December 21, 2007

MEMORANDUM TO: Luis A. Reyes
Executive Director for Operations

FROM: Brian W. Sheron, Director ***/RA/***
Office of Nuclear Regulatory Research

SUBJECT: CLOSURE OF GENERIC ISSUE GI-156.6.1, "PIPE BREAK EFFECTS ON SYSTEMS AND COMPONENTS INSIDE CONTAINMENT"

The Office of Nuclear Regulatory Research (RES) has completed the technical assessment for Generic Issue 156.6.1, "Pipe Break Effects on Systems and Components Inside Containment." In accordance with Management Directive 6.4, "Generic Issues Program," the staff will close this issue with no changes to existing regulations or guidance.

Generic Issue 156.6.1 is the last of 27 distinct generic issues that arose from the Systematic Evaluation Program. This generic issue specifically deals with the effects of a pipe break within the containment. The Standard Review Plan (SRP) contains specific criteria for postulated pipe break locations, pipe whip restraints, and separation criteria for instrumentation and control systems, so that a single pipe break does not disable systems and components needed to respond to the event. However, the U.S. Nuclear Regulatory Commission (NRC) licensed a number of reactors before those criteria were formally put in place. Although containment designs did not change significantly in response to the SRP criteria, the question arose as to whether the NRC should revisit the adequacy of the older containment designs.

Thus, Generic Issue 156.6.1 addresses whether there is a need to re-review the older nuclear power plant units — both pressurized-water reactors (PWRs) and boiling-water reactors (BWRs). Referred to as "Systematic Evaluation Program Phase II and Phase III" (SEP-II and SEP-III), these plants were licensed while the design criteria were still evolving, as specified in Appendix A to Title 10, Part 50, of the *Code of Federal Regulations* (10 CFR Part 50). Specifically, Generic Issue 156.6.1 considers whether these SEP-II and SEP-III plant designs adequately addressed the effects of pipe breaks inside containment.

For BWRs, the accident sequences of interest all involve a pipe whip that penetrates the steel primary containment wall, thereby discharging steam into the gap between that wall and the secondary concrete shield wall. Steam that is discharged into this gap will find its way to the rooms containing the equipment associated with the emergency core cooling system (ECCS), which may fail due to the resulting harsh environment. Consequently, a severe core damage event could result, with the integrity of the primary containment already lost.

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To address these scenarios, the staff performed a series of calculations using a nonlinear finite element program to estimate the effect of a pipe whip on the containment wall. The results of these calculations indicated that the containment wall would be dented, but not penetrated. In the more extreme cases, the dented steel containment wall would touch the concrete shield, but this contact would arrest any further displacement. Based on these calculations, the staff concluded that penetration of the steel wall has an exceedingly low probability of occurrence, and the BWR scenarios can be eliminated from further consideration.

Of the PWR accident scenarios, only one has an estimated frequency high enough to warrant further investigation. That sequence is initiated by a high-energy secondary system pipe break within containment. In such an event, pipe whip or jet impingement would then cause failure of instrumentation or control cables within containment, leading to failure of accident-mitigating systems.

Because of the variation in containment designs for the early PWRs, a generic approach was not possible. Instead, staff from RES and the Office of Nuclear Reactor Regulation (NRR) examined the cabling and piping layout of each SEP PWR that is still operating. In so doing, the staff discovered that some plant designs anticipated the SRP requirements for channel separation and separate penetrations on opposite sides of the containment. In other plant designs, cables were separated from piping by walls, floors, or other structures, or were spatially separated by significant distances. No instance was found where a whipping pipe or fluid jet would directly disable both channels of any safety-significant system. Thus, the staff concluded that the PWR scenario could also be eliminated from further consideration.

Enclosure 1 to this memorandum presents the background information, basis for the closeout, and the staff’s technical assessment. In addition, the staff met with the Advisory Committee on Reactor Safeguards (ACRS) on September 6, 2007, and presented the rationale for closing this issue with no further actions. The ACRS reviewed and formally endorsed the staff's recommendation, as documented in Enclosure 2 to this memorandum, which is also available under Accession No. ML072530615 in the Agencywide Documents Access and Management System (ADAMS).

Enclosures:
As stated

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