UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS
WASHINGTON, DC 20555-0001

August 13, 2007

NRC INFORMATION NOTICE 2007-26: COMBUSTIBILITY OF EPOXY FLOOR COATINGS AT COMMERCIAL NUCLEAR POWER PLANTS

ADDRESSEES

All holders of operating licenses for nuclear power reactors and fuel cycle facilities except licensees for reactors that have permanently ceased operations and who have certified that fuel has been permanently removed from the reactor vessel.

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to inform addressees of a fire protection issue raised by NRC inspectors at two nuclear power plants that involves the combustibility of epoxy floor coatings over the concrete floors in various plant areas. The issue discussed in this IN could similarly apply to fuel cycle facilities. The NRC expects that recipients of this IN will review the information for applicability to their facilities and consider taking actions, as appropriate, to avoid similar problems. However, suggestions contained in this IN are not NRC requirements; therefore, no specific action or written response is required.

DESCRIPTION OF CIRCUMSTANCES

Introduction

One of the principal goals of NRC fire protection regulation for commercial nuclear power plants is to ensure that, in the event of fire in any area of the plant, one train of equipment needed to achieve and maintain safe-shutdown conditions in the reactor will remain free of fire damage. The regulations in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," require each operating nuclear power plant to have a fire protection plan. This plan must satisfy Appendix A to Part 50, "General Design Criteria for Nuclear Power Plants," specifically General Design Criterion 3 (GDC 3), "Fire protection," as required by 10 CFR 50.48(a).

GDC 3 states, in part, "Noncombustible and heat-resistant materials shall be used wherever practical throughout the unit, particularly in locations such as the containment and control room." However, GDC 3 does not preclude the use of combustible materials. Examples of combustible materials found in nuclear power plants are electrical cable insulation and jackets, lubricants, hydraulic and control fluids, diesel generator fuel oils, charcoal and other filters, and

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flammable gases. In general, when such materials are properly managed, are accounted for in the plant design and operation, and are incorporated as integral components of the plant fire protection program, including the fire hazard analysis, they may be acceptable. NRC inspectors at two facilities raised an issue involving the fact that epoxy floor coating may or may not be considered combustible in the NRC-approved fire protection program depending on (1) the thickness with which the coating is applied, and (2) an independent laboratory testing of the flame spread rating for the specific epoxy floor coating. The inspectors found that although these licensees considered the epoxy floor coatings non-combustible, they had not evaluated and controlled the thickness with which the epoxy coating was applied on floors. When subsequent evaluation and testing by these licensees showed that the epoxy coating must be considered combustible, these licensees performed a fire hazards analysis that incorporated the combustible epoxy coating in accordance with their NRC-approved fire protection program.

The criteria for determining material combustibility are contained in NRC Generic Letter 86-10, "Implementation of Fire Protection Requirements," dated April 24, 1986, which provided guidance for satisfying NRC regulatory requirements for fire protection. Enclosure 1 to NRC Generic Letter 86-10 included interpretations related to compliance with Appendix R, "Fire Protection Program for Nuclear Power Facilities Operating Prior to January 1, 1979," to 10 CFR Part 50. Enclosure 2 to NRC Generic Letter 86-10 provided the NRC staff's responses to a list of industry questions. NRC staff's response to Question 3.6.2, "In-Situ Exposed Combustibles," states that a non-combustible material is defined as: "a. A material which in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat; and b. Material having a structural base of noncombustible material, as defined in a., above, with a surfacing not over 1/8-inch thick that has a flame spread rating not higher than 50 when measured using the test protocol of American Society for Testing and Materials (ASTM) E 84, "Standard Test Method for Surface Burning Characteristics of Building Materials.""

There is an exception to the Generic Letter 86-10 definition of non-combustible material. Appendix A to Branch Technical Position Auxiliary and Power Conversion Systems Branch 9.5-1, "Guidelines for Fire Protection for Nuclear Power Plants, Docketed Prior to July 1, 1976," dated February 24, 1977, Position D.1.(d) allows the use of combustible interior finishes when listed by a nationally recognized testing laboratory, such as Factory Mutual Research Corporation or Underwriters Laboratory, Inc., for a flame spread of 25 or less in its end use configuration using the test protocol of ASTM E 84.

Regulatory Guide 1.189 "Fire Protection for Nuclear Power Plants," states that floor covering critical radiant flux be determined by testing in accordance with National Fire Protection Association (NFPA) 253, "Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source." ASTM E 84 is the standard test method required by NRC regulations and should be in the licensing basis, unless the licensee has changed their test requirement for floor covering flame spread or adopted NFPA 253. Interior finish materials, such as epoxy floor coating, should meet the NRC regulation, testing, and qualification for surface flame spread rating when tested under approved test methods.

NRC Inspection Procedures 71111.05T, "Fire Protection (Triennial)," and 71111.05AQ, "Fire Protection (Annual/Quarterly)," provide guidance to the inspector on verification of combustible material controls in plant areas containing components, equipment, or cabling relied on for

post-fire safe-shutdown. This guidance addresses unusual configurations of combustible materials as well as other combustible material controls.

Donald C. Cook Nuclear Power Plant, Units 1 and 2

An NRC inspection report for Donald C. Cook Nuclear Power Plant (D.C. Cook) documented an unresolved item (URI) regarding the fire spread rating and the thickness of the epoxy floor coating used at the plant. (NRC Inspection Report 05000315/2003005; 05000316/2003005, dated July 16, 2003, Agencywide Documents Access and Management System (ADAMS) Accession No. ML032100754.) Specifically, the inspectors were concerned that the epoxy floor coating that was applied over the concrete flooring in various plant areas may have a combustible loading that was not accounted for in the approved fire protection program. The URI was opened pending NRC review of the licensee's evaluation and testing of the epoxy flooring's flame spread characteristics.

In response to the URI, the licensee performed additional evaluation and testing. The test report results indicated that the epoxy floor covering of the type installed at D.C. Cook had a flame spread rating of 140 at 0.115 inches thickness and 150 at 0.230 inches thickness. The test results for smoke development were 516 and 545, respectively. The licensee's overall evaluation concluded that:

- the additional combustible loads attributed to epoxy are within the amount allowed or are insignificant additions,
- the epoxy flooring did not affect the Appendix R separation criteria, and
- the epoxy flooring would not cause fires to propagate between contiguous fire zones.

However, the licensee also concluded that the characteristics of the combustion process of the coating make it undesirable as a floor coating. Considering the low ignition temperature and the test results for flame spread rate and smoke development, the licensee concluded that the use of epoxy as a coating on floors should be immediately discontinued from future use. In addition, the licensee concluded that it should develop a multi-year plan to replace the current floor coating with one that conforms to the flame spread criteria.

The NRC closed the URI based on the results of the licensee's fire hazards evaluation which indicated that the additional combustible loading due to the epoxy floor coating produced no impact on the fire load classification in the plant fire hazards analysis. There was a negligible increase in fire hazard due to the epoxy floor coating and sufficient margin existed for maintaining combustible loading/fire severity within the established allowable limits. Additionally, the fire zones that contained the epoxy floor coating did not rely on a 20-foot horizontal separation distance in order to meet Appendix R compliance. The NRC inspection report that closed the URI stated that no licensee performance deficiency or violation was identified. (NRC Inspection Report 05000315/2006002; 05000316/2006002, dated March 22, 2006, ADAMS Accession No. ML060830130.)

Duane Arnold Energy Center

An NRC inspection report for Duane Arnold Energy Center (DAEC) documented a URI that the epoxy floor covering applied over concrete floor—such as in the reactor building, high-pressure coolant injection pump room, and other plant areas—may be a combustible not accounted for in the approved fire protection program. The URI was opened pending NRC review of the licensee's evaluation and testing of the epoxy flooring's flame spread characteristics. (NRC Inspection Report 05000331/2003002, dated May 22, 2003, ADAMS Accession No. ML031430217)

In response to the URI, the licensee performed additional evaluation and testing. The epoxy testing report results indicated that the epoxy floor covering of the type installed at DAEC had a flame spread rating of 110, which is greater than the criteria of 50 specified in NRC Generic Letter 86-10, and therefore, was considered a combustible material. The licensee performed an evaluation that determined the epoxy floor coating was acceptable.

The NRC closed the URI based on the licensee's determination that there were no adjacent fire areas having the relatively high reported flame spread rating epoxy. The inspectors concluded that the coatings would not contribute towards the spread of a fire from one area to another. In addition, the combustible fire loads due to epoxy floor coatings did not present a challenge to the DAEC fire barriers. Also, those fire areas taking credit for 20-foot separation had epoxy floor coatings with a relatively low flame spread rating and were less than 1/8-inch thick. No violation was identified. (NRC Inspection Report 05000331/2005009, dated July 12, 2005, ADAMS Accession No. ML051940049.)

BACKGROUND

The basic fire protection regulation for U.S. commercial nuclear power plants is Section 50.48, "Fire protection," of 10 CFR Part 50. It requires, in part, that each operating nuclear power plant have a fire protection plan that satisfies GDC 3 in Appendix A to 10 CFR Part 50. This fire protection plan, using guidance provided in NRC Generic Letter 88-12, "Removal of Fire Protection Requirements from Technical Specifications," dated August 2, 1988, is incorporated into the operating license for the plant as a fire protection license condition.

Each operating nuclear power plant has an approved fire protection program that is anchored in the long-established defense-in-depth safety principle of providing multiple protective barriers to prevent and mitigate accidents. The concept of defense-in-depth as applied to fire protection in fire areas important to safety, is described in Section II, "General Requirements," of Appendix R to 10 CFR Part 50. It describes the following objectives: to prevent fires from starting; to detect rapidly, control, and extinguish promptly those fires that do occur; and to provide protection for structures, systems, and components important to safety so that a fire that is not promptly extinguished by the fire suppression activities will not prevent safe-shutdown of the plant. The multiple levels of protection that are embodied in the defense-in-depth philosophy ensure fire safety throughout the life of the plant by minimizing both the probability and the consequence of fires. While the NRC recognizes that no one level can be perfect or complete by itself, and strengthening any one level can compensate in some measure for known or unknown weaknesses in the others, each level of protection must meet certain minimum requirements.

All licensees are required to meet commitments in their fire protection program, as well as their

fire protection license condition. Fire prevention is the first line of defense-in-depth for fire protection. The fire prevention attributes of the program are directly related to the fire protection plan objectives that are to minimize the potential for fire to occur, involve design and administrative measures that provide a reasonable level of assurance of adequate protection and management against fire hazards, and limit fire consequences for those fires that do occur.

DISCUSSION

Epoxy floor coatings have been applied to various building concrete floors at U.S. commercial nuclear power plants as a protective coating that provides a smooth surface that is easy to clean and helps to reduce the spread of radioactive contamination. Because the epoxy floor coatings may be combustible depending on their thickness and flame spread rating, these coatings must be evaluated and controlled in accordance with the NRC-approved fire protection program. There have been instances where the installed or repaired epoxy floor coatings have been (1) purchased from numerous vendors, (2) installed to various thicknesses, (3) installed over a previous epoxy floor coating, or (4) purchased with various flame spreading ratings, that were not accounted for in the NRC-approved fire protection program.

Licensee evaluations of the epoxy floor coating serve to identify instances where the licensee may need to include the fire loading of epoxy floor coating into plant fire hazards analysis in an area where the rated fire barriers are provided. The purpose of the fire hazards analysis is to evaluate the increase in hazard due to the epoxy floor coating and to verify that the increased combustible loading due to the epoxy floor coating does not present a challenge to the plant's fire barriers. In addition, a licensee could have a fire protection exemption (i.e., a commitment to have no combustibles in the areas housing safety-related systems, equipment, and components for safe-shutdown) that would not be met with an epoxy floor coating that was combustible. The epoxy floor coating could also cause a licensee to no longer meet the 20-foot horizontal separation distance in order to meet Appendix R, Section III.G.2 of 10 CFR Part 50 requirements, i.e., no intervening combustible or fire hazards between opposite redundant trains of post-fire safe-shutdown equipment.

CONCLUSION

The problem of epoxy floor coatings that are considered combustible can be avoided by using a product with a low flame spread rating, applying it in accordance with the manufacturer's/ vendor's recommendations, and providing plant procedural controls for applying the coating to ensure it does not exceed recommended thickness. Coatings that are applied thicker than a manufacturer's recommendations may exceed the listed flame spread rating.

CONTACT

This information notice does not require any specific action or written response. Please direct any questions about this matter to the technical contacts listed below or to the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

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Note: NRC generic communications may be found on the NRC public Web site, http://www.nrc.gov, under Electronic Reading Room/Document Collections.

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