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IEEE Standard for Pole-Mounted Equipment—Enclosure Integrity for Coastal Environments

STANDARDS

IEEE Power and Energy Society

Developed by the
Transformers Committee
and the
Switchgear Committee

IEEE Std C57.12.30™-2020
(Revision of IEEE Std C57.12.30-2010)

IEEE

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Transformers Committee
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Approved 3 December 2020

IEEE SA Standards Board

Abstract: Conformance tests and requirements for the coating integrity of pole-mounted enclosures containing apparatus energized in excess of 600 V, and for application in coastal environments, are specified in this standard. These enclosures are typically located out of reach of the general public, and include, but are not limited to, the following types of equipment enclosures: pole-mounted distribution transformers, pole-mounted switches, pole-mounted regulators, pole-mounted metering equipment, pole-mounted reclosers, and pole-mounted switchgear.

Keywords: coating integrity, enclosure integrity, IEEE C57.12.30™, pole-mounted equipment, switches, transformers

The Institute of Electrical and Electronics Engineers, Inc.
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PDF: ISBN 978-1-5044-7265-4 STD24539
Print: ISBN 978-1-5044-7266-1 STDPD24539

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Introduction

This introduction is not part of IEEE Std C57.12.30-2020, IEEE Standard for Pole-Mounted Equipment—Enclosure Integrity for Coastal Environments.

The Accredited Standards Committee on Transformers, Regulators, and Reactors, C57, originally developed and correlated standards on these products, together with the Accredited Standards Committee on Power Switchgear, C37, through the Joint ASC C57/C37 Working Group on Enclosures with Joseph Martin and then with Robert C. Olen as chairman. This group is now the Enclosure Integrity Working Group of the IEEE Transformers Committee.

The data used in this work have been gathered from many sources, including the standards of the Institute of Electrical and Electronics Engineers and the National Electrical Manufacturers Association, reports of committees of the Edison Electric Institute, and others.

In this revision of the guide a Word usage clause was added, additional definitions were added, and a new impact test was also added. Furthermore, the purpose of each test was clarified, and the standard was generally updated.

Contents

IEEE Standard for Pole-Mounted Equipment—Enclosure Integrity for Coastal Environments

1. Overview

1.1 Scope

This standard covers conformance tests and requirements for the enclosure integrity of pole-mounted electrical equipment intended for installations in coastal environments. These enclosures contain electrical apparatus energized in excess of 600 V, typically not accessible to the general public, including, but not limited to, the following types of equipment:

a) Pole-mounted distribution transformers

b) Pole-mounted switches

c) Pole-mounted regulators

d) Pole-mounted metering equipment

e) Pole-mounted reclosers/sectionalizers

f) Pole-mounted capacitors

1.2 Purpose

The purpose of this standard is to describe the requirements for a comprehensive enclosure integrity system for pole-mounted equipment providing long service life with minimum maintenance.

1.3 Word usage

The word *shall* indicates mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (*shall* equals *is required to*).[1,2]

The word *should* indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required (*should* equals *is recommended that*).

[1]The use of the word *must* is deprecated and cannot be used when stating mandatory requirements; *must* is used only to describe unavoidable situations.
[2]The use of *will* is deprecated and cannot be used when stating mandatory requirements; *will* is only used in statements of fact.

The word *may* is used to indicate a course of action permissible within the limits of the standard (*may* equals *is permitted to*).

The word *can* is used for statements of possibility and capability, whether material, physical, or causal (*can* equals *is able to*).

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

ASTM B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.[3]

ASTM D523, Standard Test Method for Specular Gloss.

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

ASTM D660, Standard Test Method for Evaluating Degree of Checking of Exterior Paint.

ASTM D661, Standard Test Method for Evaluating Degree of Cracking of Exterior Paints.

ASTM D714, Standard Test Method of Evaluating Degree of Blistering of Paints.

ASTM D1654-05, Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.

ASTM D2794, Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).

ASTM D3170, Standard Test Method for Chipping Resistance of Coatings.

ASTM D3359, Standard Test Methods for Measuring Adhesion by Tape Test.

ASTM D3363, Standard Test Method for Film Hardness by Pencil Test.

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

ASTM D4585, Standard Practice for Testing Water Resistance of Coatings Using Controlled Condensation.

ASTM D4587, Standard Practice for Fluorescent UV-Condensation Exposures of Paint and Related Coatings.

3. Definitions

For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause. [4]

carbon steel: A steel containing only residual quantities of elements other than carbon, except those added for deoxidation or to counter the deleterious effects of residual sulfur. Silicon is usually limited to about 0.60%

[3]ASTM publications are available from the American Society for Testing and Materials (https://www.astm.org/).
[4]*IEEE Standards Dictionary Online* is available at: http://dictionary.ieee.org. An IEEE Account is required for access to the dictionary, and one can be created at no charge on the dictionary sign-in page.

and manganese to about 1.65% by weight. Also termed plain carbon steel, ordinary steel or straight carbon steel.

NOTE—See *The Metals Black Book, Ferrous Metals* [B2].[5,6]

coastal environment: The land area within 760 m (2500 ft) of the mean high-water line, or as determined by users to be affected by the coastal effect of salt-spray, high wind, or other harsh environmental effects.

conformance tests: Certain performance tests are conducted to demonstrate compliance with the applicable standards. The test specimen is normally subjected to all planned routine tests prior to initiation of the conformance test program.

NOTE—The conformance tests may, or may not, be similar to certain design tests. Demonstration of margins (capabilities) beyond the standard requirements is unnecessary.

design tests: Tests made by the manufacturer to determine the adequacy of the design of a particular type or model of equipment or its component parts to meet its assigned ratings and to operate satisfactorily under normal conditions and under special conditions if specified. These tests may be used to demonstrate compliance with applicable standards of the industry.

NOTE—Design tests, sometimes called type tests, are made on representative apparatus or prototypes to verify the validity of design analysis and calculation methods and to substantiate the ratings assigned to all other apparatus of basically the same design. These tests may also be used to evaluate the modification of a previous design and to verify that performance has not been adversely affected. Test data from previous similar designs may be used for current designs, where appropriate. Once made, the tests need not be repeated unless the design is changed so as to modify performance.

dry film thickness (of a coating): Thickness of any applied coating(s) measured after curing.

enclosure: The manufacturer supplied tank, cover, cover retention and integral components (like sealed bushings or overpressure devices), or other housing containing the electrical equipment, its insulating medium, and internal components. The tank or housing includes permanent attachments such as weldments necessary for the proper handling, mounting, operation, or upgrading of the equipment. This tank or other housing is typically located outdoors, above grade level, and not accessible to the general public, as some of its external components have high voltages during operation.

routine tests: Tests made for quality control by the manufacturer on every device or representative samples, or on parts or materials, as required to verify during production that the product meets the design specifications and applicable standards.

NOTE 1—Certain quality assurance tests on identified critical parts of repetitive high-production devices may be tested on a planned statistical sampling basis.

NOTE 2—**Routine tests** are sometimes called *production tests*.

substrate: The uncoated material that provides structural integrity to the enclosure.

[5]The numbers in brackets correspond to those of the bibliography in Annex B.
[6]Notes in text, tables, and figures of a standard are given for information only and do not contain requirements needed to implement this standard.

4. Enclosure design

4.1 Enclosure design requirements—Objective

The objective of this clause is to describe design and performance requirements for pole-mounted enclosures situated in coastal saltwater environments.

4.1.1 Exterior surface

The enclosure shall be designed such that all exterior surfaces are accessible for proper surface preparation and the application of a uniform amount of the coating materials. Additionally, all exterior surfaces of the enclosure shall be accessible for the purposes of inspection and maintenance of the enclosure over the life of the equipment. All welds shall be treated to prepare the weld area and the heat affected zones for coating. Weld spatter shall be removed. All welds shall be made in accordance with appropriate industrial welding standards.

4.1.2 Contaminant accumulation

The enclosure shall be designed to shed water and help minimize areas where corrosive elements can accumulate.

4.1.3 Galling

Steps must be taken in the design and manufacture of the enclosures to prevent galling. Galling is known to occur with threaded fasteners where the mating surfaces are both made of the same stainless steel alloy, aluminum alloy, or titanium alloy. Two commonly used methods to mitigate galling are listed below but are not specifically required separately or in combination. Alternative methods may be used if proven to be equally effective:

— Use dissimilar materials in threaded joints such as silicon-bronze with stainless-steel, brass with stainless-steel, etc.

  NOTE—Manufacturers and users should be aware that the use of dissimilar metals may lead to galvanic corrosion in some service environments. The use of dielectric unions or physical isolation of the materials is known to mitigate corrosion potential.

— Use anti-seize compounds or materials in the connection.

4.1.4 Other exposed surfaces

Any surface, other than coated substrate, in the assembled equipment that is left exposed to the external environment, such as seals, gaskets, and cables, must survive the same environment as the coated substrate.

4.1.5 Attachments

Any attachments to the assembled equipment (e.g., sight glass, viewing window, gauge, etc.) that are exposed to the external environment must retain their intended functionality.

4.2 Substrate requirements

4.2.1 General

The substrate(s) used on the exterior of the enclosure shall be a material that, when coated or otherwise processed, will maintain the structural integrity of the enclosure over the life of the apparatus.

4.2.2 Specification of substrate characteristics

The apparatus enclosure substrate shall exhibit a general corrosion rate not to exceed 0.03 mm (0.001 in) per year and a maximum pit depth not to exceed 0.13 mm (0.005 in) over the life of the apparatus, when exposed to natural coastal environments.

4.2.3 Substrate performance requirements

Five substrate test panels and five bare AISI 409 stainless-steel control test panels shall be evaluated for percent weight loss after exposure to 1500 h of salt spray in accordance with ASTM B117.[7] The average weight loss of each set of test panels shall not exceed 2.5%. In addition, the ratio of the average percent weight loss between the substrate test panel set and the control test panel set shall not exceed 5 to 1.[8]

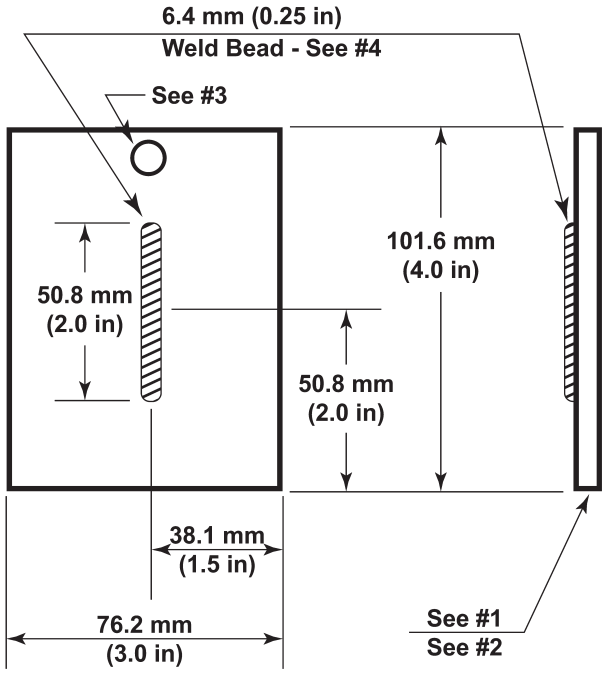
The AISI 409 stainless-steel control test panels shall be unwelded but fabricated and pretreated in accordance with Figure 2 (non-welded panel) using standard production practices prior to testing. For metallic substrates, the substrate test panels shall be fabricated in accordance with Figure 1 (welded panel) using standard production, fabrication, welding, and cleaning practices. For non-metallic substrates, the substrate test panels shall be fabricated in accordance with Figure 2 using standard production, fabrication, and cleaning practices.

The purpose of this test is to assure that the substrate does not lose more weight than the 5 to 1 ratio compared to the bare AISI 409 stainless steel when exposed to salt spray.

Exceptions: enclosures manufactured totally from AISI 409, 304L, 316, or 316L stainless steel, and welded in accordance with American Welding Society Standard Weld Procedure Specifications are exempt from this subclause.

See Annex A for the procedure for comparative weight loss analysis of the test panels.

[7]Information on references can be found in Clause 2.
[8]It is not uncommon for a welded test panel to exhibit greater weight loss due to the galvanic action between the weldment and the base metal.



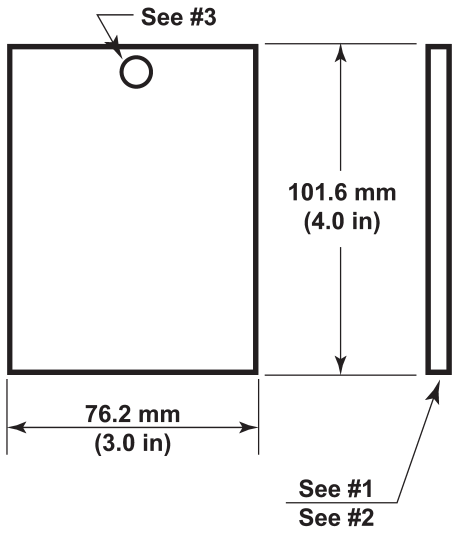
1 Panel thickness to be of typical production stock used in the manufacture of devices for which the test is intended.

2 Panel is to be cleaned and uncoated.

3 Hole can be placed in panel if required for processing. Locate centered on short dimension and 3.2 mm (1/8 in) to edge of hole on long dimension. Recommended maximum hole size is 14.3 mm (9/16 in) in diameter.

4 Weld bead to be the same type metal composition as the panel. Weld bead to be 6.4 mm (1/4 in) wide and 3.2 mm (1/8 in) high.

Figure 1—Welded substrate test panel



1 Panel thickness to be of typical production stock used in the manufacture of devices for which the test is intended.
2 Panel is to be cleaned and uncoated.
3 Hole can be placed in panel if required for processing. Locate centered on short dimension and 3.2 mm (1/8 in) to edge of hole on long dimension. Recommended maximum hole size is 14.3 mm (9/16 in) in diameter.

Figure 2—Non-welded substrate test panel

5. Coating system requirements

5.1 General

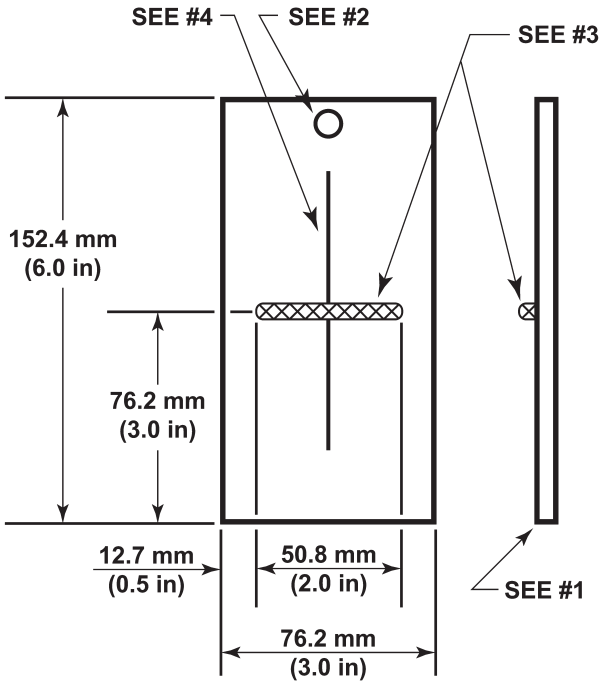
Each different combination of substrate(s) and coating(s) used on the exterior of the enclosure shall meet these design tests. If more than one substrate/coating system combination is used for different areas of the enclosure, the areas in which each is used shall be identified. The laboratory test performance data of each substrate/coating system shall be submitted for approval upon request. This data shall be resubmitted whenever there are changes in the production method and/or materials, or at least every five years.

5.2 Enclosure color

Unless otherwise specified, the topcoat color shall be Munsell Number 5BG 7.0/0.4 (ANSI Gray No. 70). The color variation of the coated product shall not exceed the Munsell Color Standard by more than a ΔE (Hunter) value of two. See Munsell Color Standards [B16].

5.3 Coating system test specimens

Test specimens shall consist of panels of the same material composition used in production. Test specimens shall be fabricated in accordance with Figure 3, Figure 4, Figure 5, and Figure 6 as to size and type. Quantity and type of panels in each test are identified under the specific test. All panels shall be cleaned and/or pretreated, coated, and cured using the production coating system. Coated test panels shall be conditioned at room temperature and humidity for a minimum of seven days prior to any testing.



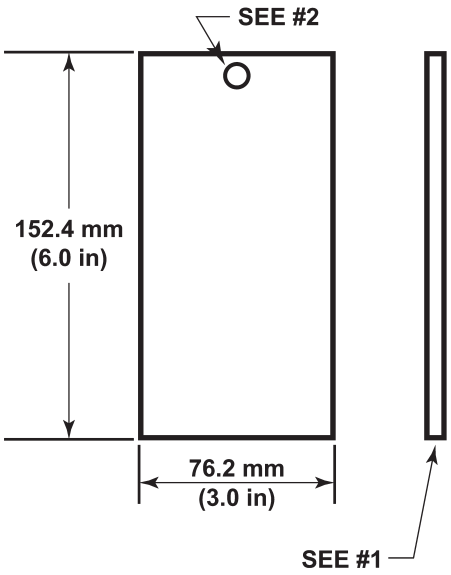
1 Test panels shall be made from typical production stock of the same material type and thickness used in the construction of the device for which the specified test is intended.

2 Hole can be placed in panel for hanging for coating operations if required. Locate centered on short dimension and 3.2 mm (1/8 in) to edge of hole on long dimension. Recommended maximum hole size 14.3 mm (9/16 in) in diameter.

3 Weld bead shall be the same type metal composition as the panel. Weld bead to be 6.4 mm (1/4 in) wide and 3.2 mm (1/8 in) high.

4 After coating, scribe per ASTM D1654–05 across weld approximately 102 mm (4 in) scribe length.

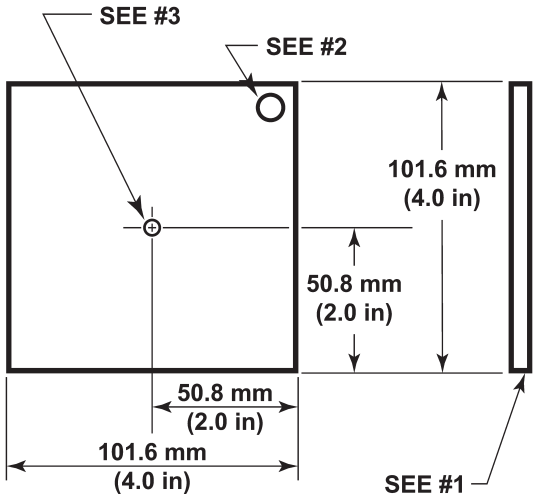
Figure 3—Scribed weld-bead coating test panel



1 Test panels shall be made from typical production stock of the same material type and thickness used in the construction of the device for which the specified test is intended.

2 Hole can be placed in panel for hanging for coating operations if required. Locate centered on short dimension and 3.2 mm (1/8 in) to edge of hole on long dimension. Recommended maximum hole size 14.3 mm (9/16 in) in diameter.

Figure 4—Plain coating test panel

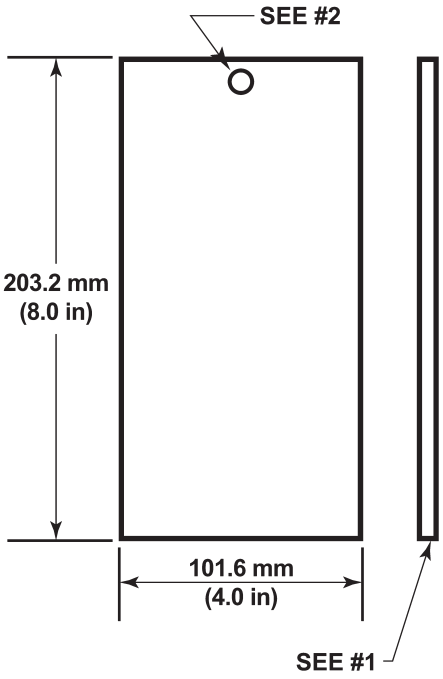


1 Test panels shall be made from typical production stock of the same material type and thickness used in the construction of the device for which the specified test is intended.

2 Hole can be placed in panel for hanging. To be located in one corner. Recommended maximum hole size 14.3 mm (9/16 in) in diameter.

3 7.9 mm (5/16 in) diameter hole to fit abraser post.

Figure 5—Abraser coating test panel



#1 Test panels shall be made from typical production stock of the same material type and thickness used in the construction of the device for which the specified test is intended.

#2 Hole can be placed in panel for hanging for coating operations if required. Locate centered on short dimension and 3.2 mm (1/8 in) to edge of hole on long dimension. Recommended maximum hole size is 14.3 mm (9/16 in) in diameter.

Figure 6—Gravelometer coating test panel

5.4 Coating system performance requirements

5.4.1 Outdoor exposure test

This test demonstrates how the coating/substrate system may perform in coastal environments.

5.4.1.1 Exposure test site

A marine environment for natural accelerated testing, located on the ocean or Gulf of Mexico, with a view of the surf-line that is unrestricted by buildings. Corrosion rate for an ingot of iron of AISI 1008 carbon steel shall be greater than 254 μm (10 mil) per year as determined by annual evaluation. Monitoring for chloride deposition (monthly), iron ingot corrosion rate (annual), temperature, and rainfall shall be maintained and historical data provided upon request.

NOTE—Examples of test sites that meet these criteria are Battelle Memorial Institute's Florida Materials Research Facility (Daytona Beach, Florida) and the Corrosion Technology Laboratory (Kennedy Space Center, Florida).

5.4.1.2 Exposure test criteria

This test requirement shall apply to all coating systems applied to the electrical distribution device. Three coated panels, shown in Figure 3, shall be scribed per ASTM D1654-05 and tested for 12 weeks at a test site that meets the criteria in 5.4.1.1. The panels shall be exposed in a rack facing the ocean at a 30° angle from the horizontal and positioned so that moisture runs down the length of the scribe line during the exposure period.

5.4.1.3 Exposure test evaluation

After the 12-week exposure, prepare the scribe for evaluation as given in ASTM D1654–05 Procedure A, method 2 (scraping). The scribe shall be divided into 14 zones 6.4 mm (0.25 in) in length and the worst spot in each zone will be evaluated [except the first 6.4 mm (0.25 in) of the scribe at each end of the scribe line]. The average of the 14 readings shall be rated as given in Table 1 of ASTM D1654–05. Scribe creepage shall include discoloration and pitting caused from corrosion, as well as loss of coating adhesion, blistering, film undercutting, and removal of coating around the scribe line. After a rating has been set for each of the three panels, the average rating of the three panels shall not be less than nine. The area away from the scribe shall have no blisters per ASTM D714 and be free of any corrosion bleed through per ASTM D610. The 6.4 mm (0.25 in) area around the perimeter of the panel and hanging hole shall not be included in the rating of the face of the panel.

5.4.2 Crosshatch adhesion test

This test demonstrates proper adhesion of the coating system to the substrate.

One coated test panel, shown in Figure 4, shall be scribed to bare substrate in accordance with ASTM D3359. Method A shall be used for films thicker than 0.13 mm (5 mil or 0.005 in). Method B shall be used for films less than or equal to 0.13 mm (5 mil or 0.005 in). There shall be 100% adhesion to the substrate and between layers. A rating of 5A for Method A and 5B for Method B per ASTM D3359 is required.

5.4.3 Humidity test

This test evaluates the performance of the coating system under controlled condensation conditions. Condensation may cause deterioration of the coating system impacting the useful service life of the equipment.

Two coated panels, shown in Figure 3, shall be tested for 1000 h in accordance with ASTM D4585 except that the test shall be conducted at 45 °C ±1 °C (113 °F ±2 °F). Upon completion of the test, panels shall be evaluated for the following:

a) Blistering—There shall be no blistering observed per ASTM D714 on the surface of the panels when inspected within 15 min after removal from the cabinet.

b) Softening—After removal from the cabinet, allow the panels to air dry for 24 h ±1 h. There shall be no more than one pencil hardness change when tested per ASTM D3363. Any color change shall be noted.

5.4.4 Impact test

This test demonstrates how the substrate/coating system stands up to deformation from impacts.

One coated panel per Figure 4 shall be impacted on a concrete floor per ASTM D2794 at a value of 9 N·m (80 in-pounds force, intrusion) utilizing a hemispherical indenter with a diameter of 15.875 mm (5/8 in).

When the substrate is a material that visibly rusts when exposed to salt spray, the test panel shall be exposed to 24 h of salt spray per ASTM B117. There shall be no visible rust or corrosion product in or around the impact (intrusion) area of the panel.

When the substrate is a material that does not visibly rust when exposed to salt spray, the test panel shall be visually inspected under 10x magnification. No bare substrate shall be present in or around the impact (intrusion) area of the panel.

5.4.5 Insulating fluid resistance tests (for fluid-filled equipment only)

This test demonstrates proper adhesion of the coating to the substrate and chemical resistance to the insulating fluid whether gaseous or liquid.

Partially immerse one coated panel, shown in Figure 4, in the insulating fluid for 72 h at the top fluid rise temperature plus 40 °C ±2 °C (104 °F ±4 °F). On the immersed portion of the panel, there shall be no loss of adhesion per ASTM D3359, no blisters per ASTM D714, no streaking, and no more than one pencil hardness change when tested in accordance with ASTM D3363, using either method. Any color shift shall be noted.

Example: For 65 °C (149 °F) rise transformers the test temperature is 105 °C ±2 °C (221 °F ±4 °F), while for 75 °C (167 °F) rise transformers the test temperature is 115 °C ±2 °C (239 °F ±4 °F).

When multiple types of insulating fluid may be used in the equipment, a separate test is required for each type of insulating fluid.

5.4.6 Ultraviolet accelerated weathering test (QUV)[9]

This test demonstrates how the substrate plus the coating system survives exposure to ultraviolet (UV) light.

Three panels prepared, per Figure 4, shall be tested per ASTM D4587, Cycle 2 (Ultraviolet Accelerated Weathering) for 500 h utilizing either the FS-40 bulb, or using UVB-313EL lamps with an irradiance control system, with a cycle of 4 h ultraviolet at 60 °C ±2 °C (140 °F ±4 °F), followed by 4 h condensation at 50 °C ±2 °C (122 °F ±4 °F). For chambers utilizing an irradiance control system, the irradiance shall be set at 0.48 W/m^2 at 310 nm. Loss of gloss shall not exceed 50% of original gloss per ASTM D523. The coating shall not exhibit cracking per ASTM D661 or checking per ASTM D660 under unaided visual inspection.

5.4.7 Abrasion resistance

This test demonstrates how the substrate plus the coating system stands up to abrasion and handling.

The following test is required only for coated surfaces on the exterior of the enclosure. One coated panel, shown in Figure 5, having the minimum dry film thickness of the total coating system shall be tested using a CS-10 wheel and 1000 g weight, in accordance with ASTM D4060. A total of 3000 cycles shall be run with the wheels resurfaced before testing and after each 500 cycle run. Upon completion of the test, the test panel shall be visually inspected under 10x magnification. No bare substrate shall be present.

5.4.8 Gravelometer test

This test demonstrates how the substrate plus the coating system stands up to chipping commonly caused by shipping, storage, and installation.

The following test is required only for coated surfaces on the exterior of the enclosure. Two coated panels per Figure 6 are to be tested per ASTM D3170 at room temperature using 410 kPa (60 psig) gauge air pressure. Expose the test panels for 24 h in salt spray per ASTM B117. Remove from salt spray, rinse, and dry the panels. Evaluate the panels for chip size. No chip shall be greater than 2.0 mm (0.08 in) in diameter.

6. General

6.1 Shipment

The manufacturer shall provide a method of shipment that will allow the enclosure to be received by the purchaser such that it still meets the performance requirements of this standard.

[9]QUV is an acronym for Q-panel Laboratory Ultra-Violet testing and is widely used in solar irradiance testing.

6.2 Coating repair procedure

A coating system repair procedure shall be recommended by the manufacturer.

6.3 Coating touch-up prior to shipment

Touch-up, when required, shall be done at final inspection before any equipment is shipped. In areas where the integrity of the coating system is violated, the touch-up shall blend smoothly and meet all performance criteria of this standard.

Annex A

(normative)

Procedure for comparative weight loss

The procedure for comparative weight loss is as follows:

a) Inspect welded panels to assure that welds are smooth and will not collect salt in any area when exposed in accordance with ASTM B117 with the major axis of the weld upright.

b) Thoroughly dry all test panels.

c) Record the weight of each panel to the nearest 0.0001 g.

d) Expose all test panels to 1500 h salt spray in accordance with ASTM B117.

e) After exposure, immediately remove the test specimen and immerse in warm water.

f) Manually scour each panel while wet using a nonmetallic, abrasive pad. Remove rust from pits with a sharp tool.

g) After scouring all panels, rinse in clean warm water (do not let the panels dry until rinsing is complete).

h) Thoroughly dry all test panels.

i) Reweigh the panels to the nearest 0.0001 g and calculate the percent weight loss.

Annex B

(informative)

Bibliography

Bibliographical references are resources that provide additional or helpful material but do not need to be understood or used to implement this standard. Reference to these resources is made for informational use only.

[B1] ANSI C2, Accredited Standards Committee C-2, National Electrical Safety Code® (NESC®).[10]

[B2] Bringas, J. E. and M. L. Wayman, The Metals Black Book, Ferrous Metals, 3rd Ed. Edmonton, AB: CASTI Publishing Inc., 1998.

[B3] IEEE Std C57.12.20™, IEEE Standard for Overhead-Type Distribution Transformers, 500 kVA and Smaller: High Voltage, 34 500 V and Below; Low Voltage, 7970/13 800Y V and Below.[11,12]

[B4] IEEE Std C57.12.21™, American National Standard Requirements for Pad-Mounted Compartmental-Type Self-Cooled Single-Phase Distribution Transformers with High-Voltage Bushings; High Voltage, 34 500 GrdY/19 920 Volts and Below; Low Voltage, 240/120 Volts; 167 kVA and Smaller.

[B5] IEEE Std C57.12.22™, American National Standard for Transformers—Pad-Mounted Compartmental-Type Self-Cooled, Three-Phase Distribution Transformers with High-Voltage Bushings, 2500 kVA and Smaller: High Voltage, 34 500 GrdY /19 920 Volts and Below; Low Voltage, 480 Volts and Below.

[B6] IEEE Std C57.12.23™, IEEE Standard for Submersible Single-Phase Transformers: 167 kVA and Smaller; High Voltage 25 000 V and Below; Low Voltage 600 V and Below.

[B7] IEEE Std C57.12.24™, IEEE Standard for Submersible, Three-Phase Transformers, 3750 kVA and Smaller: High Voltage, 34 500 GrdY/19 920 Volts and Below; Low Voltage, 600 Volts and Below.

[B8] IEEE Std C57.12.25™, American National Standard Requirements for Pad-Mounted Compartmental-Type Self-Cooled Single-Phase Distribution Transformers with Separable Insulated High-Voltage Connectors, High Voltage, 34 500 GrdY/19 920 Volts and Below; Low Voltage, 240/120; 167 kVA and Smaller.

[B9] IEEE Std C57.12.26™, IEEE Standard for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High-Voltage Connectors (34 500 GrdY/19 920 V and Below; 2500 kVA and Smaller).

[B10] IEEE Std C57.12.28™, IEEE Standard for Pad-Mounted Equipment—Enclosure Integrity.

[B11] IEEE Std C57.12.29™, IEEE Standard for Pad-Mounted Equipment—Enclosure Integrity for Coastal Environments.

[B12] IEEE Std C57.12.31™, IEEE Standard for Pole-Mounted Equipment—Enclosure Integrity.

[B13] IEEE Std C57.12.32™, IEEE Standard for Submersible Equipment—Enclosure Integrity.

[10]The NESC is available from the Institute of Electrical and Electronics Engineers (https://standards.ieee.org/).
[11]IEEE publications are available from the Institute of Electrical and Electronics Engineers (https://standards.ieee.org/).
[12]The IEEE standards or products referred to in Annex B are trademarks owned by the Institute of Electrical and Electronics Engineers, Incorporated.

[B14] IEEE Std C57.12.34™, IEEE Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers, 5 MVA and Smaller; High Voltage, 34.5 kV Nominal System Voltage and Below; Low Voltage, 15 kV Nominal System Voltage and Below.

[B15] IEEE Std C57.12.35™, IEEE Standard for Bar Coding for Distribution Transformers and Step- Voltage Regulators.

[B16] Munsell Color Standards, X-Rite Pantone, 4300 44th St. SE, Grand Rapids, MI 49512, USA.

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