UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555-0001

March 21, 1997

NRC INFORMATION NOTICE 97-11: CEMENT EROSION FROM CONTAINMENT SUBFOUNDATIONS AT NUCLEAR POWER PLANTS

Addressees

All holders of operating licenses or construction permits for nuclear power reactors.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to alert addressees to information regarding the possible erosion of cement from porous concrete subfoundations below the reactor building basemats at some reactor sites. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to monitor similar phenomena at their plants. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Background

The containment structure at Millstone Nuclear Power Station Unit 3 (MNPS-3) has a 3.05-meter [10-foot]-thick reinforced-concrete basemat founded on rock. Between the foundation rock surface and the underside of the basemat are several layers of different materials. These layers consist of (1) a 25.4-cm [10-inch]-thick leveling layer of porous concrete made of coarse aggregates and Portland cement, (2) a 0.16-cm [1/16th-inch]-thick butyl rubber waterproofing membrane, (3) a 5.08-cm [2-inch]-thick Portland cement mortar seal, (4) a second layer of 22.86-cm [9-inch]-thick porous concrete made of coarse aggregates and calcium aluminate (high-alumina) cement, and (5) a thin mortar seal (consisting of calcium aluminate cement and sand) on the top of the upper layer of the porous concrete. In the upper porous concrete layer, 15-cm [6-inch]-diameter porous concrete pipes are installed to collect and drain ground water which may seep down along the periphery of the containment wall. The collected water drains into two sumps inside the Engineered Safety Features (ESF) Building.

The MNPS-3 licensee, Northeast Nuclear Energy Company (NNECO), identified the issue of cement erosion from the porous concrete drainage system in 1987 upon examination of the accumulated sludge in the two lower drain sumps in the ESF Building. The licensee's efforts

to follow up on and resolve this concern are documented in NRC Inspection Reports 50-423/94-11 (accession number 9406060281) and 50-423/96-04 (accession number 9606180450), dated May 27, 1994, and June 6, 1996, respectively. The main concern is the adequacy of the eroded porous media to transfer the containment loads to the bedrock. The unexpected erosion of the high-alumina cement also gave rise to another concern regarding a potential for interaction between the concrete of the foundation basemat that contains Portland cement and the high-alumina cement of the subfoundation in the presence of underground water.

To address these concerns, the licensee performed strength tests on cores obtained from mockup tests that simulated accelerated degradation of the porous concrete. The licensee concluded that the load-bearing capacity of the porous concrete has not been compromised. The licensee is continuing to investigate the effects of continuous water flow on the time-dependent degradation of porous concrete. In response to a staff question on settlement of the containment structure, NNECO has stated that, to date, no detectable movement of the containment structure has been observed. Furthermore, NNECO has reported that the loss of cement as a result of erosion from porous concrete is not significant.

On the basis of a review of all the available information, it appears that there is no immediate safety concern at MNPS-3 because only an insignificant amount of cement is estimated to have possibly eroded from the porous concrete subfoundation since the plant was built in 1975, and because no adverse consequences of the cement erosion are either predicted or have been observed at the plant.

Discussion

To address the question of whether there are other nuclear power plant sites at which these types of conditions could exist, the staff reviewed the updated Final Safety Analysis Reports (UFSARs) of 24 plants selected on the basis of (1) the unique practice of the constructor or the architect and engineers (A&Es) and (2) a sampling of A&Es. The staff found that 12 reactor units had subfoundation layers of porous concrete: MNPS-3, North Anna Units 1 and 2, Surry Units 1 and 2, Nine Mile Point Unit 2 (NMP-2), Maine Yankee, FitzPatrick, Beaver Valley Units 1 and 2, Haddam Neck, and Perry. Of these 12 plants, 3 have surveillance programs for monitoring cement erosion — MNPS-3, NMP-2, and Maine Yankee. Maine Yankee Inspection Report 50-309/95-08 (accession number 9505240167), dated May 16, 1995, shows that the containment sump has been under surveillance since 1970 and that no sign of cement slurry has been found. The NMP-2 licensee has replied verbally that no calcium aluminate has been found in the sump water sample and that its surveillance findings will be documented in due course. The staff has obtained the following information from the licensees of the remaining nine plants regarding the conditions at their plants:

- Virginia Electric & Power Company (VEPCO), the licensee of North Anna Units 1 and 2 and Surry Units 1 and 2, reported on November 5, 1996, that Type II, low-alkali, Portland cement (and not calcium aluminate cement) was used in the porous concrete at North Anna and Surry sites.

At North Anna Unit 2, water samples taken recently from the basemat sump and from two domestic water wells at the plant site showed virtually no aluminum (less than 1 ppm) in the three locations. Insignificant amounts of calcium and sulfate were noticed at the mat sump. No detectable settlement of the containment basemat was noticed at North Anna Units 1 and 2.

At Surry Units 1 and 2, an external subsurface drainage system operates continuously to control groundwater level. The Unit 1 valve pit area for the internal drainage system was dry; the Unit 2 area had a few centimeters of standing water apparently leaking in through a side wall. A minimum amount of leachate was observed in this area. The settlement of the containment structures of both units at Surry were found to be less than 0.32 cm [1/8 inch], which is within the design values (1.27 cm [1/2 inch]) for settlement.

- The Haddam Neck plant (HNP) licensee, Northeast Utilities Services Company, reported on October 31, 1996, that Type II, low-alkali, Portland cement (and not calcium aluminate cement) was used in the porous concrete mix. For the last 10 years at HNP, no slurry was found in the drainage water from the external containment sump during the monthly survey done for radiological concerns. Reactor building settlement is not monitored; however, recent inspections inside the containment found no evidence of containment settlement and no indications of degradation of the concrete slab.

- The Perry nuclear power plant licensee, Cleveland Electric Illuminating Company, reported on November 4, 1996, that no cement slurry has been noted in the drainage and there has been no evidence of pea gravel in the drainage pipes or manholes. The licensee has, however, reported that dissolved calcium carbonate is being carried to the drainage pipes and the sumps, where it is solidifying as a fine particulate which hardens into hard scale. According to NRC Region III Inspection Report 50-440/96-04 (accession number 9609030241) dated August 21, 1996, the licensee also discovered an accumulation of mineral deposits that clogged the pores of the porous concrete pipes and developed an effective method of clearing the clogged pipes. The licensee plans to clear the remaining pipes. No containment structure settlement has been observed at Perry.

- The Beaver Valley Power Station (BVPS) Units 1 and 2 licensee, Duquesne Light Company (DLC), reported on November 7, 1996, that neither of the two units has experienced drainage from the porous concrete layers below the basemat. DLC further claims that such drainage is not expected at BVPS because of the plant's containment design features and the waterproof membrane that envelops the porous concrete layer, the containment mat foundation, and the exterior wall up to the plant grade level. DLC has reported that the total observed settlement of the BVPS

containment structures compares favorably with the total predicted settlement, and that it has not noted any unusual conditions that were related to the porous concrete layers at BVPS Units 1 and 2.

- The James A. FitzPatrick nuclear power plant licensee, New York Power Authority (NYPA), reported on November 8, 1996, that the porous concrete subfoundation slab of 15.24-cm [6-inch] (minimum) thickness was constructed using Type II Portland cement. This slab, laid between the basemat and the rock, is surrounded by engineered backfill. On top of the backfill, a 30.48-cm [12-inch]-diameter porous concrete drainage pipe leading to a sump was laid with its invert level about 1.22 meters [4 feet] above the top of the porous concrete slab. Any ground water seeping down along the sides of the reactor building collects in the sump and is pumped into the drainage system. NYPA has not observed any cementitious slurry in the water samples being regularly collected from the drainage sump. NYPA has also reported that the containment structure has not settled.

On the basis of this information and also on the basis of the staff's preliminary assessments of MNPS-3 and NMP-2, the staff finds that there is no immediate generic or plant-specific safety concern related to the porous concrete subfoundations below the containment basemat at nuclear power plants. However, the NRC staff is continuing to evaluate the potential long-term impact of erosion of high-alumina cement at MNPS-3.

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Thomas T. Martin, Director
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Office of Nuclear Reactor Regulation

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Information Notice No.	Subject	Date of Issuance	Issued to
97-10	Liner Plate Corrosion in Concrete Containments	03/13/97	All holders of OLs or CPs for power reactors
97-09	Inadequate Main Steam Safety Valve (MSSV) Setpoints and Performance Issues Associated with Long MSSV Inlet Piping	03/12/97	All holders of OLs or CPs for nuclear power reactors
97-08	Potential Failures for General Electric Magne-Blast Circuit Breaker Subcomponents	03/12/97	All holders of OLs or CPs for nuclear power reactors
97-07	Problems Identified During Generic Letter 89-10 Closeout Inspections	03/06/97	All holders of OLs or CPs for nuclear power reactors
97-06	Weaknesses in Plant-Specific Emergency Operating Procedures for Refilling the Secondary Side of Dry Once-Through Steam Generators	03/04/97	All holders of OLs or CPs for nuclear power reactors with with once-through steam generators
91-85, Rev. 1	Potential Failures of Thermostatic Control Valves or Diesel Generator Jacket Cooling Water	02/27/97	All holders of OLs or CPs for nuclear power reactors

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CP = Construction Permit

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original signed by M.M. Slosson
for Thomas T. Martin, Director
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