UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
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NRC INFORMATION NOTICE 2007-01: RECENT OPERATING EXPERIENCE CONCERNING HYDROSTATIC BARRIERS

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 operating experience during 2006 concerning water leaking into buildings or between rooms due to deficient hydrostatic (watertight) barriers. NRC expects that recipients will review the information for applicability to their facilities and consider 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

During 2006, there were at least three events involving water leaking into areas containing safety-related equipment due to deficient hydrostatic barriers. These barriers were either degraded, missing, or composed of non-watertight materials such as fire stop (e.g., silicone foam). These events occurred at the Catawba, Seabrook, and Surry Power Stations.

Seabrook Power Station

On February 5, 2006, at the Seabrook Power Station, the licensee inadvertently actuated one of five deluge subsystems during a scheduled surveillance test of the water deluge system in the cable spreading room (CSR). Approximately 1,000 gallons of water discharged into the CSR. Shortly after the event, the licensee discovered several small puddles of water on the floor of the safety-related “A” train essential switchgear room, located directly below the CSR. The licensee determined that most of the water had entered through degraded foam penetration seals in the CSR floor, and some water may have passed through floor construction joints.

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Upon review of the design bases documents, the licensee determined that the CSR floor was designed as a watertight hydrostatic barrier. Also, the licensee determined that they had failed to incorporate design basis flood protection requirements into the original penetration seal specifications and the CSR floor slab design. The CSR floor and associated seals were not originally specified, designed, or installed as watertight hydrostatic barriers. The licensee submitted a voluntary licensee event report (LER) to describe the event (LER 50-443/2006-003-00, Agencywide Documents Access and Management System (ADAMS) Accession No. ML0615203450).

The licensee at the Seabrook Power Station attributed the deficient hydrostatic barriers to degraded foam penetration seals, foam seals made of a non-watertight material never intended for hydrostatic applications, and unsealed floor construction joints. All of the penetration seals in the CSR floor are supposed to function as both fire and flood barriers. The licensee routinely inspected seals under a fire protection PM program but had never inspected seals from a flood protection standpoint. The criteria in the PM program allowed for small gaps and cracks of a limited size. The foam seals should expand and close up the cracks when exposed to high temperatures such as those experienced in a fire. However, following the CSR deluge event, the plant staff recognized that the acceptance criteria for a penetration seal to function as a fire barrier are not sufficient enough to ensure function as a watertight hydrostatic barrier.

Catawba Power Station

On May 22, 2006, at the Catawba Power Station, the licensee identified water leaking through cable conduits into the 1A emergency diesel generator (EDG) room. The licensee attributed the water to one of Catawba's mechanical draft cooling towers, which had overflowed when excessive silting clogged the cooling tower screens. The overflow entered cable trenches and migrated downhill, from the cooling tower to the diesel generator room. The water entered the 1A EDG room through unsealed, underground, 4-inch conduits. The flow rate was greater than the capacity of the EDG room sump pumps. As a result, the licensee declared the 1A EDG inoperable. The licensee installed portable sump pumps to mitigate the flooding conditions.

Subsequently, the licensee determined that the 4-inch conduits had been unsealed since initial plant construction. During an extent-of-condition review, the licensee identified unsealed or improperly sealed conduits leading into all four EDG rooms, load sequencer corridors, or areas of the auxiliary building containing safety-related equipment. Some of the improperly sealed conduits contained only fire stop, and others had fire stop topped with a water-tight sealant, which had loosened or degraded over time. Of the degraded seals, most were installed at initial plant construction and were never inspected to ensure continued watertight construction. NRC inspectors identified several deficiencies in how the licensee maintained and tested their hydrostatic seals (NRC Inspection Report 50-413; 414/2006-009, ADAMS Accession No. ML0618003292).

The licensee's corrective actions included developing a preventative maintenance (PM) program to periodically inspect and repair hydrostatic seals. Before this PM program could be completely implemented, a similar event occurred in which water entered the turbine building through a nonsafety-related flood wall intended to protect the 6.9-kV transformers.

Surry Power Station

On October 7, 2006, at the Surry Power Station, heavy rainfall resulted in water leaking into the Unit 1 turbine building basement (TBB) and the Unit 2 emergency switchgear room (ESGR). In the Unit 1 TBB at the "D" ductbank, the estimated flow rate was 200 gpm - 250 gpm; in the Unit 1 TBB in the lube oil storage room the estimated flow rate was 1 gpm - 3 gpm and in the Unit 2 ESGR, the estimated flow rate was 5 gpm - 10 gpm. The water entered through a manhole in the switchyard at a rate exceeding the capacity of the two installed sump pumps. As a result, water from this manhole overflowed into a second manhole where the water exceeded the capacity of a 6-inch gravity drain. An increasing water level in the second manhole caused a pressure increase forcing the water through six unsealed 5-inch conduits into the "D" ductbank, thereby entering the Unit 1 TBB and the Unit 2 ESGR.

The TBB conduits were unsealed. In the ESGR, the licensee found that inadequate installation of the fire stop (i.e., General Electric RTV silicone fire foam) in the ESGR allowed water pressure to push the seal out of the conduit penetration.

During initial construction at Surry, the licensee used fire resistant silicone foam to seal electrical conduits. In 1991, the licensee upgraded its conduit seal standards. The new requirements stipulated that conduits which penetrate any building, such that one end is in an electrical enclosure and the other end is inside the building, shall be sealed at the end with the highest elevation. However, the licensee applied the new standard to new conduit seal activities only and, thus, did not prevent this event.

BACKGROUND

Relevant Generic Communications

NRC Information Notice 92-69, "Water Leakage from Yard Area Through Conduits Into Buildings"

NRC IN 92-69 describes two events when large quantities of water entered areas of buildings that contained safety-related equipment. The safety analysis did not consider the leak paths specifically through manholes and connecting conduits. The licensee neither inspected nor tested the conduit seals to detect the absence or deterioration of the seals.

NRC Information Notice 88-60, "Inadequate Design and Installation of Watertight Penetration Seals"

NRC IN 88-60 describes an event at Vogtle Unit 1 from June 3, 1988, when an inadvertent pressurization of the fire protection system in the "B" train CSR caused water to accumulate around cable penetrations in the floor. As water seeped through the floor into the control room, it entered various process panel cabinets and triggered the opening of a pressurizer power-operated relief valve at power.

DISCUSSION

These events illustrate the importance of installing and maintaining watertight hydrostatic barriers in accordance with plant design controls to avoid any adverse effect on safety-related equipment from water intrusion. In particular, when a penetration seal functions as both a fire barrier and a flood barrier, it is important for licensees to consider both functions in the design, installation, inspection, and maintenance. This includes accounting for static head pressure to ensure watertight seals do not dislodge.

CONTACT

This information notice requires no specific action or written response. Please direct any questions about this matter to the technical contacts listed below.

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