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Determination of Substrate and Surface Temperature Limits for Insulative Coatings used for Personnel Protection

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ABSTRACT

The purpose of this NACE International test method is to standardize the testing methods and conditions used to determine acceptable temperature limits for personnel protection for insulative coatings in accordance with ASTM C1055. The temperature limits determined when using this test method are specific for each coating tested at a particular thickness and substrate temperature. A standardized test method can validate the temperature limits of a coating used for personnel protection, and enable direct comparison of its performance. This test method is intended for use by facility owners, engineers, health and safety specialists, coatings manufacturers, and other interested parties.

KEYWORDS

ASTM C1055, ASTM C1057, coating temperature limits, contact time, data logger, emissivity, first-degree burn, infrared thermometer, insulative coatings, IR meter, NBS TN-816, substrate temperature, surface temperature, test method, test panel, TG 477, temperature limits, thermesthesiometer.

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Foreword

In NACE standards, the terms shall, must, should, and may are used in accordance with the definitions of these terms in the NACE Publications Style Manual. The terms shall and must are used to state a requirement, and are considered mandatory. The term should is used to state something good and is recommended, but is not considered mandatory. The term may is used to state something considered optional.

The purpose of this NACE International test method is to standardize the testing methods and conditions used to determine acceptable temperature limits for personnel protection for insulative coatings in accordance with ASTM[(1)] C1055.[1] The temperature limits determined when using this test method are specific for each coating tested at a particular thickness and substrate temperature. A standardized test method can validate the temperature limits of a coating used for personnel protection, and enable direct comparison of its performance. This test method is intended for use by facility owners, engineers, health and safety specialists, coatings manufacturers, and other interested parties.

In the 1980s, ASTM International (ASTM) published two standards, ASTM C1055 and ASTM C1057,[2] that outlined a process to determine acceptable surface temperatures for heated systems in relation to personnel protection. These standards defined the hazards for burns to human skin; and provided certain criteria to be used in these determinations and provided maximum allowable skin temperatures for defined burn risks.

For purposes of personnel protection, the generally accepted temperature limit for metallic surfaces on piping and equipment is 60 °C (140 °F) for a maximum touch time of 5 seconds. Hot surfaces with temperatures greater than 60 °C (140 °F) in areas accessible to workers are typically insulated or personnel protection is provided. This criterion is often cited by field personnel regardless of the type of material of which the hot object is made. However, these limits generally only apply to metals. Materials with lower thermal conducting properties such as insulation coatings can be touched at higher temperatures without burning the skin.[1-4] The method for determining surface temperature limits of any material is established in ASTM C1057 Method B, using a thermesthesiometer (TM).

The temperature limit recommended in ASTM C1057 for a simulated skin temperature reading with a thermesthesiometer is 58 °C (137 °F) for a contact time of 5 seconds. At a skin temperature of 58 °C (137 °F), the skin is just beginning to experience a first-degree burn. To put this in perspective, a metal surface at a temperature of 60 °C (140 °F) will give a thermesthesiometer reading of about 58 °C (137 °F) after a contact time of 5 seconds.

Insulative coatings are often used to provide effective burn protection when applied to hot equipment and/or piping. In combination with a corrosion protective primer, these coatings also provide corrosion protection and minimize corrosion under insulation (CUI) because the primer and insulative coating combination bonds directly to the steel substrate. Other insulation materials (i.e., block and fiber insulation) have air gaps between the metal and the insulation where water can ingress. The hot/moist condition in these gaps is a common cause of CUI.

This NACE standard test method was prepared in 2017 by Task Group (TG) 477, "Test Methods for Determining True Insulation Value of Liquid Insulative Materials Applied on Steel Surfaces from 27 to 191 °C (80 to 375 °F)." This TG is administered by Specific Technology Group (STG) 02, "Coatings and Linings, Protective—Atmospheric." This standard is issued by NACE under the auspices of STG 02.

[(1)] ASTM International (ASTM), 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

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Section 1: General

1.1 This test method uses a thermesthesiometer (TM) instrument and defines specific test procedures and conditions to standardize the method for determining the temperature limits of the coating that pertain to personnel protection. These temperature limits are different from the service temperature limit of the insulative coating. This test method describes only one specific test, using the thermesthesiometer, for insulative coating systems. The reader is cautioned that other testing may be required for particular services. The user is responsible for investigating the need for other testing. Inclusion of other test methods is beyond the scope of this standard.

1.2 This test method includes procedures to determine substrate and surface temperature limits for exterior insulative coatings used on hot equipment and piping. These coatings are used in a typical temperature range of 27 to 191 °C (80 to 375 °F) and thicknesses of approximately 0.1 to 5 mm (4 to 200 mil). They are typically liquid and applied onto primed substrates by spray application.

1.3 The coating temperature limits are based on the temperature of the metal substrate to which the coating is bonded, or the temperature at the surface of the coating. These limits are used in relation to personnel protection against thermal burns to the skin. The end user and coating manufacturer can determine the coating's ability to provide personnel protection based on the temperature limits on the substrate or the coating surface.

1.3.1 The limits based on the metal substrate temperature shall be used to determine the minimum coating thickness required for a specific service temperature. (See Section 2, definition of Substrate Temperature Limit of the Coating.)

1.3.2 The limits based on the coating surface temperature shall be used to validate that an existing or newly applied insulative coating is acceptable for personnel protection. See Section 2, definition for Surface Temperature Limit of the Coating.

1.4 Test variables include coating thickness and the metal substrate temperature. The criteria used in this test method to determine the temperature limits are in accordance with ASTM C1055 and ASTM C1057. The thermesthesiometer shall be used in accordance with the design parameters in ASTM C1057 and calibrated in accordance with NBS[(2)] TN-816.[5]

1.5 This test method does not apply to conventional insulation materials that are typically greater in thickness than insulative coatings and are applied as blocks or forms to the equipment or piping. This test method is intended to be performed in the laboratory.

1.6 Commercial primers that are not part of the insulation coating system, such as thermal spray coatings, shop primers, pre-primer coatings (blast retaining coatings), etc., shall not be included in this test unless they are approved by the insulation coating system manufacturer or the facility owner before commencement of the testing.

[(2)] National Institute of Standards and Technology (NIST), 100 Bureau Drive, Stop 8500, Gaithersburg, MD 20899-8500. (Formerly the National Bureau of Standards [NBS]).