



# Standard Guide for Establishing Procedures to Monitor the Performance of Safety-Related Coating Service Level III Lining Systems in an Operating Nuclear Power Plant<sup>1</sup>

This standard is issued under the fixed designation D7167; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This guide covers procedures for establishing a program to monitor the performance of Coating Service Level III lining (and coating) systems in operating nuclear power plants. Monitoring is an ongoing process of evaluating the condition of the in-service lining systems.

1.2 Coating Service Level III lining systems subject to this guide are generally those applied to metal substrates comprising raw water, condensate-quality water, or fuel oil wetted (that is, full or intermittent immersion) surfaces in systems that may include:

- 1.2.1 Service water piping upstream of safety-related components,
- 1.2.2 Service water pump internals (draft tube, volutes, and diffusers),
- 1.2.3 Service water heat exchangers including the channels, pass partitions, tubesheets, end bells, and covers
- 1.2.4 Service water strainers,
- 1.2.5 Reactor water storage tanks (RWSTs),
- 1.2.6 Refuel cavity water storage tanks,
- 1.2.7 Reactor makeup water system,
- 1.2.8 Component cooling water system,
- 1.2.9 Lube oil tanks for safety-related equipment, and
- 1.2.10 Emergency diesel fuel oil system.

1.3 It is the intent of this guide to provide a recommended basis for establishing a linings monitoring program, not to mandate a singular basis for all programs. Variations or simplifications of the program described in this guide may be appropriate for any given operating nuclear power plant depending on its licensing commitments. Similar guidelines may be applicable for certain Coating Service Level II applications such as fluid immersion systems.

<sup>1</sup> This guide is under the jurisdiction of ASTM Committee D33 on Protective Coating and Lining Work for Power Generation Facilities and is the direct responsibility of Subcommittee D33.04 on Quality Systems and Inspection.

Current edition approved Nov. 1, 2012. Published February 2013. Originally approved in 2005. Last previous edition approved in 2005 as D7167 – 05. DOI: 10.1520/D716-12.

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:<sup>2</sup>

- D610 Practice for Evaluating Degree of Rusting on Painted Steel Surfaces
- D714 Test Method for Evaluating Degree of Blistering of Paints
- D1186 Test Methods for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base (Withdrawn 2006)<sup>3</sup>
- D1400 Test Method for Nondestructive Measurement of Dry Film Thickness of Nonconductive Coatings Applied to a Nonferrous Metal Base (Withdrawn 2006)<sup>3</sup>
- D3359 Test Methods for Measuring Adhesion by Tape Test
- D4537 Guide for Establishing Procedures to Qualify and Certify Personnel Performing Coating and Lining Work Inspection in Nuclear Facilities
- D4538 Terminology Relating to Protective Coating and Lining Work for Power Generation Facilities
- D4541 Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
- D6677 Test Method for Evaluating Adhesion by Knife
- D7108 Guide for Establishing Qualifications for a Nuclear Coatings Specialist
- D7230 Guide for Evaluating Polymeric Lining Systems for Water Immersion in Coating Service Level III Safety-Related Applications on Metal Substrates

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

- F1130 Practice for Inspecting the Coating System of a Ship**  
**2.2 ANSI/ASME Standards:**<sup>4</sup>  
**ANSI/ASME N 45.2.6 Qualification of Inspection, Examination, and Testing Personnel for Nuclear Power Plants**  
**ANSI/ASME NQA-1 Quality Assurance Requirements for Nuclear Facility Applications**  
**2.3 SSPC Standard:**<sup>5</sup>  
**SSPC-PA 2 Measurement of Dry Paint Thickness With Magnetic Gages**  
**SSPC-VIS 2 Standard Method of Evaluating Degree of Rusting on Painted Steel Surfaces**  
**2.4 U.S. Nuclear Regulatory Commission Documents:**<sup>6</sup>  
**Generic Letter 89-13 Service Water System Problems Affecting Safety-Related Equipment**

### 3. Terminology

- 3.1 *Definitions*—Definitions for use with this standard are shown in Terminology **D4538** or other applicable standards.
- 3.2 *The following definitions of terms are repeated for convenience and clarity:*
- 3.2.1 *Coating Service Level III, n*—areas outside the reactor containment where lining (or coating) failure could adversely affect the safety function of a safety-related structure, system, or component (SSC).

3.2.2 *lining, n*—particular type of coating intended for protection of substrates from corrosion as a result of continuous or intermittent fluid immersion.

### 4. Significance and Use

4.1 Establishment of an in-service linings monitoring program permits planning and prioritization of lining maintenance work as needed to maintain lining integrity and performance in nuclear Coating Service Level III systems. Refer to ASTM **MNL-8, Manual on Maintenance Coatings for Nuclear Power Plants**,<sup>7</sup> and Guide **D7230**, which provides guidance for selecting lining materials for new construction or maintenance of safety-related lining systems.

4.2 A linings monitoring program enables early identification and detection of potential problems in lining systems. Some Coating Service Level III lining systems may be known in advance to be suspect, deficient, or degraded. Monitoring lining performance will assist in developing follow-up procedures to resolve any significant deficiency relative to lining work.

4.3 Degraded linings may generate debris under normal operation and testing or during upset conditions that could adversely affect the performance of safety-related systems. In most cases, the consequence of the debris generation is flow

blockage, essential heat transfer reduction, or both; ultimately leading to degradation of equipment or system performance. A linings monitoring program may be required to fulfill licensing commitments for Coating Service Level III lining work.

### 5. Responsibility

5.1 The owner/operator shall identify the department or group within the organization responsible for establishing the applicable requirements for activities or procedures covered by this guide and shall document the scope of their responsibility. Owner/operator delegation of this responsibility to other outside qualified organizations is permitted and shall be documented.

5.2 It is the responsibility of the owner/operator or his designee performing these activities to specify the detailed methods and procedures for meeting the applicable requirements of this guide.

5.3 The owner/operator or his designee shall assign a coordinator to be responsible for supervising lining inspection activities, data collection and documentation, and for ensuring that personnel performing inspection are adequately trained and qualified.

5.4 The owner/operator shall assign responsibility for evaluating the results of inspection activities carried out under the linings performance monitoring program.

### 6. Frequency

6.1 Frequency of in-service lining inspection monitoring shall be determined by the owner/operator.

6.2 Inspection frequency should be based on the impact of lining failures on plant safety, potential problems identified during prior inspections, service life history, availability and accessibility of the linings, considerations with respect to satisfying “as low as reasonably achievable” (ALARA) objectives, and outage schedules. In many cases, lining condition assessments can be performed in conjunction with other routine maintenance performed on the lined equipment (for example, tank inspections and Generic Letter 89-13 heat exchanger inspections).

6.3 Inspection frequencies may change based on the assessment findings. Should two or more consecutive inspections indicate satisfactory conditions, then frequencies of future inspections can be adjusted accordingly.

### 7. Records and Past History

7.1 Surface preparation, lining materials that are acceptable for the service conditions, and quality of the application are important factors that determine the longevity of a Coating Service Level III system. Operating conditions also can influence the service life of the linings. Flow conditions (cavitation, erosion, etc.), water chemistry, system upsets, and temperature gradients (“cold wall” configurations) can result in premature failure.

7.2 Initial assessments shall include a review of the past lining history. Past lining history data to be reviewed may include:

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

<sup>5</sup> Available from Society for Protective Coatings (SSPC), 40 24th St., 6th Floor, Pittsburgh, PA 15222-4656, <http://www.sspc.org>.

<sup>6</sup> 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>.

<sup>7</sup> Available from ASTM International Headquarters, 100 Barr Harbor Dr., Box C700, West Conshohocken, PA 19428-2959.

7.2.1 Copies of lining specifications, manufacturer's product data sheets, and application procedures for in-place linings.

7.2.2 Quality control documentation for the existing in-place lining systems and their application.

7.2.3 Copies of previous inspection or monitoring reports.

7.2.4 Documentation pertaining to any maintenance work performed on in-place lining systems.

7.2.5 Review of industry operating experience for the lining material.

7.3 Assessments shall always include a review of the last two or more performance monitoring reports, if available, pertaining to the lining systems and may include review of the documentation outlined in 7.2.1 – 7.2.5.

## 8. Premonitoring Procedure

8.1 Before conducting an inspection of the lining systems, the responsible organization shall ensure that the necessary services and equipment required for inspection are provided. Factors that must be considered while planning the inspection activities include, but are not limited to, lighting, access to lined surfaces, cleaning surfaces of any deposit or buildup, ventilation, and where necessary, special underwater inspection requirements.

8.2 Station access procedures for Coating Service Level III lining systems monitoring shall be followed. While access procedures may vary from plant to plant, specific station access procedures may include:

8.2.1 Security clearance for protected, radiation-controlled, and vital areas and escorted or unescorted clearance as required;

8.2.2 Radiological history including prior radiation exposure for all personnel involved;

8.2.3 Health physics classroom training in the use of radiation detection and monitoring devices and procedures for wearing anti-contamination clothing;

8.2.4 Radiation work permit based on health physics radiological survey of the work location;

8.2.5 Compliance with radiation work permit requirements and other special radiation controls unique to each work location;

8.2.6 Issuance of dosimetry; and

8.2.7 Confined space permits and personnel rescue/recovery protocols.

8.3 The safety requirements of the facility owner/operator, including system lock-outs/tag-outs, must be met when performing all inspection operations.

## 9. Personnel Requirements, Qualifications, and Training

9.1 The facility owner/operator shall specify the requirements and guidelines for qualification and training of personnel involved in the program.

9.1.1 Personnel performing inspections of Coating Service Level III lining systems shall be knowledgeable coatings personnel meeting the requirements of Guide D4537, ANSI/ASME N45.2.6, or ANSI/ASME NQA-1.

9.2 The evaluator and coordinator shall be the Nuclear Coatings Specialist (Guide D7108) or personnel judged to be acceptable by the Nuclear Coating Specialist.

## 10. Inspection Plan

10.1 The owner/operator shall develop a plant-specific inspection plan to accomplish the objectives of the monitoring program. The plan may reference other plant programs that dictate inspection frequency or identify required linings/inspections. The inspection plan shall address the following based on specific owner/operator requirements:

10.1.1 A pre-inspection briefing to familiarize program personnel with the objectives of the inspections, the procedures to be followed, and the precautions to be taken;

10.1.2 A listing of the required assessment frequencies for each system segment or component; and

10.1.3 Maps, drawings, or visual media depicting the specific systems and components to be inspected. These shall be used to document the locations of all defects and all tests that are performed. These may also be used as a tool to identify additional testing, lining repair, relining, and further monitoring.

10.2 Condition assessments shall include a visual inspection of the designated lined/surfaces to identify defects, such as blistering, cracking, flaking/peeling/delamination, rusting, and physical damage.

10.2.1 *Blistering*—Compare any blistering found to the blistering pictorial standards for coatings defects (refer to Test Method D714) and record size and frequency. If the blisters are larger than those on the comparison photographs, measure, record size and extent, and photograph. Report if blistered portions are intact. Report if there is blister fluid. If fluid is present, samples may be taken.

10.2.2 *Cracking*—Cracking can be limited to the one layer of a lining system or can extend through to the substrate. Measure the length of the crack or, if extensive cracking has occurred, measure the size of the area affected. Determine if the cracking is isolated or is part of a pattern. Record measurements and describe crack depth and pattern on the inspection report. Photograph the area affected.

10.2.3 *Flaking/Peeling/Delamination/Detachment*—Measure the approximate size of the peels and note the pattern formed. Carefully test to see if lifting can be easily achieved beyond the obvious peeled/detached area. Note all observations on the inspection report and photograph the area affected.

10.2.4 *Rusting*—Compare with the pictorial standards such as Test Method D610, SSPC-VIS 2, or Practice F1130 to determine the degree of rusting. Try to determine the source of rusting (that is, is it surface stain caused by rusting elsewhere or degradation of the lining allowing the substrate to rust). Photograph the affected area and record observations on the inspection report.

10.2.5 If no defects are found, indicate that the lining is intact and has no defects on the inspection report.

10.2.6 If portions of the lining cannot be inspected, note the specific areas on the location map-inspection report, along with the reason why the inspection cannot be conducted.

10.3 Written or photographic documentation with written description of lining inspection areas, failures, and defects shall be made and the process of documentation standardized by the facility owner/operator. Written documentation practice for inspection of a lining system as given in Practice F1130 may be used for guidance.

10.4 For lining surfaces determined to be suspect, deficient, or degraded, one or more physical tests, such as dry film thickness (Test Methods D1186, D1400, and SSPC-PA 2) and adhesion (Test Methods D3359, D6677, and D4541), may be performed when directed by coordinator or evaluator. Samples may be gathered, and the size and extent of defective patterns may be described. To the extent that such testing is intrusive, lining repair criteria should be defined.

10.5 Instruments and equipment needed for inspection may include, but are not limited to, inspection instruments, flashlights, spotlights, marker pen, mirror, measuring tape, magnifier, binoculars, camera, polyethylene zip lock sample bags, hypodermic needles, sample vials, and MIC (microbiologically induced corrosion) sample kits.

10.6 For areas that are not readily accessible for direct inspection, such as pipelines, lined heat exchanger tubes, and other equipment, consideration should be given to the use of remote or robotic inspection tools. Divers should be considered for inspection of water storage tanks when draining the tanks for inspection is not feasible or practicable

## 11. Reporting and Documentation

11.1 Inspection reports for submittal to responsible evaluation personnel based on specific owner/operator requirements should be prepared and should include at least the following information:

11.1.1 A list and location of all areas evidencing deterioration,

11.1.2 A description, using the standards and procedures referenced above, of each type of defect detected,

11.1.3 A listing of any tests that were performed and the results of that testing,

11.1.4 *Inspection Data Sheets*—A typical data sheet is given in Fig. 1, and

11.1.5 *Photographic Documentation or Other Visual Media*—All images shall be clearly identified by equipment number and component description using elevations, locations, directions, P & ID designations, and such other means as are applicable.

## 12. Evaluation

12.1 The inspection report shall be evaluated by the responsible evaluation personnel. The evaluator shall prepare a report that includes, as appropriate:

12.1.1 A summary of findings.

12.1.2 An analysis of the reasons or suspected reasons for failure.

12.1.3 An identification of the scope of repair work and a corrective action plan.

12.1.4 An acceptable timetable for completing repair work.

12.1.4.1 The determination as to whether a degraded lining is acceptable to leave as-is should be based on an assessment of the impact of the lining degradation on the operation of the safety-related system.

12.1.4.2 The effects on system integrity should also be addressed.

12.1.5 Identification of future surveillances.

12.1.6 Identification of the consequences of a generic issue with the Coating Service Level III linings applied in the plant.

## 13. Keywords

13.1 Coating Service Level III; inspection; lining; lining performance; linings monitoring program; maintenance; nuclear power plant; safety-related linings; surveillance



*ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.*

*This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.*

*This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or [service@astm.org](mailto:service@astm.org) (e-mail); or through the ASTM website ([www.astm.org](http://www.astm.org)). Permission rights to photocopy the standard may also be secured from the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, Tel: (978) 646-2600; <http://www.copyright.com/>*