathodic disbondment at 20 °C | 20 mm maximum radius | 3 | CSA Z245.21, Clause 12.3 | Number of specimens is not specified in CSA Z245.21 |
| 28 d cathodic disbondment at maximum design temperature | Meets company specification | 3 | CSA Z245.21, Clause 12.3 | — |
| Adhesion to steel | Leaves film on substrate | 3 | Visual | — |
| Adhesion to existing coating | Leaves film on substrate | 3 | Visual | — |
| Flexibility | No cracking of tape | 3 | CSA Z245.20, Clause 12.11 | — |

Ⓟ ①

## Table 6
## Applicator qualification and coating quality test requirements for Systems FC1, FC2, and FC3

(See Clauses 6.1.2.4, 6.1.2.5.1, 6.1.2.6, 6.2.3.1, 7.1, 7.4, 7.5.2.1, 7.5.3.2, 7.5.4.1, and 7.5.4.2 and Table 8.)

| Item | Test method | Acceptance criteria | Minimum frequency for each applicator (for coating quality tests only)* |
|---|---|---|---|
| Surface preparation | SSPC-VIS 1 | Per MQAP† | 100% |
| Surface profile | ASTM D4417 | Per MQAP† | a) For coating applications of new girth welds: 1 per 25 coating applications or minimum 1 per day, whichever is greater.<br>b) For coating applications of pipe, components, and other welds coated with the identical coating (same MQAP): as specified by the company, but with a minimum of one per day.<br>**Note:** *Three readings per joint in different quadrants of the piping surface.* |
| Soluble salts (chloride) | SSPC-Guide 15 | < 20 mg/m$^2$ | a) For coating applications of new girth welds: 1 per 50 coating applications with a minimum of 1 per day, whichever is greater.<br>b) For coating applications of pipe, components and other welds coated with the identical coating (same MQAP): as specified by the company; in consideration of the likelihood of the presence of soluble salts caused during transportation or storage of the pipe and components to be coated. |
| Piping preheat temperature | Digital surface contact thermometer | MQAP† | 100% |
| Hardness** | Shore D hardness in accordance with Clause 12.1 of this Standard | MQAP† | a) For coating applications of new girth welds: 1 per 25 coating applications or minimum 1 per day, whichever is greater.<br>b) For coating applications of pipe, components, and other welds coated with the identical coating (same MQAP): as |

*(Continued)*

  

**Table 6 (Continued)**

| Item | Test method | Acceptance criteria | Minimum frequency for each applicator (for coating quality tests only)* |
|---|---|---|---|
| | | | specified by the company, but with a minimum of one per day. |
| Cure†† | MQAP† | MQAP† | a) For coating applications of new girth welds: 1 per 25 coating applications or minimum 1 per day, whichever is greater.<br>b) For coating applications of pipe, components, and other welds coated with the identical coating (same MQAP): as specified by the company, but with a minimum of one per day. |
| Wet film thickness (WFT) | Coating thickness gauge | MQAP† | 100% of coating applications; as specified in the MQAP |
| Dry film thickness (DFT) | SSPC-PA 2 Coating thickness gauge | MQAP† | 100% of coating applications<br>**Note:** *Five readings per test are required.* |
| Adhesion to steel | ISO 21809-3, Annex Q modified‡§ | Rating of 1 or 2 | a) For 1 to 4 identical applications (same MQAP): as specified by the company.<br>b) For 5 or more identical coating applications:<br>i) For coating applications of new girth welds: 1 per 50 coating applications or minimum 1 per day, whichever is greater.<br>ii) For coating applications of pipe, components, and other welds coated with the identical coating (same MQAP): as specified by the company, but with a minimum of one per day. |
| Adhesion to existing coating | ISO 21809-3, Annex Q modified‡§ | Rating of 1 or 2 | a) For 1 to 4 identical applications (same MQAP): as specified by the company.<br>b) For 5 or more identical coating applications:<br>i) For coating applications of new girth welds: 1 per 50 coating applications or minimum 1 per day, whichever is greater.<br>ii) For coating applications of pipe, components and |

*(Continued)*

  

**Table 6 (Concluded)**

| Item | Test method | Acceptance criteria | Minimum frequency for each applicator (for coating quality tests only)* |
|---|---|---|---|
| | | | other welds coated with the identical coating (same MQAP): as specified by the company, but with a minimum of one per day. |
| Overlap length | Tape measure | 50 mm minimum | 100% of coating applications |
| Holiday testing | NACE SP0188‡ | No holidays | 100% of coated surface |
| Appearance | Visual inspection | Deleterious imperfections such as<br>• chips, scratches, nicks, pinholes<br>• indentations<br>• excessive runs, sags, and drips<br>• fisheyes<br>• dimples<br>• improper overlap<br>• discoloration, heat damage, or signs of improper mixing | 100% of coated surface |

* *The company shall determine the frequency of coating quality tests for repair, maintenance, and tie-in activities on existing pipeline systems.*
† *For MQAP, see Clause 5.3.2.*
‡ *Alternative test methods may be used, provided they are approved by the company*
§ *Modified to allow thicknesses in excess of 0.5 mm up to 2.0 mm.*
** *Applies to liquids only.*
†† *Applies to FBE only.*

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## Table 7
## Applicator qualification and coating quality test requirements for Systems FC4, FC5, and FC7

(See Clauses 6.1.2.4, 6.1.2.5.1, 6.1.2.6, 6.2.3.1, 7.1, 7.4, 7.5.2.1, 7.5.3.2, 7.5.4.1, and 7.5.4.2 and Table 8.)

| Item | Test method | Specified value | Minimum frequency for each applicator (for coating quality tests only) * |
|---|---|---|---|
| Surface preparation‡ | SSPC-VIS 1 or SSPC-VIS 3, as appropriate | MQAP† | 100% |
| Surface profile‡ (as required per SSPC specification) | ASTM D4417 | MQAP† | a) For coating applications of new girth welds: 1 per 25 coating applications or minimum 1 per day, whichever is greater.<br>b) For coating applications of pipe, components, and other welds coated with the identical coating (same MQAP): as specified by the company, but with a minimum of one per day.<br>**Note:** *Three readings per test, in different quadrants of the surface to be coated are required.* |
| Preheat temperature | Digital surface contact thermometer | MQAP† | 100% |
| Wet film thickness of epoxy or other primer — for Systems FC4 and FC5 only | ASTM D4414 Wet film thickness (WFT) | MQAP† | 100% of coating applications or as specified in the MQAP.<br>**Note:** *Five readings per test are required.* |
| Dry film thickness of epoxy primer — for System FC5 only | SSPC-PA 2 Dry film thickness (DFT) | MQAP† | 100% of coating applications or as specified in the MQAP.<br>**Note:** *Five readings per test are required.* |
| Adhesion of epoxy primer to steel — for System FC5 only | ISO 21809-3, Annex Q modified§** | Rating of 1 or 2 | a) For 1 to 4 identical coating applications (same MQAP): as specified by the company.<br>b) For 5 or more identical coating applications:<br>i) For coating applications of new girth welds: 1 per 50 coating applications |

*(Continued)*

**Table 7 (Continued)**

| Item | Test method | Specified value | Minimum frequency for each applicator (for coating quality tests only) * |
|---|---|---|---|
| | | | or minimum 1 per day, whichever is greater.<br>ii) For coating applications of pipe, components, and other welds coated with the identical coating (same MQAP): as specified by the company, but with a minimum of 1 per day. |
| Overlap length | Tape measure | MQAP† | 100% of coating applications |
| Peel adhesion to steel — for Systems FC4 and FC5 only‡ | Peel test; see Clause 12.2 of this Standard | Visual: more than 80% of the surface area of the adhesive remains bonded to the steel substrate, or the company shall specify a minimum value for the peel force. | a) For 1 to 4 identical coating applications (same MQAP): as specified by the company.<br>b) For 5 or more identical coating applications:<br>i) For coating applications of new girth welds: 1 per 50 coating applications or minimum 1 per day, whichever is greater.<br>ii) For coating applications of pipe, components, and other welds coated with the identical coating (same MQAP): as specified by the company, but with a minimum of 1 per day. |
| Peel adhesion to existing coating — for Systems FC4 and FC5 only ‡ | Peel test; see Clause 12.2 of this Standard | Visual: more than 80% of the surface area of the adhesive remains bonded to the steel substrate, or the company shall specify a minimum value for the peel force. | a) For 1 to 4 identical coating applications (same MQAP): as specified by the company.<br>b) For 5 or more identical coating applications:<br>i) For coating applications of new girth welds: 1 per 50 coating applications or minimum 1 per day, whichever is greater.<br>ii) For coating applications of pipe, components, and other welds coated with the identical coating (same MQAP): as specified by the company, but with a minimum of 1 per day. |

*(Continued)*

  

**Table 7 (Continued)**

| Item | Test method | Specified value | Minimum frequency for each applicator (for coating quality tests only) * |
|---|---|---|---|
| Adhesion to steel — System FC7 only | Leaves film on substrate | Visual | a) For 1 to 4 identical coating applications (same MQAP), specified by the company.<br>b) For 5 or more identical coating applications, one of the following:<br>i) For coating applications of new girth welds: 1 per 50 coating applications or minimum 1 per day, whichever is greater.<br>ii) For coating applications of pipe, components, and other welds coated with the identical coating (same MQAP), specified by the company, but with a minimum of 1 per day. |
| Adhesion to existing coating — System FC7 only | Leaves film on substrate | Visual | a) For 1 to 4 identical coating applications (same MQAP), specified by the company.<br>b) For 5 or more identical coating applications, one of the following:<br>i) For coating applications of new girth welds: 1 per 50 coating applications or minimum 1 per day, whichever is greater.<br>ii) For coating applications of pipe, components, and other welds coated with the identical coating (same MQAP), specified by the company, but with a minimum of 1 per day. |

*(Continued)*

  

## Table 7 (Concluded)

| Item | Test method | Specified value | Minimum frequency for each applicator (for coating quality tests only) * |
|---|---|---|---|
| Holiday testing‡ | NACE SP0188, NACE SP0274§ | No holidays | 100% of coated surface |
| Appearance | Visual assessment | Deleterious imperfections such as<br>• wrinkles, splits, cracks, scratches, nicks, pinholes<br>• indentations<br>• air entrapment<br>• improper overlap<br>• incorrect closure position<br>• lack of adhesive bleed out<br>• discoloration or heat damage<br>• incomplete coverage<br>• missing components of the multi-layer system (for System FC5 only) | 100% of coated surface |

* *The company shall determine the frequency of coating quality tests for repair, maintenance, and tie-in activities on existing pipeline systems.*
† *For MQAP, see Clause 5.3.2.*
‡ *For System FC6 using a System FC4 or System FC5 as the outer jacket, the peel adhesion shall be tested at the overlap onto the outer jacket of the existing coating. For System FC7 in accordance with the MQAP.*
§ *Alternative test methods may be used, provided they are approved by the company.*
** *Modified to allow thicknesses in excess of 0.5 mm up to 2.0 mm.*

  

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## Table 8
## Applicator qualification and coating quality test requirements for System FC6

(See Clauses 6.1.2.4, 6.1.2.5.1, 6.1.2.6, 6.2.3.1, 7.1, 7.4, 7.5.2.1, 7.5.3.2, and 7.5.4.2.)

| Item | Test method | Specified value | Minimum frequency for each applicator (for coating quality tests only) * |
|---|---|---|---|
| **Anti-corrosion coating** | | | |
| Systems FC1 and FC2 | See Table 6 | See Table 6 | See Table 6 |
| Systems FC4 and FC5 | See Table 7 | See Table 7 | See Table 7 |
| **Polyurethane foam insulation** | | | |
| Thickness | MQAP† | −3 mm/+10 mm of factory-applied insulation thickness | 100% of coating applications |
| Compressive strength at 20 °C ± 3 °C | | | |
| Spray foam | ASTM D1621 | ≥ 0.3 MPa | Specified by the company |
| Mould foam | ASTM D1621 | ≥ 0.2 MPa | Specified by the company |
| Density | ASTM D1622/ D1622M | MQAP† | a) For 1 to 4 identical coating applications (same MQAP) specified by the company.<br>b) For 5 or more identical coating applications one of the following:<br>i) For coating applications of new girth welds, 1 per 50 coating applications or minimum 1 per day, whichever is greater.<br>ii) For coating applications of pipe, components, and other welds coated with the identical coating (same MQAP), specified by the company, minimum 1 per day. |
| Adhesion to substrate | MQAP† | Bond exceeds strength of foam insulation | Specified by the company |
| Adhesion to factory-applied insulation cutback | MQAP† | Bond exceeds strength of foam insulation | Specified by the company |

*(Continued)*

## Table 8 (Concluded)

| Item | Test method | Specified value | Minimum frequency for each applicator (for coating quality tests only) * |
|---|---|---|---|
| Appearance of foam insulation layer | Visual assessment | Deleterious imperfections or indications such as<br>• cracks<br>• voids<br>• incomplete cure<br>• improperly mixed foam<br>• protrusions | 100% of coated surface |
| **Outer jacket** | | | |
| Outer jacket | See Table 7 ‡ | See Table 7‡ | See Table 7‡ |

* *The company shall determine the frequency of coating quality tests for repair, maintenance, and tie-in activities on existing pipeline systems.*

† *For MQAP, see Clause 5.3.2.*

‡ *Except holiday detection.*

  


ISBN 978-1-4883-1407-0