CONTACTS

This IN requires no specific action or written response. Please direct any questions about this matter to the technical contacts listed below or the appropriate 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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UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
OFFICE OF NEW REACTORS
WASHINGTON, DC 20555-0001

February 16, 2011

NRC INFORMATION NOTICE 2011-03: NONCONSERVATIVE CRITICALITY SAFETY ANALYSES FOR FUEL STORAGE

ADDRESSEES

All holders of operating licenses or construction permits for a nuclear power reactor issued under the provisions of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities."

All holders of or applicants for a standard design certification, standard design approval, manufacturing license, or combined license issued under 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to inform addressees of possible nonconservative technical specifications related to the criticality safety of fuel storage. The 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.

BACKGROUND

Paragraph 50.68(b)(4) of 10 CFR 50.68, "Criticality Accident Requirements," requires the following:

> If no credit for soluble boron is taken, the k-effective of the spent fuel storage racks loaded with fuel of the maximum fuel assembly reactivity must not exceed 0.95, at a 95 percent probability, 95 percent confidence level, if flooded with unborated water. If credit is taken for soluble boron, the k-effective of the spent fuel storage racks loaded with fuel of the maximum fuel assembly reactivity must not exceed 0.95, at a 95 percent probability, 95 percent confidence level, if flooded with borated water, and the k-effective must remain below 1.0 (subcritical), at a 95 percent probability, 95 percent confidence level, if flooded with unborated water.

NUREG/CR-6698, "Guide for Validation of Nuclear Criticality Safety Calculational Methodology," January 2001 (Agencywide Document and Management System (ADAMS) Accession

No. ML050250061), provides guidance on determining the bias uncertainty for Monte Carlo codes.

The primary NRC staff guidance regarding the depletion uncertainty is an internal NRC memorandum from L. Kopp to T. Collins, "Guidance on the Regulatory Requirements for Criticality Analysis of Fuel Storage at Light-Water Reactor Power Plants," dated August 19, 1998 (ADAMS Accession No. ML003728001) (Kopp Letter). The Kopp Letter is referenced by virtually all spent fuel pool criticality license amendment requests submitted since its issuance.

Regarding the depletion uncertainty, the Kopp Letter states the following:

> A reactivity uncertainty due to uncertainty in the fuel depletion calculations should be developed and combined with other calculational uncertainties. In the absence of any other determination of the depletion uncertainty, an uncertainty equal to 5 percent of the reactivity decrement to the burnup of interest is an acceptable assumption.

DESCRIPTION OF CIRCUMSTANCES

Beaver Valley Power Station

By letter dated April 9, 2009, FirstEnergy Nuclear Operating Company submitted a license amendment request for Beaver Valley Power Station, Unit 2 (BVPS-2), to modify the technical specifications to support the installation of high-density storage racks in the BVPS-2 fuel pool. A vendor provided a criticality safety analysis to support the BVPS-2 license amendment request.

During the review of the BVPS-2 application, the NRC staff found that the statistical treatment of the Monte Carlo code bias uncertainty used in the criticality safety analysis was inappropriately based on the standard deviation of the mean k-effective value calculated for the critical experiments. 10 CFR 50.68 requires that the estimated k-effective be less than 1.0 at a 95-percent probability, 95-percent confidence level (95/95 confidence). Therefore, the correct statistical approach is to determine the Monte Carlo code bias uncertainty using the standard deviation of the population about the mean, not the standard deviation of the mean. Using the correct statistical approach, the bias uncertainty was found to be larger by 0.0079 over the previous analysis. The large increase in the value for the bias uncertainty also resulted in a significant increase in the estimated k-effective.

St. Lucie Nuclear Power Plant

By letter dated April 16, 2010, Florida Power and Light Company submitted information about the current licensing basis for fuel storage criticality safety at St. Lucie Nuclear Power Plant, Unit 1, as part of a license amendment request for an extended power uprate. During the acceptance review of the request, the NRC found that the current licensing basis criticality safety analysis for fuel storage did not include the depletion uncertainty for the unborated cases. 10 CFR 50.68 requires licensees to demonstrate that k-effective is less than 1.0 with a 95/95 confidence for the unborated cases. When these demonstrations rely upon fuel

depletion, the depletion uncertainty must be included in both the borated and unborated analyses. The estimated k-effective will likely increase when the depletion uncertainty is factored into the analysis.

DISCUSSION

The two issues discussed in this IN relate to the Monte Carlo code bias uncertainty and the depletion uncertainty. Both of these uncertainties, if not properly treated, may lead to nonconservative estimation of the maximum k-effective, and regulatory compliance may not be assured. Analyses with small margins to the regulatory limit are especially vulnerable to noncompliance with 10 CFR 50.68 and nonconservative technical specifications if these issues are present.

In 10 CFR 50.68, the NRC requires a 95-percent probability with a 95-percent confidence level that a calculation demonstrating subcriticality of a spent fuel storage rack actually is subcritical. The primary NRC guidance for criticality code validation, NUREG/CR-6698, includes guidance on the determination of the bias uncertainty for Monte Carlo codes based on the population of critical experiments. Guidance for determining the bias uncertainty in NUREG/CR-6698 can be used to ensure compliance with 10 CFR 50.68.

Most nuclear criticality safety analyses performed to support spent fuel pool licensing actions include reactor depletion calculations, whether it is a boiling-water reactor establishing the most reactive point in the life of a fuel assembly lattice or a pressurized-water reactor taking burnup credit. Licensing actions that include reactor depletion calculations should consider the uncertainty of those calculations to ensure the 95/95 confidence requirement for k-effective is met. The Kopp Letter provides the NRC's current guidance for determining uncertainties for reactor depletion calculations. As with other NRC guidance, addressees may choose an alternative method for determining the depletion uncertainty, although additional NRC staff review should be expected.

The NRC is working to improve its guidance in these areas. The NRC Office of Nuclear Reactor Regulation (NRR) has established an Action Plan, "On Site Spent Fuel Criticality Analyses" (ADAMS Accession No. ML101520463), to monitor and track these activities. The NRC has received public comment on Draft Interim Staff Guidance DSS-ISG-2010-01, "Staff Guidance Regarding the Nuclear Criticality Safety Analysis of Spent Fuel Pools" (ADAMS Accession No. ML101520463), and expects to issue the final version in the first quarter of 2011. The NRC expects to issue more durable guidance by the first quarter of 2013.