September 27, 2005

MEMORANDUM TO: Gary S. Janosko, Chief
Fuel Cycle Facilities Branch
Division of Fuel Cycle Safety
and Safeguards
Office of Nuclear Material Safety
and Safeguards

THROUGH: Julie A. Olivier, Acting Section Chief /RA/
Fuel Cycle Facilities Branch
Division of Fuel Cycle Safety
and Safeguards
Office of Nuclear Material Safety
and Safeguards

FROM: Kevin M. Ramsey, Project Manager /RA/
Fuel Cycle Facilities Branch
Division of Fuel Cycle Safety
and Safeguards
Office of Nuclear Material Safety
and Safeguards

SUBJECT: WESTINGHOUSE ELECTRIC COMPANY, SUMMARY OF SEPTEMBER 6-8, 2005, SITE VISIT RE: MARGIN OF SUBCRITICALITY (TAC L31869)

On September 6-8, 2005, the Nuclear Regulatory Commission (NRC) staff visited the Westinghouse Electric Company facility in Columbia, SC, to gain a better understanding of the technical basis and implementation of the margin of subcriticality used in the licensee's criticality safety program. The following individuals participated in the meetings:

NRC:
Kevin Ramsey
Christopher Tripp
Melanie Galloway

Westinghouse:
Ralph Winiarski
Nancy Parr
Scott Revolinski
Marc Rosser
Mike Corum
Dane Graham
Carl Snyder
Sean Gough

After opening remarks, a site tour was conducted. Westinghouse presented a briefing on application of the margin of subcriticality at the facility. A copy of the slides are provided in Enclosure 1. The licensee believes the margin of subcriticality of 0.02 is justified by the following:

1. Rigorous validation,
2. Conservative margins in system parameters,
3. System sensitivity analysis, and
4. Documented methodology.

The NRC agreed that these were four aspects of the criticality safety program that provide assurance of subcriticality. The NRC stated that a licensee would need to demonstrate a fully satisfactory criticality safety program for NRC to approve a typical margin of subcriticality (i.e., 0.05). To approve the 0.02 margin of subcriticality used by Westinghouse, the NRC needs to find the criticality safety program to be more than fully satisfactory, or "superior," and in particular with regard to each of the four areas.

Validation Documents

To better understand the rigor of the licensee's validation, the participants reviewed CRI-04-025, "Determination of Bias for Homogeneous Systems Modeled using KENO Va." This is one of four validation documents used by the licensee. This validation has recently been upgraded. The other three validation documents will be upgraded over the next few months. The licensee estimates that the validation upgrades will be complete by Spring 2006.

The NRC staff considers this validation to be fully satisfactory in all areas. Some areas are considered to be superior, including (1) the number and pedigree of benchmark experiments (e.g., all experiments were taken from the International Handbook of Evaluated Criticality Safety Benchmark Experiments) and use of the 238-group cross section library. In addition, the two MCNP validations had the benefit of using continuous energy cross sections, and the licensee stated that the benchmark experiments used to validate heterogeneous systems had a very high degree of similarity to the Westinghouse fuel applications. However, for the NRC to make a finding that the entire validation is superior, the licensee needs to provide enhanced rigor in some areas. Some areas in which this enhanced rigor could be realized were discussed.

Criticality Calculations and Application of Sensitivity Procedure :

The participants reviewed CN-CRI-05-16, "Determination of k-eff for Solvent Extraction Area with all Tanks Filled with TBP Saturated with Uranyl Nitrate and Mixed with Kerosene." The calculation evaluated k-eff for various volume percentages of solvent (10 - 100 percent TBP). Operations normally run at 30 percent TBP. The licensee noted that it doesn't perform a sensitivity analysis if the worst case situation doesn't create an unacceptable k-eff. It was agreed that graphing the entire range of solvent percentages is essentially a sensitivity analysis.

The NRC asked about the amount of conservatism in the models. The licensee stated that normally, it doesn't quantify each conservatism. The licensee noted it uses the following conservatisms:

- Assume that tank walls go to zero thickness.
- Assume 5 percent enrichment (normally up to 4.8 percent).
- Assume 100 percent theoretical density of pellets.
- Assume no credit for poisons and other additives in fuel. The NRC noted that the reactivity worth of integral absorbers in the final fuel assemblies would provide a "ballpark figure" of this conservatism. The licensee was asked to provide the reactivity worth of absorbers in its final fuel assemblies, since it had this information.

The participants reviewed NCS-002, "Criticality Safety Evaluation (CSE) Guidelines." This document contains the assumptions that analysts should use when performing a CSE. The NRC asked if the document stated not to take credit for poisons. The licensee said no, but a statement would be added. The licensee noted that analysts could assume less than optimum conditions if optimum conditions weren't credible. The NRC asked how often analysts deviated from optimum conditions. The licensee estimated 5 percent of the time.

The participants reviewed CRI-05-11, "Criticality Safety Assessment for the Fuel Assembly Storage Area." This is a new assessment that includes a full sensitivity analysis for each of the controlled parameters. The participants discussed how the assessment results are used to make decisions about controlled parameter values, the need for additional controls, and system modifications.

The participants reviewed CRI-03-015, "Bounding Calculation for the Pellet Grinder Bowl Feed Collection Chutes - ADU Pelleting and Erbia," and CN-CRI-98-011, "ADU Conversion Line Precipitator Criticality." These are older calculations that will be upgraded. The participants discussed how the sensitivity procedure will be applied and how many parameters will be considered.

Based a review of procedure RA-313, "Criticality Safety Evaluations (CSEs)," NRC asked the licensee to explain the Safety Margin Improvement Controls (SMICs) and tertiary contingencies mentioned on page 16. The licensee explained that SMICs were additional controls that provided defense in depth. The licensee stated that it intends to eliminate SMICs and make them formal controls (i.e., IROFS) if they are really needed. Tertiary contingencies are a third contingency that must occur before a system can go critical. Some systems require more than two unlikely events to go critical. The NRC requested a list of SMICs and tertiary contingencies.

The participants reviewed the hypothetical examples in the slides presented by Westinghouse. The NRC staff raised questions about how the sensitivity procedure was applied. The participants reviewed procedure RA-312, "NCS Calc Note Generation, Format, and Content Requirements." The NRC noted that the instructions on page 5 concerning the sensitivity analysis were difficult to understand. The NRC indicated that the procedure was deficient in two regards: (1) it did not contain clear criteria for when the existing margin of 0.02 was acceptable; and (2) it did not specify what the analyst should do if the existing margin was not acceptable. The licensee drafted revised instructions, including a mathematical equation for evaluating system sensitivity and determining whether additional margin was needed. Systems

that have "high" sensitivity (i.e., k_{eff} has a large rate of change with respect to a parameter) would require additional margin in the system parameter. Systems that have "low" sensitivity would be acceptable with the margin of 0.02 and the parameter could be at its USL value. After some discussion, the participants agreed that the revised instructions provided needed clarity, but still needed further refinement to ensure accuracy.

The participants reviewed Chapter 6, Nuclear Criticality Safety, from the current license application to determine the extent to which it contained clear commitments with regard to the conservatism in modeling. The NRC asked questions about statements that were unclear and discussed changes that would be needed to improve the language.

Documented Methodology

The participants discussed a number of criticality safety program procedures, which the licensee stated provided its documented methodology. The NRC stated that, with the exception of NCS-002 and RA-312, the procedures did not appear to provide any additional assurance of subcriticality. The NRC stated that by itself the existence of procedures could not be relied on as part of the basis of the 0.02 margin, but that commitments in each of the three primary areas (e.g., validation rigor, conservatism in system parameters, and sensitivity analysis) should be included in the license.

Summary:

The NRC staff stated that the site visit was very beneficial. The NRC staff stated that each of the four following points needs to be addressed in a high quality manner to demonstrate a margin of subcriticality of 0.02:

1. Criticality Validation - the NRC staff believes the Westinghouse validation is the best developed among those it has reviewed. The following areas are considered to be superior:

    - Number of benchmarks (above average).
    - Source of benchmarks (high quality).
    - Data library (238-group provides finer resolution).

    For NRC to make a finding that the entire validation is superior, the licensee needs to demonstrate enhanced rigor in some areas. Those areas are:

    - Use of additional statistical analyses (i.e., additional tests for normality).
    - Some multidimensional specification of the area of applicability (e.g., two-dimensional distribution of benchmarks, such as use of certain materials over certain energy ranges).
    - Analyzing different energy ranges, i.e., characterizing the spectrum in terms of three energy parameters (thermal, intermediate, and fast fission fractions) instead of the mean neutron energy.
    - More sophistication in the trending analysis (e.g., trending against more parameters, or two-dimensional trending, such as neutron energy and H/X).

    Westinghouse Action: Provide enhanced rigor in criticality validations.

2. Conservatism in System Parameters - the NRC staff stated that it needed clear statements on where conservatism has been systematically used, including information on the differences between actual conditions and assumed conditions.

   Westinghouse Action: Provide the following:

   - Clear statements on where conservatism is used in system parameters and where it applies in the process.
   - The reactivity worth of absorbers in final fuel assemblies.
   - List of Safety Margin Improvement Controls and tertiary contingencies.

3. System Sensitivity Analyses - the NRC staff has a much clearer understanding of the analysis to be performed and how it will be used, but further development is needed.

   Westinghouse Action: Provide a final procedure containing the algorithm for the sensitivity analysis and guidance on how the results are used in decision-making related to enhancing the margin of subcriticality.

4. Documented Methodology - the NRC staff explained that the framework of the Westinghouse program must be specified in the license renewal application to provide a basis for the NRC findings. It was noted that the application could be accepted with some incomplete information, but complete information on the areas discussed in the meeting would have to be provided later. The NRC staff suggested referring to the guidance in NUREG-1520, "Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility," as a tool to assist in addressing some areas discussed during the meeting.

   Westinghouse Action: Incorporate the appropriate amount of detail concerning the criticality safety program into the license renewal application, including validation approach, incorporation of conservatism, and use of the sensitivity analysis.

Westinghouse estimated that the analyses for Action No. 1 would require some time. The NRC indicated that the cases should all be run, and that this should involve only re-analyzing the results. The information for Action No. 2 would take time also, but the information was available. Westinghouse noted that it was in the process of changing how Safety Margin Improvement Controls are identified and maintained. The NRC staff stated that Westinghouse should describe ongoing efforts in its submittal. The information for Action No. 3 could be provided within a few weeks (this was the only area requiring generation of new information). The information for Action No. 4 will be provided in the license renewal application or in a revision to it.

Westinghouse stated that the upgrades to its criticality calculations are to be complete by June 2008. The review of the technical basis documents to identify high, medium and low priority upgrades should be completed by Spring 2006. Then work on high priority upgrades will begin.

Docket No.: 70-1151
License No.: SNM-1107

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OFC	FCFB		FCFB		FCFB	
NAME	K.Ramsey		V.Cheney		J.Olivier	
DATE	09/22/2005		09/26/2005		09/27/2005	

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