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REGULATORY GUIDE 1.36

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Nonmetallic Thermal Insulation for Austenitic Stainless Steel

A. INTRODUCTION

Purpose

This regulatory guide describes methods and procedures that the staff of the U.S. Nuclear Regulatory Commission (NRC) considers acceptable when selecting and using nonmetallic thermal insulation to minimize any contamination that could promote stress-corrosion cracking in the stainless steel portions of the reactor coolant pressure boundary and other systems important to safety. This guide applies to light-water-cooled reactors.

Applicable Rules and Regulations

- General Design Criterion (GDC) 1, "Quality Standards and Records," of Appendix A "General Design Criteria for Nuclear Power Plants," (Ref. 1), to Title 10, Part 50, Domestic Licensing of Production and Utilization Facilities," of the *Code of Federal Regulations* (10 CFR Part 50) requires that structures, systems, and components important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety function to be performed.

- GDC 14, "Reactor Coolant Pressure Boundary," and GDC 31, "Fracture Prevention of Reactor Coolant Pressure Boundary," require assurance that the reactor coolant pressure boundary will have an extremely low probability of abnormal leakage, gross rupture, or rapidly propagating fracture. Stress-corrosion cracking, which is promoted by certain contaminants, is one mechanism whereby such failures may be postulated.

Purpose of Regulatory Guides

The NRC issues regulatory guides to describe to the public methods that the staff considers acceptable for use in implementing specific parts of the agency's regulations, to explain techniques that the staff uses in evaluating specific problems or postulated accidents, and to provide guidance to applicants. Regulatory guides are not substitutes for regulations and compliance with them is not required. Methods and solutions that differ from those set forth in regulatory guides will be deemed acceptable if they provide a basis for the findings required for the issuance or continuance of a permit or license by the Commission.

Written suggestions regarding this guide or development of new guides may be submitted through the NRC's public Web site under the Regulatory Guides document collection of the NRC Library at http://www.nrc.gov/reading-rm/doc-collections/reg-guides/contactus.html .

Electronic copies of this regulatory guide, previous versions of this guide, and other recently issued guides are available through the NRC's public Web site under the Regulatory Guides document collection of the NRC Library at http://www.nrc.gov/reading-rm/doc-collections/ . The regulatory guide is also available through the NRC's Agencywide Documents Access and Management System (ADAMS) at http://www.nrc.gov/reading-rm/adams.html, under ADAMS Accession No. ML15026A664. The regulatory analysis may be found in ADAMS under Accession No. ML14079A669 and the staff responses to the public comments on DG-1312 may be found under ADAMS Accession No. ML15026A678.

Paperwork Reduction Act

This regulatory guide contains information collection requirements covered by 10 CFR Part 50 that the Office of Management and Budget (OMB) approved under OMB control number 3150-0011. The NRC may neither conduct nor sponsor, and a person is not required to respond to, an information collection request or requirement unless the requesting document displays a currently valid OMB control number.

B. DISCUSSION

Reason for Revision

RG 1.36, Revision 1, updates NRC guidance to approve for use current voluntary consensus standards (specifications) related to thermal insulation in contact with austenitic stainless steel. The standards have been revised and improved in recent years; thus they represent current best practices available for that purpose. Significantly, the current standards offer more than one test method to satisfy the objective of the standard. Additionally, several test methods identified in the previous RG 1.36 are no longer in use and the references to them have been removed.

Background

Whether sensitized or not, austenitic stainless steel is subject to stress corrosion and should be protected from certain contaminants that can promote cracking. Chloride and fluoride ions are the most serious contaminants, so it is necessary to minimize the levels of these ions (and others that have the potential to cause stress-corrosion cracking) in all material that may come in contact with austenitic stainless steel.

Thermal insulation is often employed adjacent to, or in direct contact with, stainless steel piping and components. Accidental spillages and leakages of fluids through pipe fittings, valves, and equipment cannot be entirely prevented, and contaminants present in the thermal insulation may be leached by these liquids and deposited on the stainless steel surfaces. Extensive test programs by Dana (Ref. 2) demonstrated that stress-corrosion cracking of both unsensitized and sensitized austenitic stainless steel can be induced by chloride or fluoride ions leached from many representative thermal insulation materials. Whorlow, et. al. (Ref. 3) has further shown that leachable sodium and silicate ions have differing qualities for inhibiting the adverse effects of the chloride and fluoride ions.

A quality assurance program is typically implemented at all steps from manufacturing through installation to minimize pickup of contaminants from external sources. These Controls are recommended to ensure that nonmetallic thermal insulations employed in nuclear power plants do not contribute significantly to stress corrosion of stainless steel.

To provide reasonable assurance that nonmetallic thermal insulation will not contribute to stress-corrosion cracking of stainless steels, each type[1] of insulating material should be evaluated in conditions similar to those routinely found in reactor operations. The requirements of American Society for Testing and Materials (ASTM) C795, "Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel," (Ref. 4) define testing conditions which more approximate the stresses of operational conditions at power plants. A Preproduction Corrosion Test in accordance with ASTM C692, "Standard Test Method for Evaluating the Influence of Thermal Insulation on External Stress Corrosion Cracking Tendency of Austenitic Stainless Steel," (Ref. 5) and a chemical analysis acceptance test for the

[1] Type means material of similar composition, form, and class of consistent quality, formulation, and manufacturing process.

material in accordance with ASTM C871, "Test Method for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate and Sodium Ions" (Ref. 6) are required for those who voluntarily wish to meet ASTM C795 for qualification of the insulation material. During production, each lot[2] of insulation material should be evaluated to demonstrate acceptability. The Staff Regulatory Guidance section provides specific reference to these standards.

Harmonization with International Standards

The International Atomic Energy Agency (IAEA) has established a series of safety guides and standards constituting a high level of safety for protecting people and the environment. IAEA Nuclear Energy Series Technical Reports provide information in the areas of nuclear power, nuclear fuel cycle, radioactive waste management and decommissioning, and on general issues that are relevant to all of the above-mentioned areas.

The NRC staff identified one IAEA document pertinent to this regulatory guide, IAEA Nuclear Energy Series NP-T-3.13, "Stress Corrosion Cracking in Light Water Reactors: Good Practices and Lessons Learned" (Ref. 7), issued September 2011. The IAEA document addresses the importance of stress-corrosion cracking as one of the significant aging degradations for major components of both pressurized-water reactors and boiling-water reactors. This regulatory guide incorporates similar design and testing guidelines and is consistent with the basic principles provided in IAEA Nuclear Energy Series NP-T-3.13.

Documents Discussed in Staff Regulatory Guidance

This regulatory guide endorses the use of one or more codes or standards developed by external organizations and other third-party guidance documents. These codes, standards and third-party guidance documents may contain references to other codes, standards or third party guidance documents ("secondary references"). If a secondary reference has itself been incorporated by reference into NRC regulations as a requirement, then licensees and applicants must comply with that standard as set forth in the regulation. If the secondary reference has been endorsed in a regulatory guide as an acceptable approach for meeting an NRC requirement, then the standard constitutes a method acceptable to the NRC staff for meeting that regulatory requirement as described in the specific regulatory guide. If the secondary reference has been neither incorporated by reference into NRC regulations nor endorsed in a regulatory guide, then the secondary reference is neither a legally binding requirement nor a "generic" NRC-approved acceptable approach for meeting an NRC requirement. However, licensees and applicants may consider and use the information in the secondary reference, if appropriately justified, consistent with current regulatory practice, and consistent with applicable NRC requirements.

[2] A lot (batch) is defined as a definite quantity of some product manufactured under conditions of production that are considered uniform for quality analysis. A batch is not to be confused with an "inspection" lot, which is the sample taken to test the production batch. ASTM C390-08 (Ref. 8)

C. STAFF REGULATORY GUIDANCE

The levels of leachable contaminants in nonmetallic insulation materials[3] that come in contact with austenitic stainless steels of the American Iron & Steel Institute (AISI) Type 3XX series used in fluid systems important to safety should be carefully controlled so that stress-corrosion cracking is not promoted. Insulation for the above application should minimize the leachable chlorides and fluorides to the lowest practicable levels by meeting the following conditions:

1. All insulating materials should be manufactured, processed, packaged, shipped, stored, and installed in a manner that will limit, to the maximum extent practical, chloride and fluoride contamination from external sources.

2. Qualification Testing. The test methods of ASTM C692 and ASTM C871 should be used as directed by ASTM C795.

   a) Preproduction qualification testing.

      Each material should be tested for stress corrosion effects using the 28-day stress corrosion test as specified in ASTM C692 to determine acceptability using the criteria of ASTM C795. Duplicate specimens of each type of thermal insulating material used should be chemically analyzed using the test method ASTM C871 to determine leachable chloride, fluoride, sodium, silicate, and pH, sufficient to meet the acceptance criteria of ASTM C795, Figure 1, and to establish baseline values for confirming production quality control.

   b) Production testing

      Duplicate specimens from each lot (batch) of insulation should be chemically analyzed as specified in ASTM C795 to determine leachable chloride, fluoride, sodium, silicate, and pH. The material should meet the acceptance criteria of ASTM C795, Figure 1 using the averaged results from the duplicate specimens for each lot.

      For each lot chemical analysis, the chloride plus fluoride ion concentrations should not exceed 150 percent of the average values determined on the sample used for preproduction qualification testing.

      For each lot chemical analysis, the sodium plus silicate ion concentrations should not fall below 50 percent of the average values determined on the sample used for preproduction qualification testing.

3. Requalification. The manufacturer's production quality program should address periodic requalification requirements. Additionally, the insulation material should be re-qualified by repeating the preproduction (2.a) qualification testing when a change is made in the type, nature, or quality of the ingredients, the formulation, or the manufacturing process.

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[3] Thermal insulating materials include block insulation, pipe insulation, board insulation, and blanket insulation, and the cements and adhesives employed in their application.

D. IMPLEMENTATION

The purpose of this section is to provide information on how applicants and licensees[4] may use this guide and information regarding the NRC's plans for using this regulatory guide. In addition, it describes how the NRC staff complies with 10 CFR 50.109, "Backfitting" and any applicable finality provisions in 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

Use by Applicants and Licensees

Applicants and licensees may voluntarily[5] use the guidance in this document to demonstrate compliance with the underlying NRC regulations. Methods or solutions that differ from those described in this regulatory guide may be deemed acceptable if they provide sufficient basis and information for the NRC staff to verify that the proposed alternative demonstrates compliance with the appropriate NRC regulations. Current licensees may continue to use guidance the NRC found acceptable for complying with the identified regulations as long as their current licensing basis remains unchanged**.**

Licensees may use the information in this regulatory guide for actions that do not require NRC review and approval such as changes to a facility design under 10 CFR 50.59, "Changes, Tests, and Experiments." Licensees may use the information in this regulatory guide or applicable parts to resolve regulatory or inspection issues.

Use by NRC Staff

The NRC staff does not intend or approve any imposition or backfitting of the guidance in this regulatory guide. The NRC staff does not expect any existing licensee to use or commit to using the guidance in this regulatory guide unless the licensee makes a change to its licensing basis. The NRC staff does not expect or plan to request licensees to adopt this regulatory guide voluntarily to resolve a generic regulatory issue. The NRC staff does not expect or plan to initiate NRC regulatory action that would require the use of this regulatory guide. Examples of such unplanned NRC regulatory actions include issuance of an order requiring the use of the regulatory guide, requests for information under 10 CFR 50.54(f) as to whether a licensee intends to commit to the use of this regulatory guide, and generic communication or promulgation of a rule requiring the use of this regulatory guide without further backfit consideration.

During regulatory discussions on plant-specific operational issues, the staff may discuss with licensees various actions consistent with staff positions in this regulatory guide as one acceptable means of meeting the underlying NRC regulatory requirement. Such discussions would not ordinarily be considered backfitting even if prior versions of this regulatory guide are part of the licensing basis of the facility. However, unless this regulatory guide is part of the licensing basis for a facility, the staff may not represent to the licensee that the licensee's failure to comply with the positions in this regulatory guide constitutes a violation.

If an existing licensee voluntarily seeks a license amendment or change and (1) the NRC staff's consideration of the request involves a regulatory issue directly relevant to this new or revised regulatory guide and (2) the specific subject matter of this regulatory guide is an essential consideration in the staff's

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4 In this section, "licensees" refers to licensees of nuclear power plants under 10 CFR Parts 50 and 52, and the term "applicants" refers to applicants for licenses and permits for (or relating to) nuclear power plants under 10 CFR Parts 50 and 52 and applicants for standard design approvals and standard design certifications under 10 CFR Part 52.

5 In this section, "voluntary" and "voluntarily" mean that the licensee is seeking the action of its own accord without the force of a legally binding requirement or an NRC representation of further licensing or enforcement action.

determination of the acceptability of the licensee's request, then the staff may request that the licensee either follow the guidance in this regulatory guide or provide an equivalent alternative process that demonstrates compliance with the underlying NRC regulatory requirements. This is not considered backfitting as defined in 10 CFR 50.109(a)(1) or a violation of any of the issue finality provisions in 10 CFR Part 52.

In addition, an existing applicant may be required to comply with new rules, orders, or guidance if 10 CFR 50.109(a)(3) applies.

If a licensee believes that the NRC is either using this regulatory guide or requesting or requiring the licensee to implement the methods or processes in this regulatory guide in a manner inconsistent with the discussion in this Implementation section, then the licensee may file a backfit appeal with the NRC in accordance with the guidance in NUREG-1409, "Backfitting Guidelines" (Ref. 9) and the NRC Management Directive 8.4, "Management of Facility-Specific Backfitting and Information Collection" (Ref. 10).

REFERENCES[6]

1. *U.S. Code of Federal Regulations* (CFR), "Domestic Licensing of Production and Utilization Facilities," Part 50, Chapter 1, Title 10, "Energy."

2. Dana, Jr., A.W., "Stress Corrosion Cracking of Insulated Austenitic Stainless Steel," *ASTM Bulletin*, 1957. (Agencywide Documents and Management System (ADAMS) Accession Number ML14087A400)

3. Whorlow, Kenneth M. et.al., "Effects of Halogens and Inhibitors on the External Stress Corrosion Cracking of Type 304 Austenitic Stainless Steel," STP 1320, "Insulation Materials: Testing and Applications," Vol. 3, American Society for Testing and Materials (ASTM)[7], West Conshohocken, PA.

4. ASTM C795-08 (Reapproved 2013), "Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel," West Conshohocken, PA.

5. ASTM C692-13, "Standard Test Method for Evaluating the Influence of Thermal Insulation on External Stress Corrosion Cracking Tendency of Austenitic Stainless Steel," West Conshohocken, PA.

6. ASTM C871-11, "Standard Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions," West Conshohocken, PA.

7. International Atomic Energy Agency (IAEA)[8], No. NP-T-3.13, "Stress Corrosion Cracking in Light Water Reactors: Good Practices and Lessons Learned," Nuclear Energy Series, September 2011, Vienna, Austria.

8. ASTM C390-08, (Reapproved 2013), "Standard Practice for Sampling and Acceptance of Thermal Insulation Lots," West Conshohocken, PA.

9. U.S. Nuclear Regulatory Commission (NRC), "Backfitting Guidelines," NUREG-1409, issued July 1990, Washington, DC.

10. NRC, "Management of Facility-Specific Backfitting and Information Collection," Management Directive 8.4, Washington, DC

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6 Publicly available NRC published documents are available electronically through the NRC Library on the NRC's public Web site at http://www.nrc.gov/reading-rm/doc-collections/ and through the NRC's Agencywide Documents Access and Management System (ADAMS) at http://www.nrc.gov/reading-rm/adams.html The documents can also be viewed online or printed for a fee in the NRC's Public Document Room (PDR) at 11555 Rockville Pike, Rockville, MD. For problems with ADAMS, contact the PDR staff at 301-415-4737 or (800) 397-4209; fax (301) 415-3548; or e-mail pdr.resource@nrc.gov.

7 Copies of American Society for Testing and Materials (ASTM) standards may be purchased from ASTM, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959; telephone (610) 832-9585. Purchase information is available through the ASTM Web site at http://www.astm.org.

8 Copies of IAEA documents are available at: http://www.iaea.org/Publications/index.html.