August 16, 2006

Mr. J. A. Gresham
Regulatory Compliance and Plant Licensing
Westinghouse Electric Company Nuclear Services
P.O. Box 355
Pittsburgh, PA 15230-0355

SUBJECT: NUCLEAR REGULATORY COMMISSION RESPONSE TO WESTINGHOUSE LETTER LTR-NRC-06-46 DATED JULY 14, 2006, REGARDING PRESSURIZED WATER REACTOR (PWR) CONTAINMENT SUMP DOWNSTREAM EFFECTS

Dear Mr. Gresham:

The NRC received letter LTR-NRC-06-46 (ADAMS Accession Number ML062080682) from Westinghouse requesting clarification of certain requirements in Title 10 of the Code of Federal Regulations (CFR). The need for these clarifications was identified on April 12, 2006, when the NRC staff met with representatives from Westinghouse to discuss ongoing efforts by the PWR Owners Group (PWROG) to provide a standard methodology for nuclear plant licensees to use for evaluating the potential effects of debris that could potentially be injected into the reactor vessel following the transition to sump recirculation in a post loss-of-coolant accident (LOCA) environment. Licensees may use this methodology as part of their resolution of Generic Safety Issue 191, "Assessment of Debris Accumulation [Effect] on PWR Sump Performance."

The specific clarifications requested are listed below, followed by the NRC responses.

1) *It is requested that NRC provide clarification of the requirements and acceptance criteria for long-term core cooling once the core has quenched and reflooded. This clarification will be used by Westinghouse, and potentially the PWROG, in developing the GSI-191 debris ingestion evaluation method for reactor fuel.*

The 10 CFR 50.46 rule was constructed in two parts. The first part governs the performance of the emergency core cooling system (ECCS) during the initial phases of blow-down, quench and re-flood. During this period, the ECCS is injecting water from the refueling water storage tank (RWST) into the reactor in an effort to ensure that fuel damage is minimized. The criteria used to conclude that fuel damage is minimized are the temperature criteria for the cladding and the oxidation and hydrogen generation values. The rule then establishes a criterion for long-term cooling during any recirculation phase (whether natural or forced recirculation). The acceptance criterion is simply that the calculated core temperature shall be maintained at an acceptably low value and decay heat shall be removed for the extended period of time required by the long-lived radioactivity remaining in the core.

The NRC staff has typically considered the criteria in paragraph (b)(5) to be satisfied when the fuel in the core is quenched, the switch from injection to recirculation phases is complete, and the recirculation flow is large enough to match the boiloff rate. The staff is concerned about the potential for loss of long-term cooling capability from chemical effects (boron precipitation) or physical effects (debris). For example, the staff's standard position is that a core flushing flow path should be established well before boron concentrations reach the precipitation limit (Ref. Information Notice 93-66). Similarly, analysis should demonstrate that no significant increase in calculated peak clad temperature (PCT) occurs by demonstrating that the bulk temperature at the core exit is maintained essentially constant at the temperature achieved at the initiation of recirculation or is continuing to decrease. The following paragraph provides further qualification of the NRC concerns with respect to increases in fuel temperature during the recirculation phase.

While the current staff position is conservative with respect to protection of the fuel, other options may be available that provide protection of the fuel, assure a coolable geometry, and could be used to demonstrate compliance with paragraph (b)(5). The staff notes that fuel qualification testing has been restricted to heating the fuel cladding to the regulatory limit and then quenching the material to examine the ductility and strength remaining. The staff is not aware of any testing done to examine the subsequent reheating of fuel to the 10 CFR 50.46 limit with a subsequent second quench (either slow or fast). Situations showing a localized moderate (on the order of 100 - 200 degrees C) PCT increase could be considered as acceptably low if properly justified. The staff would expect any such justifications to consider degradation of the cladding oxide layer, hydrogen embrittlement of the cladding, and accumulated diffusion of oxygen within the cladding microstructure. Duration of time at elevated temperature and peak temperature experienced by the clad should also be limited and justified. The staff would expect the justifications to be supported by test data, where possible. The submitted information would form the basis for any determination that the calculated core temperatures remain acceptably low as required by the rule.

The second clause of 10 CFR 50.46(b)(5), "decay heat removed for the extended period of time required by the long-lived radioactivity remaining in the core" was not identified as an issue needing clarification in Westinghouse letter LTR-NRC-06-46, or at the meeting with Westinghouse on April 12, 2006. The Westinghouse representatives in attendance at the meeting agreed with the staff on the definition of this clause and had no questions on its meaning. Based on this, the staff expects that this clause needs no further clarification.

2) *The standard mission time employed for GSI-191 is 30 days. This mission time may not be appropriate for evaluation of nuclear fuel issues. The NRC staff is requested to provide clarification on this requirement and how it applies to evaluation of debris ingestion effects on reactor fuel. Westinghouse, and potentially the PWROG, will use this clarification in developing the GSI-191 debris ingestion evaluation method for reactor fuel.*

For GSI-191, the 30-day criterion was originally intended for evaluation of operability of equipment. For analysis of core cooling following debris ingestion into the reactor vessel, the staff believes that an adequate post-LOCA evaluation duration would be demonstrated when bulk and local temperatures are shown to be stable or continuously decreasing with the additional assurance that any debris entrained in the cooling water supply would not be capable of affecting the stable heat removal mechanism due to sump screen clogging or downstream effects.

If you have any questions, or would like to discuss this further, please contact Tom Hafera at 301-415-4097.

Sincerely,

/RA/

Thomas O. Martin
Division Director,
Division of Safety Systems
Office of Nuclear Reactor Regulation

If you have any questions, or would like to discuss this further, please contact Tom Hafera at 301-415-4097.

Sincerely,

/RA/

Thomas O. Martin
Division Director,
Division of Safety Systems
Office of Nuclear Reactor Regulation

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