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Standard Guide for Use of Protective Coating Standards in Nuclear Power Plants¹

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^{e1} NOTE—The title of Guide D 5163 was corrected editorially in April 2009.

INTRODUCTION

Protective coatings (paints) have been used extensively in the nuclear industry to protect the surfaces of facilities and equipment from corrosion and contamination by radioactive nuclides in accordance with ALARA. In the absence of a standard method of selecting, testing, and evaluating coatings, many sites evaluated paints by empirical tests to determine which were useful in their particular operation. Understandably, the methods of testing were not uniform throughout the industry. It has been very difficult, consequently, to compare the results obtained at one site with those obtained at another. Standard tests whereby industrial (nuclear) users of paints systematically prepare specimens and subject them to selected evaluations, thus permitting uniform comparisons, are advantageous, internationally as well as domestically.

The designer of light water-moderated nuclear reactor systems must consider the possibility of a Design Basis Accident (DBA) and the subsequent events which might lead to the release or expulsion of a fraction of the fission-product inventory of the core to the reactor containment facility. Engineered safety features, principally a reactor containment facility, are provided to prevent the release of fission products to the biological environment during and after this improbable event. The design, fabrication, quality assurance, and testing of these engineered safety features ensure reliable operation and safety under all anticipated conditions.

Large areas of the reactor-containment facility are painted with safety-related coatings. If severe delamination, peeling, or flaking causes significant portions of the coating to be discharged into the common water reservoir, the performance of the safety systems could be seriously compromised by the plugging of strainers, flow lines, pumps, spray nozzles, and core coolant channels. Safety-related coatings may also exist outside of the reactor-containment.

This guide is the result of a comprehensive examination of the experience and data that have been developed on protective coatings in the nuclear industry over approximately 40 years. Standards pertaining to nuclear coatings have historically been covered by ANSI N5.12, N101.2, N5.12, ANSI N101.2, and ANSI N101.4. Responsibility for updating, rewriting, and issuing appropriate ANSI replacement standards has been transferred to ASTM, specifically ASTM Committee ~~D-33~~, D33, on Protective Coating and Lining Work for Power Generation Facilities.

The objective of this guide is to provide a common basis on which ~~to define and specify protective coatings for the performance requirements for the coatings that will~~ surfaces of nuclear power generating facilities may be used in nuclear facilities. ~~qualified and selected by reproducible evaluation tests.~~ This guide also provides guidance for application and maintenance of protective coatings. Quality assurance in the nuclear industry is a mandatory requirement for all aspects of safety-related nuclear coatings work. Licensees of nuclear power plants are required to determine if coated surfaces are within the scope of 10CFR50.65; “The, “The Maintenance Rule”-Rule.” Any coated surfaces found to be within the scope of 10CFR50.65 must satisfy the requirements of 10CFR50.65. ASME Section XI, Subsection IWE contains the requirements for periodic evaluation of

¹ This guide is under the jurisdiction of ASTM Committee ~~D-33~~ D33 on Protective Coating and Lining Work for Power Generation Facilities and is the direct responsibility of Subcommittee D33.02 on Service and Material Parameters.

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the reactor-containment steel pressure boundary.

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1. Scope

1.1 This guide provides a common basis on which protective coatings for the surfaces of nuclear power generating facilities may be qualified and selected by reproducible evaluation tests. This guide also provides guidance for application and maintenance of protective coatings. Under the environmental operating and accident conditions of nuclear power generation facilities, encompassing pressurized water reactors (PWR's)(PWRs) and boiling water reactors (BWR's)(BWRs), coating performance may be affected by exposure to any one, all, or a combination of the following conditions: ionizing radiation; contamination by radioactive nuclides and subsequent decontamination processes; chemical and water sprays; high-temperature high-pressure steam; and abrasion or wear.

1.2 The content of this guide includes:

Referenced Documents	Section
Terminology	2
Significance and Use	3
Coating Material Testing	4
Thermal Conductivity	5
Surface Preparation, Coating Application, and Inspection for Shop and Field Work	5
Thermal Conductivity	6
Quality Assurance	Quality Assur- ance
Keywords ⁹	8
Keywords	8

1.2.1 In addition, this guide addresses technical topics within ANSI N5.12 and ANSI N101.2 that are covered by separate ASTM standards, for example, surface preparation, (shop and field) and coating application, (shop and field).

1.2.2 Applicable sections of this guide and specific acceptance criteria may be incorporated into specifications and other documents where appropriate.²

1.3

1.3 The values stated in inch-pound units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*³

C 177 [Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus](#)

D 3843 [Practice for Quality Assurance for Protective Coatings Applied to Nuclear Facilities](#)

D 3911 [Test Method for Evaluating Coatings Used in Light-Water Nuclear Power Plants at Simulated Design Basis Accident \(DBA\) Conditions](#)

D 3912 [Test Method for Chemical Resistance of Coatings Used in Light-Water Nuclear Power Plants](#)

D 4060 [Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser](#)

D 4082 [Test Method for Effects of Gamma Radiation on Coatings Used for Use in Light-Water Nuclear Power Plants](#)

D 4227 [Practice for Qualification of Coating Applicators for Application of Coatings to Concrete Surfaces](#)

D 4228 [Practice for Qualification of Coating Applicators for Application of Coatings to Steel Surfaces](#)

D 4537 [Guide for Establishing Procedures to Qualify and Certify Inspection Personnel Performing Coating Work Inspection in Nuclear Facilities](#)

D 4538 [Terminology Relating to Protective Coating and Lining Work for Power Generation Facilities](#)

D 4541 [Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers](#)

D 5139 [Specification for Sample Preparation for Qualification Testing of Coatings to Be Used in Nuclear Power Plants](#)

D 5163 [Guide for Establishing a Program for Condition Assessment of Coating Service Level I Coating Systems in Nuclear Power Plants](#)

D 7167 [Guide for Establishing Procedures to Monitor the Performance of Safety-Related Coating Service Level III Lining Systems in an Operating Nuclear Power Plant](#)

D 7230 [Guide for Evaluating Polymeric Lining Systems for Water Immersion in Coating Service Level III Safety-Related Applications on Metal Substrates](#)

² Certain ASTM standards are available in compilation form (which includes this guide), as *Compilation of ASTM Standards for Use of Protective Coating Standards in Nuclear Power Plants* for expedient reference and usage by personnel involved in nuclear coating work.

³ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards*, Vol 04.06, volume information, refer to the standard's Document Summary page on the ASTM website.

- [D 7234 Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers](#)
[D 7491 Guide for Management of Non-Conforming Coatings in Coating Service Level I Areas of Nuclear Power Plants](#)
[E 84 Test Method for Surface Burning Characteristics of Building Materials](#)
[E 684 Practice for Approximate Determination of Current Density of Large-Diameter Ion Beams for Sputter Depth Profiling of Solid Surfaces](#)
[E 1461 Test Method for Thermal Diffusivity of Solids by the Flash Method](#)
[E 1530 Test Method for Evaluating the Resistance to Thermal Transmission of Materials by the Guarded Heat Flow Meter Technique](#)

2.2 Other Standards:

- [ANSI N5.12 Protective Coatings \(Paints\) for the Nuclear Industry⁴](#)
[ANSI N101.2 Protective Coatings \(Paints\) for Light Water Nuclear Reactor Containment Facilities⁴](#)
[ANSI N101.4 Quality Assurance for Protective Coatings Applied to Nuclear Facilities⁴](#)
[ASME Boiler and Pressure Vessel Code \(BPVC\), Section XI, “Rules for Inservice Inspection of Nuclear Power Plant Components,” Subsection IWE “Requirements for Class MC and Metallic Liners of Class CC Components of Light-Water Cooled Power Plants” ASME Boiler and Pressure Vessel Code \(BPVC\) Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, Subsection IWE Requirements for Class MC and Metallic Liners of Class CC Components of Light-Water Cooled Power Plants⁵](#)
[EPRI 1003102 \(November 2001\) Guideline on Nuclear Safety-Related Coatings Revision 1 \(formerly TR-109937\)⁶](#)
[EPRI TR-109937 \(1998\) Guideline on Nuclear Safety-Related Coatings 10CFR50 Appendix B: Title 10, Chapter 1, Energy, Part 50, Domestic Licensing of Production and Utilization Facilities, Appendix B, Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants⁷](#)
[10CFR50. Appendix B: Title 10, Chapter 1, Energy, Part 50, Domestic Licensing of Production and Utilization Facilities, Appendix B, Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants⁷](#)
[10CFR50.65 Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants⁷](#)
[Guide 1.54 Regulatory/\(1973\) Quality Assurance Requirements for Protective Coatings Applied to Water-Cooled Nuclear Power Plants¹¹](#)
[Regulatory/\(1973\) Quality Assurance Requirements for Protective Coatings Applied to Water-Cooled Nuclear Power Plants⁷](#)
[USNRC Standard Review Plan 6.1.2 Protective Coating Systems \(Paints\) Organic Materials⁷](#)
[USNRC Review Plan 6.1.2 Protective Coating Systems \(Paints\) Organic Materials¹¹](#)
[10CFR20.1\(C\) Standards for Protection Against Radiation; Purpose¹¹](#)
[USNRC Regulatory Guide 8.8 Information Relevant to Ensuring that Occupational Radiation Exposures At Nuclear Power Stations Will Be As Low As Is Reasonably Achievable⁷](#)

3. Terminology

3.1 *Definitions*—Definitions for use with this guide are shown in Terminology D 4538 or other applicable standards.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *ALARA*—the concept of reducing radiation exposure to personnel to levels “as low as is reasonably achievable,” as defined in the USNRC Regulation Guide 8.8, and 10CFR20.1(C):

3.2.2 *Coating Service Level I*—Terms used to describe areas inside the reactor-containment where coating failure could adversely affect the operation of post-accident fluid systems and, thereby, impair safe shutdown.

3.2.3 *Coating Service Level II*—Terms used to describe areas outside the reactor-containment where coating failure could impair, but not prevent, normal operating performance. The function of *Coating Service Level II* coatings is to provide corrosion protection and decontaminability in those areas outside the reactor-containment subject to radiation exposure and radionuclide contamination. *Service Level II* coatings are not safety-related.

3.2.4 *Coatings Service Level III*—Terms used to describe areas outside the reactor-containment where coating failure could adversely affect the safety function of a safety-related structure, system or component (SSC):

3.2.5 *Safety-Related Coating System*—A coating system used inside or outside of the reactor-containment, the detachment of which could adversely affect the safety function of a safety-related structure, system or component (SSC):

⁴ Annual Book of ASTM Standards, Vol 06.02.

⁴ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

⁵ Annual Book of ASTM Standards, Vol 06.01.

⁵ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

⁶ Annual Book of ASTM Standards, Vol 04.07.

⁶ Available from EPRI Distribution Center, 207 Coggins Drive, P.O. Box 23205, Pleasant Hills, CA 94523 (510) 934-4212.

⁷ Annual Book of ASTM Standards, Vol 14.02.

⁷ Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401, <http://www.access.gpo.gov>.