UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, DC 20555-0001

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NRC INFORMATION NOTICE 2007-17: FIRES AT NUCLEAR POWER PLANTS INVOLVING INADEQUATE FIRE PROTECTION ADMINISTRATIVE AND DESIGN CONTROLS

ADDRESSEES

All holders of operating licenses for nuclear power reactors, except those who have permanently ceased operations and 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 two recent fires at nuclear power plants that involved the inadequate implementation of approved fire protection program elements, design, procedures, and administrative controls. The NRC anticipates 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

The following describes the site conditions that existed and sequence of events that occurred which led to recent fires at the Beaver Valley and Peach Bottom Stations.

Beaver Valley Power Station Unit 1 Fire

On August 18, 2006, during reactor operation at the Beaver Valley Power Station Unit 1, a fire began during welding activities for a plant modification that installed ventilation duct through a concrete wall, a 3-hour fire barrier, that separates a potentially contaminated shop area from the safety-related west cable vault. After an opening was created in the concrete wall, workers inserted a metal sleeve box through the opening and installed a steel plate that covered the end of the box on the west cable vault side. Because the concrete wall opening was larger than the metal sleeve box, an annular space existed. In the annular space adjacent to the west cable vault steel plate, a worker stuffed combustible materials (i.e., cotton rags), then sealed it with duct tape to limit dust and control air flow into the cable vault from the shop. In addition, plastic

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sheeting material[1] (Tarp J-Flexx String Reinforced Polyethylene) that was used to catch dust and debris while boring through the concrete wall remained in place in the west cable vault.

The fire began while welding angle clips on a ventilation sleeve box from the shop side of the 3-hour fire barrier. The heat transfer through the metal sleeve box ignited the duct tape and rags. The burning rags and tape fell through the concrete wall opening into the cable vault and onto the plastic sheeting. The plastic sheeting was ignited by the burning rags and as it burned debris and drops of hot burning plastic fell onto conduit-protected cables and a concrete platform. There was no continuous fire watch on the cable vault side of the fire barrier during this plant modification, but the smoke from the burning plastic activated a nearby smoke detector, which sounded in the control room. The fire was manually suppressed by an auxiliary operator dispatched by the control room. The fire burned for about 6 minutes.

The plastic sheeting material exhibited significant ignition and flame spread characteristics and after the initial heat exposure the fire continued self-sustained burning. This is not consistent with flame-retardant specifications that the manufacturer certified for this plastic sheeting.

The licensee's root cause analysis determined:

- There was an inadequate level of detail and implementation of the specific fire protection administrative controls and compensatory measures.
- The presence of combustible material and plastic sheeting film that was not fire retardant was within 35 feet of hot work and not in compliance with the approved fire protection program requirements or the National Fire Protection Association (NFPA) 51B "Standard for Fire Prevention During Welding, Cutting, and Other Hot Work."
- The use of combustible material (cotton rags and duct tape) within the annular space of an opening in a fire-rated barrier should not have occurred.
- There was inadequate coordination of compensatory measures (fire watch patrols) for breaching fire barriers and performing hot work. There were also an inoperable carbon dioxide fire suppression system that had an hourly fire watch posted.
- Lack of station sensitivity to hot work impacted risk significant areas.
- Inadequate corrective action from prior fire events caused by hot work.
- Plastic sheeting material (Tarp J-Flexx String Reinforced Polyethylene) was supplied as fire retardant material but it did not meet NFPA 701 flame-retardant test requirements.

[1]The plastic sheeting is a non-safety consumable item that was specified and expected to be flame-retardant. The material purchased is advertised as a flame-retardant material and was acquired by the licensee (Diamond Pattern/See-Thru, FENOC P/N 8594957, G/O Corp P/N GA1045) from G/O Corporation via Fastenal Company (a distributor). The plastic sheeting is manufactured by MidWest Canvas.

Peach Bottom Atomic Power Station Fire

On August 15, 2006, after 21 hours of a 24-hour endurance run surveillance test of the E-3 emergency diesel generator (EDG), combustible roofing material on the EDG building caught fire near the diesel exhaust pipe penetration (roof stack) area. The roofing material caught fire where it came in contact with the steel penetration sleeve that the EDG exhaust pipe passes through. The fire burned (smoldered) at least 35 minutes from the time the fire was visually identified to the time it was extinguished by the plant fire brigade. As the flashing was removed by the fire brigade, some flaming occurred as the vapor mixed with air.

The licensee found that fire was caused by improperly installed roofing materials. There is a 2-inch air-gap around the exhaust pipe as it passes through the steel sleeve that penetrates the concrete roof slab. A rain-hood is bolted to the exhaust pipe extending out over the 2-inch air-gap. The design drawing calls for a 1½ inch air-gap below the rain-hood which allows the heated air in the penetration to escape to prevent excessive heatup of the steel penetration sleeve. However, when the EDG building roof was replaced in 1997 and 1998, the roofing materials and flashing were installed leaving only a ½ inch or less of air gap below the rain-hood. Additionally, either some of the original non-fire rated (combustible) built-up roofing or new vapor membrane repair materials (combustible) were installed incorrectly and remained abutting the steel penetration sleeve. During the extended EDG run, the steel penetration sleeve heated to the point that caused the adjacent roofing materials to ignite. The exhaust stack operating temperature is approximately 900 °F, but asphalt roofing paper burns at approximately 400 °F. The EDG building roofing replacement was accomplished as a non-safety-related modification and was performed by a commercial roofing contractor.

The licensee at Peach Bottom reviewed industry operating experience and found two similar events, both at the McGuire Nuclear Station Unit 1 on April 15, 2003, and on June 11, 2003, that involved Unit 1A EDG building roof. The air gap for the EDG exhaust stack penetration was covered with insulation, which caused excessive heating of the steel penetration sleeve resulting in the ignition of adjacent roofing materials. (NRC Integrated Inspection Report 05000369; 05000370/2003003, dated July 18, 2003, Agencywide Documents Access and Management System Accession No. ML032020537)

The licensee determined that the causes of the fire at Peach Bottom were:

- There was no oversight and no hold point for a site inspection prior to closing the penetration area and no final inspection upon completion.
- There was no verification of design requirements, i.e., the air gap.
- The lack of controls over the roofing contractor allowed combustible materials to come in contact with a surface that normally exceeds their ignition temperature.

BACKGROUND

The primary objective of the fire protection programs at U.S. nuclear power plants is to minimize the probability and consequences of a fire in accordance with Title 10 of the *Code of Federal Regulations* Part 50, Appendix A, General Design Criterion 3, “Fire Protection.” The concept of defense-in-depth applied to fire protection in fire areas important to safety, is

described in Regulatory Guide 1.189, "Fire Protection for Nuclear Power Plants." The Regulatory Guide 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.

As part of a defense-in-depth approach, the fire protection program at nuclear power plants implement administrative controls to minimize fire hazards in areas containing systems, structures, and components important to safety. These control activities include but are not limited to: review of past events and proposed work activities to identify in-situ and transient fire hazards that require fire protection; control of ignition sources; and control of specific types of combustibles that may require treatment with a fire retardant. The fire protection review of these conditions with proposed work activities are an essential element of a fire protection program.

One aspect of the fire protection program is that the use of noncombustible and heat-resistant materials shall be used wherever practical throughout the unit, particularly in locations such as the containment and control room. In addition, the control of hot work and the proper assessment of adequate compensatory measures is essential to this approach. A breakdown of programmatic and design controls can impact one or more elements of defense-in-depth and result in a fire.

Previous NRC Generic Communications Related to Fire Protection

- NRC Regulatory Issues Summary 2006-10, "Regulatory Expectations with Appendix R Paragraph III.G.2 Operator Manual Actions," June 2006.
- NRC Regulatory Issues Summary 2005-07, "Compensatory Measures to Satisfy the Fire Protection Program Requirements," April 2005.
- NRC Regulatory Issues Summary 2005-30, "Clarification of Post-Fire Safe Shutdown Circuit Regulatory Requirements," December 2005.
- NRC IE Bulletin Nos. 75-04, 75-04A and 75-04B, "Cable Fire at Browns Ferry Nuclear Plant," 1975.

DISCUSSION

The breakdown of specific elements in the fire protection program at these nuclear power plants resulted in fires that could have been prevented. In both events the defense-in-depth elements were successful in controlling and extinguishing the fires. However, the potential existed for a more severe and challenging fire. The Peach Bottom fire resulted from construction/repair work that was not installed properly around an ignition source. The installation was not inspected by the plant staff prior to closing the penetration around the exhaust stack and/or after the work was completed to verify the quality of the work. The Beaver Valley fire resulted from the improper types of materials being utilized in the improper places and an ignition source being directly applied. In both events the use of administrative, design controls and compensatory measures were not properly assessed prior to the work activity to prevent a fire.

These fire protection program elements are basic when reviewing and specifying controls for specific work activities. At Peach Bottom these events involved a lack of basic oversight of design details that should be inherently inspected in the field to ensure quality work products regardless of the area of the plant and perceived risk significance.

The breakdown of the fire protection program at Beaver Valley included multiple elements; however, the defense-in-depth approach was successful in the automatic detection of the fire, followed by an operator response. The fire prevention, design/modification review, procedural training, and the compensatory measures all failed to prevent the fire.

Fire protection programs at nuclear power plants are required to be structured to provide defense-in-depth and implemented through a fire protection plan and program that provides the resources and organization to ensure the level of safety throughout the plant.

CONCLUSION

The licensee's fire protection program in both events failed to provide administrative and design controls to prevent a fire and had an inadequate level of fire detection in place. The licensee's oversight and self-assessment of the fire protection program is an essential part of maintaining an adequate fire protection program to ensure fire safety at the plant and should identify these weaknesses. The risk of fires will be substantially elevated without a fire protection program that implements a strong level of defense-in-depth.

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 the appropriate Office of Nuclear Reactor Regulation.

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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.