February 23, 2012

Mr. David J. Precht, Plant Manager
Westinghouse Electric Company
Commercial Nuclear Fuel Division
5801 Bluff Road
Hopkins, SC 29061-9121

SUBJECT: INSPECTION REPORT NO. 70-1151/2012-201

Dear Mr. Precht:

The U.S. Nuclear Regulatory Commission (NRC) conducted a routine and announced criticality safety inspection at your facility in Columbia, South Carolina, from January 23-26, 2012. The purpose of the inspection was to determine whether activities involving licensed material were conducted safely and in accordance with NRC requirements. Observations and findings were discussed with your staff throughout the inspection and during an exit meeting held on January 26, 2012.

The inspection, which is described in the enclosure, focused on the most hazardous activities and plant conditions; the most important controls relied on for safety and their analytical basis; and the principal management measures for ensuring controls are capable, available, and reliable to perform their functions relied on for safety. The inspection consisted of analytical basis review, selective review of related procedures and records, examinations of relevant nuclear criticality safety (NCS)-related equipment, interviews with NCS engineers and plant personnel, and facility walkdowns to observe plant conditions and activities related to safety basis assumptions and related NCS controls.

In accordance with Title 10 of the *Code of Federal Regulations* 2.390 of NRC's "Rules of Practice," a copy of this letter and the enclosure will be made publicly available in the Public Electronic Reading Room of the NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/ADAMS.html.

If you have any questions concerning this report, please contact Thomas Marenchin at (301) 492-3209, or via e-mail to Thomas.Marenchin@nrc.gov.

Sincerely,
/RA/

Thomas G. Hiltz, Chief
Technical Support Branch
Division of Fuel Cycle Safety
and Safeguards
Office of Nuclear Material Safety
and Safeguards

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

Enclosure:
Inspection Report 70-1151/2012-201

cc w/enclosure:
Mr. Marc Rosser, Westinghouse

cc w/o enclosure:
Mr. Aaron A. Gantt, Chief
Bureau of Radiological Health
South Carolina Department of Health
and Environmental Control
2600 Bull Street
Columbia, SC 29201

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U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS

Docket No.:	70-1151
License No.:	SNM-1107
Report No.:	70-1151/2012-201
Licensee:	Westinghouse Electric Company
Location:	Columbia, South Carolina
Inspection Dates:	January 23-26, 2012
Inspectors:	Thomas Marenchin, Criticality Safety Inspector Christopher Tripp, Criticality Safety Inspector Timothy Sippel, Criticality Safety Inspector
Approved by:	Thomas G. Hiltz, Chief Technical Support Branch Division of Fuel Cycle Safety and Safeguards Office of Nuclear Material Safety and Safeguards

Enclosure

EXECUTIVE SUMMARY

Westinghouse Electric Company
NRC Inspection Report 70-1151/2012-201

Introduction

Staff of the U.S. Nuclear Regulatory Commission (NRC) performed a routine and announced nuclear criticality safety (NCS) inspection of the Westinghouse Electric Company's (WEC), Columbia, South Carolina, facility from January 23-26, 2012. The inspection included an onsite review of the licensee's NCS program, NCS evaluations, NCS training and qualification, NCS audits, and recent NCS-related events, the criticality accident alarm system, and open items. The inspection focused on risk-significant fissile material processing activities and areas including ammonium diuranate (ADU) conversion, uranium dioxide (UO_2) powder handling and pelletizing, fuel manufacturing—including Erbia and integral fuel burnable absorber (IFBA) fuel manufacturing, uranium recovery, the incinerator, uranium hexafluoride (UF_6) cylinder wash, and UF_6 cylinder recertification.

Results

- No safety concerns were identified regarding the licensee's NCS Program.
- No safety concerns were identified regarding the licensee's NCS audits.
- No safety concerns were identified regarding NCS training.
- An Inspector Follow-up Item (IFI) concerning accumulation of powder in the powder lift enclosure was identified during a review of recent licensee investigation of internal events. No other safety concerns were identified.
- No safety concerns were identified during plant walkdowns.

REPORT DETAILS

1.0 Summary of Plant Status

WEC manufactures light water reactor fuel at its Columbia, SC, facility. During the inspection, the plant operated normally.

2.0 NCS Program (IP 88015, IP 88016)

a. Inspection Scope

The inspectors reviewed selected criticality safety evaluations (CSEs) generated or revised since the last inspection to determine the adequacy of the analytical basis for facility operations. The inspectors reviewed selected aspects of the following documents:

- CN-CRI-06-9, "Integrated Fuel Burnable Absorber (IFBA) Pellet Coaters," Revision 0, dated August 2006
- CN-CRI-07-32, "S-1030 Scrubber Ductwork"
- CN-CRI-07-41, "Uranyl Nitrate Bulk Storage System," Revision 0
- CN-SB-08-30, "S-1030 Scrubber Filter Housing Criticality Accident Potential," Revision 0, dated February 11, 2009
- CN-SB-08-37, "ADU Pelleting Powder Criticality Accident Potential," Revision 0, dated May 26, 2009
- CSE-01-L, "Criticality Safety Evaluation (CSE) for S-1030 Scrubber Ventilation System," Revision 1, dated January 2011
- CSE-02-A, "Uranyl Nitrate Bulk Storage and HF Spiking Station," Revision 3, dated June 2011
- CSE-08-B, "Criticality Safety Evaluation (CSE) for ADU Pelleting Powder Preparation and Pressing Operations," Revision 0, dated May 2009
- CSE-14-B, "Criticality Safety Evaluation (CSE) for Integrated Fuel Burnable Absorbers (IFBA) Coaters," Revision 4, dated November 2011
- CSE-16-F, "Floor Storage of Special Nuclear Material," Revision 5, dated October 2011
- CSE-16-I, "Ventilation Clean-Out Containers," Revision 1, dated June 2011
- CSE-16-K, "Common Containers," Revision 5, dated July 2011
- CSE-99-G, "Criticality Safety Evaluation for Inadvertent Containers," Revision 1, dated June 2011
- CSE-99-J, "Coated Pellet Moisture Absorption Testing," Revision 0, dated August 2011
- Drawing 600F29AR01, "Plant Wide Emergency Evacuation Routes," Revision C1, dated July 28, 2011
- Issue Report No. 12-024-C012, "Document Compliance with 10 CFR 70.61 for Natural Phenomena Hazards)," dated January 24, 2012
- NCS-017, "Guidance for the NCSIP 2," Revision 2, dated November 22, 2010
- RA-313, "Criticality Safety Evaluations (CSEs)," Revision 12, dated December 19, 2011

- RA-314, “Implementation of Criticality Safety Evaluations,” Revision 15, dated January 17, 2012
- Work Order 551800, dated June 2, 2011
- Work Order 572873, dated January 9, 2012
- Work Order 572900 dated January 9, 2012

b. Observations and Findings

The inspectors observed that NCS evaluations were prepared by qualified NCS engineers and that independent reviews of the evaluations were completed by other qualified NCS engineers, and limits on controlled parameters were established and maintained. The inspectors verified that NCS controls for equipment and processes were implemented and adequate to prevent an inadvertent criticality.

The inspectors observed that several CSEs had been revised to change how incredible scenarios are handled as part of the second Nuclear Criticality Safety Improvement Project (NCSIP 2). The inspectors reviewed CSE-99-G for inadvertent containers, in particular, the scenario of solution from uranium-bearing process equipment collecting into unfavorable geometry containers. The licensee had categorized this event as being incredible based on involving “a sequence of many unlikely upsets, including human actions or errors for which there is no reason or motive” (second criterion in NCS-017). The inspectors determined that, while the scenario discussion identified which of the three criteria applied, it did not clearly identify the “many unlikely upsets” required. Based on review of the scenario and discussion with NCS staff, the event sequence appears to include the following—(1) having a sufficiently large leak to challenge the single parameter limits (SPLs) on volume, cylinder diameter, or slab height; (2) leaving prohibited containers in solution areas; and (3) migration of leaked solution into such containers. The inspectors questioned the incredibility of this event because leaks in solution areas are known to occur, and the prohibition on using unfavorable geometry containers is a simple administrative control. The scenario appears to require only three events, none of which seemed particularly unlikely.

To support review of this CSE, the inspectors walked down the chemical area to observe the control of inadvertent containers. The majority of the plant appeared to comply with the controls in CSE-99-G. However, the inspectors observed five inadvertent containers in the FA-3 portion of the IFBA area:

- One open plastic bag containing unidentified material leaning against a rack that contained trays of unidentified material
- Two open plastic bags taped to a workbench and hanging vertically
- Two open cardboard boxes on the bottom shelf of the workbench containing flat plastic bags

The containers were observed in an area containing the IFBA filter press and associated process piping. The inspectors also observed an apparent water leak between the filter press and the first plastic bag. The licensee determined that the containers all exceeded the applicable SPL, the plastic bags having volumes of approximately 4 gallons and the shorter cardboard box being approximately 5 inches deep. The licensee determined that the first bag contained paint chips and floor sweepings that had been in place for

approximately 1 week. However, the contents were expected to have very low levels of uranium, and there was an inadvertent hole from being dragged across the floor. The material in the trays adjacent to the bag was identified as drying filtercake, which has historically had uranium concentrations of ~2000 ppm. The other bags, including those in the cardboard boxes, were used for the collection of empty glass vials and had been there for an unknown length of time.

As a result, the licensee issued a corrective action program (CAP) 12-025-C019 and opened Redbook Issue 50789 for violation of the Structures Systems and Controls (SSC) FLOOR-109 prohibiting the use of unfavorable geometry inadvertent containers. The licensee removed the containers and stated that, given the medium significance of the event, an apparent cause analysis would be performed within 21 days. In addition, NCS would discuss the situation with all shifts in the affected area. The inspectors determined that the presence of inadvertent containers in the IFBA area constitutes a violation of minor significance that is not subject to enforcement action in accordance with Section 2.2.2 of the Enforcement Policy.

The inspectors also examined CSE-14-B regarding the IFBA coaters. While this CSE was revised recently, it has not yet been upgraded to the standard of NCSIP 2. The inspectors determined that the CSE did not identify any credible scenarios leading to criticality. The inspectors questioned this determination because the coaters contain greater than safe mass, are unfavorable geometry equipment, and contain sources of moderator (e.g., water coolant acknowledged capable of leaking). Although the CSE has not been upgraded to clearly specify which of the three criteria for incredibility are being used, it does identify several events that would have to happen before criticality is possible. First, the total inventory in the coater is divided into 12 separate fixtures (cages), each containing approximately 13 kg of pellets. In the calculation CN-CRI-06-9, the licensee determined that it would take a minimum of 65 kg of pellets in a spherical configuration, or 140 kg in a slab configuration, to exceed the licensed k_{eff} limit. Thus, a minimum of five fixtures would have to fail before there is sufficient material for criticality. The licensee stated that there were no identified failure-in-service scenarios. If a failure were to occur while the fixtures were being inserted into or withdrawn from the coater, its failure would be immediately observed by operators. Then the pellets would have to fall by gravity and accumulate in the bottom of the coater into the worst-case configuration (spherical geometry, optimum pitch, optimum moderation, and full reflection). The licensee determined that such an occurrence is not credible because the released pellets would distribute themselves randomly, and would tend to settle on equipment such as the cathodes and cathode shields rather than in the bottom of the coater shell. In addition, moderation would be needed before criticality could occur. While the presence of water is considered credible, due to the presence of water lines supplying coolant to the cathodes, moderation is treated as defense-in-depth, because the SPL on mass was evaluated considering optimal moderation. The inspectors reviewed the discussion of this scenario and determined that it appeared to be appropriate and meets the criteria for being a sequence of many unlikely upsets.

The inspectors reviewed several other CSEs as part of its review of internal events.

c. Conclusions

No safety concerns were identified regarding the licensee's NCS program, other than the minor violation involving the presence of inadvertent containers in the IFBA area.

3.0 NCS Inspections, Audits, and Investigations (IP 88015)

a. Inspection Scope

The inspectors reviewed the licensee's audit procedure and accompanied an NCS engineer on a routine, internal audit. The inspectors reviewed selected aspects of the following documents:

- RA-316, "NCS Facility Walkthrough Assessments [FWA]," Revision 5, dated April 14, 2011
- FWA "ADU Pelleting Powder Operations," dated December 30, 2011
- FWA "Cylinder Wash," dated December 30, 2011
- FWA "Dry and Wet Trash Collection/Assay System," dated December 30, 2011
- FWA "Analytical Services Lab/Met Lab/Chem Dev Lab," dated December 29, 2011
- FWA "ADU Conversion Drying," dated December 30, 2011
- FWA "ADU Bulk Blending," dated December 30, 2011
- FWA "Conversion Decontamination Room," dated December 30, 2011
- FWA "UF_6 Vaporization," dated December 30, 2011
- FWA "Torits," dated December 30, 2011
- FWA "IFBA Miscellaneous Operations," dated December 22, 2011
- FWA "Erbia Powder Processing," dated December 22, 2011
- FWA "Final Assembly," dated December 15, 2011
- FWA "Waterglass/Warm Caustic/Aqueous Waste," dated December 15, 2011
- FWA "Safe Geometry Dissolvers/Flouride Stripping," dated December 14, 2011
- FWA "Conversion Scrap Cage," dated December 14, 2011
- FWA "Erbia Pelleting," dated December 22, 2011
- Issue Report No. 12-025-C006, "SSC BAEGRIND-129 is out of tolerance," dated January 25, 2012
- Issue Report No. 12-025-C007, "RA-316 Definition Clarification," dated January 25, 2012

b. Observations and Findings

The inspectors spoke with the licensee's NCS staff and determined that the licensee's NCS inspections, called "Facility Walkthrough Assessments (FWA)," were conducted in accordance with written procedures. The inspectors accompanied an NCS engineer on an FWA in the rod storage area. The inspectors noted that FWAs were performed by NCS engineers who reviewed the NCS analysis for the inspected area; reviewed open NCS issues from previous audits; reviewed the adequacy of control implementation; reviewed plant operations for compliance with license requirements, procedures, and postings; examined equipment and operations to determine that past evaluations remained adequate; and interviewed operators to verify understanding of controls.

The inspectors observed that during the FWA for Erbia Pelleting, the licensee's personnel identified that SSC BAEGRIND-129 was 7/8 of an inch higher than the requirement in the CSE. The licensee's personnel reported the discrepancy to management and verified that the current CSE bounded the as-found condition. The licensee planned to update the CSE as part of NCSIP 2. The inspectors discussed with the licensee that Procedure RA-316 has a procedural step to enter all of the findings from the FWA into the CAP. The licensee stated that this was not a finding but an observation. Procedure RA-316 did not identify that a finding could be classified as an observation similar to other audit procedures that are used at the facility. The licensee entered the item into their CAP (No. 12-025-C006) and generated another corrective action item to update their procedure to be more consistent with their other auditing procedures (No. 12-025-C007).

c. Conclusions

No safety concerns were identified regarding the licensee's NCS audits.

4.0 NCS Training (IP 88015)

a. Inspection Scope

The inspectors reviewed training and qualifications procedures to determine if the NCS staff met specified qualification requirements. The inspectors interviewed staff and reviewed qualification records to verify completion of training. The inspectors reviewed selected aspects of the following documents:

- CA-220, "Nuclear Safety Qualification Training," Revision 2, dated November 3, 2011
- Printouts of training records from Electronic Training and Procedure System
- RA-125, "Indoctrination, Training, and Qualification of EH&S Personnel," Revision 15, dated November 17, 2011

b. Observations and Findings

The inspectors reviewed two administrative procedures controlling the qualification of NCS engineers. The inspectors also reviewed the latest revision of the licensee's NCS staff's training qualifications documents (RAF-125-5) to ensure that criticality safety activities are performed by qualified staff and in accordance with license requirements. Additionally, inspectors reviewed the procedure for worker (operators, maintenance personnel, etc.) nuclear safety training—and training records to ensure that personnel handling special nuclear material (SNM) were properly qualified according to written procedures.

c. Conclusions

No safety concerns were identified regarding NCS training.

5.0 Nuclear Criticality Safety Event Review and Follow-up (IP 88015, 88016, 88017)

a. Inspection Scope

The inspectors reviewed the licensee's response to internally-reported events. The inspectors reviewed the progress of investigations and interviewed the licensee's staff regarding immediate and long-term corrective actions. The inspectors reviewed selected aspects of the following documents:

- CSE-03-J, "Criticality Safety Evaluation for Fitzmill and Product Hoods," Revision 1, dated August 2011
- CSE-14-C, "Criticality Safety Evaluation for Miscellaneous Operations in the IFBA Area," Revision 4, dated August 2010
- Redbook Issue Report 41689, dated September 28, 2011
- Redbook Issue Report 47190
- Redbook Issue Report 49069

b. Observations and Findings

The inspectors reviewed Redbook Issue 41689 concerning a procedural noncompliance. An administrative control (SSC-IFBA-MISC-107) in procedure COP-874040 (Rev. 8, issued November 8, 2011), Step J, requiring that "SNM material removed from the filter press during cleanout shall be removed from the filter press hood prior to returning the filter press to service" had not been followed. This was identified and reported by an operator at the beginning of the next shift and promptly corrected. In this event, the licensee's staff correctly identified and took corrective actions, in compliance with the CAP.

The inspectors reviewed CAPs Issue 12-010-C-001 (and associated Redbook Issue 49069) concerning the discovery of larger than anticipated accumulations of powder in the Line 4 powder lift enclosure during an enrichment cleanout (ECO). ECOs are performed to prevent cross-contamination when changing product enrichment, which is a frequent occurrence. At the time of discovery, approximately 45 kg of uranium oxide was removed from the powder lift enclosure. Apart from the contents of a single powder lift pan (maximum of 18 kg), according to CSE-08-B, "significant amounts of powder are not allowed to accumulate in the lift enclosure." The inspectors examined the applicable scenario in the CSE to determine whether the controls in place at the time of the event were adequate. As stated in the CSE, the primary contingency consisted of preventing the accumulation of powder in the lift enclosure by means of two-level probes (PELPREP-106 and -107). The level probes are designed to alarm and stop operation of the lift if the powder level exceeds the safe depth of 3.1." The second contingency consisted of the structural integrity of the lift enclosure and associated equipment, as well as controls to prevent operation of the lift when the enclosure doors were open. Because the accumulation was not discovered until performance of the ECO, the inspectors questioned the adequacy of the level probes to limit the mass buildup in the enclosure.

The licensee stated that the primary control was actually a geometry/volume control rather than a mass control, pointing to the parameter table in the CSE. While this table

identified geometry rather than mass as a controlled parameter, the scenario discussion stated that the level probes were intended to prevent accumulation of mass. Discussion with the criticality safety analyst revealed that the intent of the level probes was to detect a mass buildup in the bottom of the lift enclosure, where it could attain an unfavorable geometry and subsequently be moderated. The actual distribution of material within the lift enclosure was not documented, but may have been present on any of the three levels of the enclosure. In addition, a significant amount of powder appears to have settled in the motor housing, above the level of the level probes.

The licensee stated that it would revise the CSE to add the scenario of introducing moderation during performance of an ECO because this activity would necessitate breaching the moderation barrier and disabling the active-engineered interlocks. The licensee also stated that it would evaluate the placement and operation of the level probes because of the possibility that powder could mound unevenly at the bottom of the enclosure. The licensee took prompt corrective action in removing the material from the enclosure and initiating a CSE revision. The inspectors reviewed the event fault tree and determined that because the moderation barriers remained intact, the performance requirements were still met and the event was not reportable. However, because of the lack of clarity over the safety function and adequacy of the level probes, the revision to CSE-08-B will be tracked as **Inspector Follow-up Item (IFI) 70-1151/2012-201-01**.

The inspectors reviewed CAPs Issue 11-341-M042 (and associated Redbook Issue 47190) concerning the discovery of 3-4" of liquid in the ductwork between the S1030 scrubber and 1030A filter housing. The inspectors reviewed CSE-1-L for the scrubber ventilation system and the associated calculation CN-CRI-07-32, which established an SPL for depth of liquid in the scrubber ductwork. The inspectors determined that the SPL of ~7.8" was for uranium solution at an H/^{235}U ratio of 200, whereas the liquid found in the ductwork was water with only ppm quantities of uranium. Therefore, the event did not challenge the SPL and the performance requirements were still met.

The inspectors determined that no reportable events occurred since the last inspection, that the licensee had properly entered internal events into its CAP, and that it had taken prompt and effective corrective action.

c. Conclusions

No safety concerns were identified during a review of recent licensee investigation of internal events, with the exception of an IFI regarding accumulation of powder in the powder lift enclosure.

6.0 Plant Operations (IP 88015, IP 88016)

a. Inspection Scope

The inspectors walked down portions of the facility to determine whether risk-significant fissile material operations were being conducted safely and in accordance with regulatory requirements including those addressed by newly issued or revised CSEs mentioned in Section 2.0.

b. Observations and Findings

The inspectors performed walkdowns of operations in ADU conversion, UO_2 powder handling and pelletizing, fuel manufacturing—including Erbia and IFBA fuel manufacturing, uranium recovery, the incinerator, UF_6 cylinder wash, and UF_6 cylinder recertification. The inspectors verified that controls identified in NCS analyses were installed or implemented and were adequate to ensure safety. The cognizant, NCS engineers were knowledgeable and interacted regularly with operators on the process floors. The inspectors verified the adequacy of management measures for assuring the continued availability, reliability, and capability of safety-significant controls relied upon by the licensee for controlling criticality risks.

c. Conclusions

No safety concerns were identified during plant walkdowns.

7.0 Exit Meeting

The inspectors presented the inspection scope and results to members of the licensee's management and staff during an exit meeting on January 26, 2012. The licensee acknowledged and understood the findings as presented.

SUPPLEMENTARY INFORMATION

1.0 List of Items Opened, Closed, and Discussed

Items Opened

IFI 70-1151/2012-201-01	Tracks revision to CSE-08-B to address the scenario of moderator intrusion into the powder lift enclosure during enrichment cleanout and address function of the level probes.

Items Closed

None.

2.0 Inspection Procedures Used

IP 88015	Nuclear Criticality Safety Program
IP 88016	Nuclear Criticality Safety Evaluations and Analyses

3.0 Partial List of Persons Contacted

WEC

D. Precht	Plant Manager
G. Couture	EH&S
D. Graham	EH&S
C. Snyder	NCS
J. Vining	NCS

NRC

T. Marenchin	Criticality Safety Inspector, Headquarters (HQ)
C. Tripp	Criticality Safety Inspector, HQ
T. Sippel	Criticality Safety Inspector, HQ

All attended the exit meeting on January 26, 2012.

4.0 List of Acronyms

ADAMS	Agencywide Documents Access and Management System
ADU	ammonium diurante
CAP	corrective action program
CSE	criticality safety evaluation
CFFF	Columbia Fuel Fabrication Facility
ECO	enrichment cleanout
EH&S	environment, health, and safety
ETAPS	Electronic Training and Procedure System
FWA	Facility Walkthrough Assessments
HQ	Headquarters
IFBA	integral fuel burnable absorber
IFI	Inspector Follow-up Item
IP	inspection procedure
NCS	nuclear criticality safety
NCSIP	nuclear criticality safety improvement project
SNM	special nuclear material
SPL	single parameter limit
SSC	safety-significant control
UF_6	uranium hexafluoride
UO_2	uranium dioxide
URI	unresolved item
URRS	uranium recycle and recovery
WEC	Westinghouse Electric Company (licensee)