



**UNITED STATES  
NUCLEAR REGULATORY COMMISSION**  
REGION II  
245 PEACHTREE CENTER AVENUE NE, SUITE 1200  
ATLANTA, GEORGIA 30303-1257

November 16, 2016

EA-16-173  
EN 52090

Mr. Mike Annacone  
Vice President, Columbia Fuel Operations  
Westinghouse Electric Company  
5801 Bluff Road  
Hopkins, SC 29061

**SUBJECT: NUCLEAR REGULATORY COMMISSION CONFIRMATORY ACTION LETTER  
INSPECTION REPORT NO. 70-1151/2016-008**

Dear Mr. Annacone:

On October 19, 2016, the U.S. Nuclear Regulatory Commission (NRC) completed inspections of those commitments required for restart of specified equipment, made by Westinghouse Electric Company, Columbia Fuel Fabrication Facility (CFFF) in a letter from David J. Precht dated August 9, 2016 (ML16223A003). This letter was written in response to the uranium buildup reported to the NRC in July 2016 (EN 52090). The inspections were conducted to ensure that the causes of the uranium buildup had been adequately identified and evaluated, and that appropriate corrective actions had been implemented prior to restart of conversion area equipment and the S-1030 scrubber. The enclosed report (Enclosure 1) documents the inspection results which were discussed with you and other members of your staff during an exit meeting on October 19, 2016.

On July 14, 2016, Westinghouse reported to the NRC that it had exceeded the uranium mass limit for the S-1030 scrubber transition section determined in the criticality safety evaluation. The uranium was discovered in the scrubber transition section during a required annual cleanout in May 2016. On July 31, 2016, Westinghouse updated their report to the NRC indicating that the S-1030 scrubber packing section had also exceeded the uranium mass limit. On July 28, 2016, the NRC chartered an augmented inspection team (AIT) to review the facts and circumstances surrounding the uranium buildup. The AIT completed its inspection on September 2, 2016, and the results are documented in inspection report 70-1151/2016-007 (ML 16211A001).

On August 11, 2016, the NRC issued a Confirmatory Action Letter (CAL) (ML16224B082) to confirm commitments by Westinghouse to take certain actions prior to restart of the S-1030 scrubber system and conversion process equipment at the CFFF. In addition, the CAL identified other long term corrective actions not necessary for a safe restart. The actions documented in the CAL were intended to ensure that the root causes of the event which occurred in May 2016 were adequately evaluated, and that appropriate corrective actions were implemented before resumption of operations.

The objective of the CAL restart inspections was to verify that those CAL commitments required prior to restart of the S-1030 scrubber system and conversion process equipment were completed, and ensure the actions taken by Westinghouse provided reasonable assurance of Westinghouse's ability to safely operate the CFFF. From September 7 to October 19, 2016, the NRC conducted inspections of those CAL items designated as actions required prior to restart. Additional NRC inspections will continue until all remaining CAL items are completed. The enclosure to the CAL which contains those commitments is contained in Enclosure 2 of this report.

By letter dated October 19, 2016 (ML16293A175), Westinghouse requested to restart conversion area process equipment and the S-1030 scrubber system. In that letter, Westinghouse stated that CAL items (1) through (4) were completed, that all specified restart activities had been completed, and that any compensatory measures instituted as part of those CAL items were to remain in place until the required permanent corrective actions are completed. Pursuant to the terms of the CAL, Westinghouse was given written consent (ML16294A296) for restart of conversion process equipment and the S-1030 scrubber system.

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice and Procedure," a copy of this letter and its enclosures will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Web site at <http://www.nrc.gov/reading-rm/adams.html> (the Public Electronic Reading Room).

If you have any questions on this matter, please contact Tom Vukovinsky, Projects Branch 2, at 404-997-4622.

Sincerely,

*/RA/*

Eric C. Michel, Chief  
Projects Branch 2  
Division of Fuel Facility Inspection

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

Enclosures:

1. NRC Inspection Report 70-1151/2016-008  
w/Supplemental Information
2. Westinghouse Electric Company Commitments

cc: (See page 3)

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Sincerely,  
**/RA/**  
 Eric C. Michel, Chief  
 Projects Branch 2  
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Docket No. 70-1151  
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1. NRC Inspection Report 70-1151/2016-008  
 w/Supplemental Information
2. Westinghouse CAL restart commitments

cc: (See page 3)

PUBLICLY AVAILABLE    NON-PUBLICLY AVAILABLE    SENSITIVE    NON-SENSITIVE  
 ADAMS:  Yes   ACCESSION NUMBER: ML16323A011    SUNSI REVIEW COMPLETE    FORM 665 ATTACHED

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Letter to Mr. Mike Annacone from Eric C. Michel dated November 16, 2016

SUBJECT: NUCLEAR REGULATORY COMMISSION CONFIRMATORY ACTION LETTER  
INSPECTION REPORT NO. 70-1151/2016-008

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U. S. NUCLEAR REGULATORY COMMISSION  
REGION II  
CONFIRMATORY ACTION LETTER RESTART INSPECTIONS

Docket No.: 70-1151

License No.: SNM-1107

Report No.: 70-1151/2016-008

Licensee: Westinghouse Electric Company

Facility: Columbia Fuel Fabrication Facility

Location: Hopkins, SC 29061

Dates: September 7 through October 19, 2016

Inspectors: B. Adkins – Senior Fuel Facility Inspector  
L. Pitts – Senior Fuel Facility Inspector  
T. Vukovinsky – Senior Fuel Facility Inspector  
K. Kirchbaum – Fuel Facility Inspector  
D. Morgan – Fuel Facility Inspector  
J. Munson – Fuel Facility Inspector

Approved by: Eric C. Michel, Chief  
Projects Branch 2  
Division of Fuel Facility Insection

Enclosure 1

## **EXECUTIVE SUMMARY**

### **Westinghouse Electric Company - Columbia Fuel Fabrication Facility Nuclear Regulatory Commission Inspection Report 70-1151/2016-008 September 7 through October 19, 2016**

The objective of the Confirmatory Action Letter (CAL) restart inspections was to verify the commitments made in the CAL required prior to restarting the S-1030 scrubber system and conversion process equipment were completed, and ensure the actions taken provided reasonable assurance of Westinghouse's ability to safely operate the Columbia Fuel Fabrication Facility (CFFF).

#### **CAL Restart Commitments**

No violations of significance were identified during the CAL restart inspections. The Nuclear Regulatory Commission (NRC) concluded that the corrective actions implemented to date by Westinghouse are reasonable and have sufficient likelihood of being effective to support a determination that the conversion process equipment and S-1030 scrubber can be operated safely in accordance with the facility license. (Paragraph A)

#### **Attachment:**

Key Points of Contact  
List of Items Opened, Closed, and Discussed  
Inspection Procedures Used  
Documents Reviewed

## **REPORT DETAILS**

The Westinghouse facility is located near Columbia, South Carolina, and is situated on a 1,151 (approximate) acre site in Richland County, approximately eight miles southeast of the Columbia city limits, along State Highway 48 (Bluff Road). The facility fabricates fuel assemblies for pressurized water reactors and boiling water reactors using low enriched uranium (LEU). The facility uses a wet-chemical ammonium diuranate (ADU) process to convert uranium hexafluoride ( $UF_6$ ) gas into uranium dioxide ( $UO_2$ ) powder. The process consists of hydrolyzing vaporized  $UF_6$  gas (which separates most of the fluorides from the uranium), and then precipitating the solution with ammonia followed by separation of liquid and solid phases. The solid phase (ADU) is then calcined and reduced to remove the ammonia and produce  $UO_2$  powder. The powder is then pressed into pellets and sintered. These processes are followed by fuel rod loading and sealing, and fuel assembly fabrication. Westinghouse also performs recovery/disposal operations of scrap fuel produced during the fabrication process. Recovery operations can process a variety of fuel forms from this process.

### **Background:**

On May 28 - 29, 2016, Westinghouse conducted a planned annual inspection and cleanout of the main conversion area scrubber (S-1030) and associated ventilation ductwork. The function of this scrubber is to remove gases and particulates from various exhaust streams associated with the uranium conversion process. During the cleanout, personnel noticed an abnormal amount of material buildup in the inlet transition region and associated ductwork (specifically an elbow). Over the course of the two day maintenance evolution approximately 197 kilograms of material were removed from these two sections. These sections are not a favorable geometry from a nuclear criticality safety (NCS) perspective. Since the facility personnel were under the assumption that this material had a low uranium concentration, operators attempted to break up and wash away the material to facilitate its removal. The facility personnel did not sample the material to confirm the uranium concentration before conducting these activities. After the material was removed, grab samples of the material were taken and analyzed for uranium concentration. The grab sample results indicated that the uranium concentrations ranged from 34wt% – 55wt%, which corresponded to approximately 87 kilograms of uranium. As such, the criticality safety evaluation mass limit of 29 kilograms was exceeded by a factor of 3.

After the cleanout activities were completed, the scrubber was restarted. The scrubber was in operation for a period of six weeks when the facility shutdown the scrubber to perform another cleanout of the inlet transition region and elbow. Facility personnel removed 24 kilograms of material which corresponded to approximately 5 kilograms of uranium. The scrubber was restarted again following the cleanout. Approximately one week later, while discussing the extent of condition, the licensee decided to shut down the scrubber again, and thoroughly inspect the entire scrubber to ensure that it was free of uranium accumulation. An additional 184 kilograms of material was removed from the scrubber body, and about 71 kilograms of material was removed from the packing material.

In this incident, the mass limit was exceeded by a factor of 3; moderation was available from the scrubber spray nozzles and the clean out process; and the scrubber packing, elbow, and transition region sections are all unfavorable geometries. As a result, the



safety margin available to preclude an inadvertent criticality was significantly degraded. The scrubber was shut down and the licensee commenced extent of condition and root cause evaluations. There were no actual health consequences to the public, workers, or the environment.

In response to this event, the NRC sent an augmented inspection team (AIT) to inspect and assess the facts and circumstances surrounding the uranium accumulation. The results of that inspection were documented in inspection report 70-1151/2016-007, and included four unresolved items: (1) failure to ensure criticality accident sequences remain highly unlikely, (2) failure to assure that under credible normal and abnormal conditions, all nuclear processes were subcritical including use of an approved margin of subcriticality, (3) failure to establish adequate management measures to ensure that IROFS to perform their function when needed, and (4) failure to make a 1 hour report.

### **Inspection Scope:**

The objective of the Confirmatory Action Letter (CAL) restart inspections was to verify the commitments made in the CAL required prior to restarting the S-1030 scrubber system and conversion process equipment were completed, and ensure the actions taken provided reasonable assurance of Westinghouse's ability to safely operate the Columbia Fuel Fabrication Facility (CFFF). The inspection included a review of operating procedures, criticality safety evaluations (CSEs), integrated safety analyses (ISAs), configuration management and maintenance documents, modifications to the S-1030 scrubber system, training, and operational decision making. Areas examined during the inspection are identified in each charter item listed below. For each CAL restart commitment, the inspection consisted of a selective examination of procedures and records, interviews with personnel, and observation of activities to determine if they were in accordance with Nuclear Regulatory Commission (NRC) requirements and met the requirements for restart as identified in the CAL.

### **A. Confirmatory Action Letter Restart Requirements (Inspection Procedure 92703)**

1. CAL Item 1: Complete a Root Cause Analysis (RCA) investigation for this event. In accordance with the RCA Charter, the RCA will include an assessment of the nuclear safety culture (NSC) contributors to the event and identify necessary corrective actions to address gaps noted in the NSC at Columbia.

- a. Inspection Scope and Observations

The inspectors reviewed the RCA for adequacy of scope, depth, identification of contributing causes, and proposed corrective actions. In addition to configuration management issues, the RCA identified that there was a long-standing weakness in the safety culture at Westinghouse. The inspectors performed their own "mini-MORT" and arrived at similar conclusions regarding safety culture concerns as CFFF's RCA. Corrective actions were identified by the RCA, including the need to develop a CFFF leadership assessment and coaching program. The inspectors noted that an employee-wide NCS survey had been performed and the survey results would provide input for site management to assess the safety culture at the site.

b. Conclusion

No violations of significance were identified. The inspection team determined that the requirements of this CAL item were met.

2. CAL Item 2: If the RCA investigation identifies additional actions necessary to assure safe operations, then Westinghouse will revise its restart plan to include those actions. Additional immediate or compensatory actions will be identified and put in place for any corrective action to prevent recurrence that is not completed prior to restart.

a. Inspection Scope and Observations

The S-1030 Scrubber Event Recovery Plan (Recovery Plan) detailed the required restart actions as a result of the RCA and as required by the CAL. The RCA identified six corrective actions to prevent reoccurrences (CAPRs). Of these six CAPRs, three required interim compensatory measures to meet the restart requirements outlined in the CAL. The inspectors reviewed the interim corrective actions and noted that they met the requirements of the CAPRs as they pertain to the S-1030 scrubber system. Longer-term corrective actions to complete the remaining CAPRs are being tracked in Westinghouse's corrective action program (CAP) and will be reviewed for completeness in subsequent NRC inspections.

Corrective actions to prevent recurrence for this event included:

- Revision of the configuration control procedure to require up-front planning between project, area, and criticality safety engineering.
- Revisions of the electronic training system to implement a formal review for process changes with impact to safety aspects.
- Revision of the configuration control procedure to require an independent technical review if a system or component that is described in a CSE is modified.
- Conduct of a performance based assessment to identify needed improvements in design calculations and design packages.
- Revision of the S-1030 scrubber inspection and cleanout procedure to clearly specify the recording of data needed to confirm the effectiveness of IROFS in maintaining uranium mass below the limits and to provide clear guidance for timely review and evaluating the data.
- Development or revision of applicable procedures to identify personnel who need training on the safety basis for CSEs.

b. Conclusion

No violations of significance were identified. The inspection team determined that the requirements of this CAL item were met.

3. CAL Item 3.a: The design, operating and maintenance history of the S-1030 scrubber system, including changes to influents to the scrubber system, will be reviewed to understand the impacts on the mass build up noted in this event. Based upon this review, the safety basis for the scrubber system will be revised.

a. Inspection Scope and Observations

The inspectors reviewed the operating and maintenance history of the S-1030 scrubber to verify that the licensee understood the impacts and potential causes of the mass accumulation. The inspectors reviewed the revised NCS safety basis as well as physical modifications to limit future uranium (U) accumulations within the S-1030 scrubber.

The inspectors reviewed the revised NCS safety basis for the S-1030 scrubber to verify that the licensee identified all normal and credible abnormal conditions, applied sufficient controls to limit the likelihood of criticality to “highly unlikely” and ensure subcriticality with an approved margin under these conditions, and applied sufficient factors of safety to ensure that at least two unlikely, independent, and concurrent changes in process conditions are required before criticality is possible. Additionally, the inspectors verified that no un-validated assumptions were present in the revised NCS safety basis.

The inspectors inspected the physical modifications made to the S-1030 scrubber, and evaluated the adequacy of the controls identified in the revised NCS safety basis, including both administrative and engineered controls, credited to limit the likelihood of inadvertent criticality. The administrative controls evaluated included:

- weekly visual inspection of the inlet transition under NCS oversight (VENT-S1030-126)
- six week clean-out and mass quantification of the packing section under NCS oversight (VENT-S1030-127, 128, and 129)
- visual inspection of the spray nozzle pressure (VENT-S1030-105)
- control on the feed rate for the liquid blowdown system (VENT-S1030-147)
- periodic visual inspection and gamma survey of ductwork greater than 10 inches in diameter (VENT-S1030-111 and VENT-901)
- weekly inspection of the differential pressure across the packing section (VENT-S1030-136)
- use of a filter in the Blue-M oven plenums capable of capturing at least 95% of any entrained U mass particulate (VENT-S-1030-130)
- feed and bleed system (VENT-S1030-141)

The engineered controls evaluated included the sizing and placement of the drains to ensure that a safe solution slab height is not exceeded (VENT-S1030-131 and 132).

The inspectors reviewed the applied management measures to verify that they were adequate to maintain the availability and reliability of both administrative and engineered items relied on for safety (IROFS). The inspectors reviewed new and revised procedures and training to implement the administrative IROFS discussed above to verify that the IROFS could be effectively implemented as designed. The inspectors reviewed surveillance procedures and other applied management measures to ensure the availability and reliability of the associated engineered IROFS.

The inspectors observed the licensee's newly developed training regarding new and revised controls applied to the S-1030 scrubber. This training included operator-specific training, as well as training for management.

In addition to reviewing the revised NCS safety basis for the S-1030 scrubber, the inspectors reviewed new and revised NCS safety bases for various systems site-wide to verify that review and approval of corrective actions were performed by independent NCS experts, and that the licensee maintained external NCS oversight.

b. Conclusion

No violations of significance were identified. The inspection team determined that the requirements of this CAL item were met.

4. CAL item 3.a.i: Review and revise procedures that implement administrative IROFS to ensure administrative limits are properly defined and to ensure inspection methods that validate compliance to the administrative IROFS can be effectively implemented to meet its safety function.

a. Inspection Scope and Observations

The inspectors reviewed new and revised procedures and training to implement the administrative IROFS, described in CAL item 3.a above, to verify that the IROFS could be effectively implemented as designed. The inspectors reviewed surveillance procedures and other applied management measures to ensure the availability and reliability of engineered IROFS.

b. Conclusion

No violations of significance were identified. The inspection team determined that the requirements of this CAL item were met.

5. CAL item 3.a.ii: Review the adequacy of the management measures applied that support the availability and reliability of the administrative IROFS and correct any identified deficiencies.

a. Inspection Scope and Observations

The licensee conducted a focused self-assessment to evaluate whether the management measures and implementation controls were available and reliable as prescribed in the license application. The focus was on management measures supporting administrative IROFS, which included a review of procedure use and adherence related to the implementation of the safety basis. The inspectors reviewed the self-assessment and noted that it was led by an off-site independent team leader, and that the identified findings, deficiencies, and recommendations were being tracked in the licensee's CAP for resolution. The inspectors noted that the licensee had expanded this CAL item beyond the ventilation system to include management measures applied to support the availability and reliability of IROFS throughout the facility.

b. Conclusion

No violations of significance were identified. The inspection team determined that the requirements of this CAL item were met.

6. CAL item 3.a.iii: Review and approval of the above actions and the identified corrective actions will be performed by independent criticality safety experts.

a. Inspection Scope and Observations

The inspectors noted that an independent criticality safety team reviewed all the revised CSEs and provided recommendations for improvement, which the licensee incorporated into the revised CSEs. The independent criticality safety team approved changes to the CSEs and management measures applied to ensure compliance with the safety basis.

b. Conclusion

No violations of significance were identified. The inspection team determined that the requirements of this CAL item were met.

7. CAL item 3.a.iv: Complete the installation of physical modifications needed to support the revised safety basis.

a. Inspection Scope and Observations

The inspectors reviewed the physical modifications needed to support the revised safety basis. The scope of the modifications included:

- installation of a passive overflow
- existing drain line modifications
- installation of scrubber basket system
- installation of a scrubber liquid level alarm system
- scrubber blowdown line flow transmitter installation
- connection of sifter enclosures to Torit system
- new Blue M hood filters
- new scrubber inlet transition
- new inlet transition spray header
- scrubber spray pH display and trending
- scrubber spray makeup water level modifications

Specifically, the inspectors reviewed the Change Control Forms (CCFs) associated with the physical modifications to verify that the scope of the modifications was consistent with the requirements of the CSEs and ISA. The inspectors reviewed the CCFs to determine if they met the requirements of the licensee's change control procedure. Specifically, the inspectors determined whether CCFs received proper review and approval by the Environmental, Safety, and Health (ES&H) organization, contained an adequate technical basis for the change, and contained pertinent design information and work instructions to implement the change. The inspectors

reviewed the associated Title 10 of the Code of Federal Regulations (10 CFR) 70.72 evaluations to determine if the licensee adequately reviewed the changes to determine if NRC pre-approval was required.

The inspectors conducted walk downs to determine if the physical modifications were installed in accordance with the associated CCFs. The inspectors reviewed the CSEs and ISA Summary to determine if the licensee adequately flowed down safety requirements into the detailed design. With respect to the implementation of management measures, the inspectors reviewed post-modification test records to determine if the licensee adequately tested modifications prior to placing them into service. The inspectors reviewed drawings and procedures to determine if they were updated in accordance with their configuration management program. The inspectors observed training and reviewed training records to verify that training for physical modifications designated as IROFS was completed prior to restart.

b. Conclusion

No violations of significance were identified. The inspection team determined that the requirements of this CAL item were met.

8. CAL item 3.a.v: Conduct training on the changes with personnel impacted or involved in the revised IROFS and management measures for this system.

a. Inspection Scope and Observations

The inspectors observed portions of the training, and confirmed that its focus was on the changes to the CSEs, the revised IROFS, and management measures.

b. Conclusion

No violations of significance were identified. The inspection team determined that the requirements of this CAL item were met.

9. CAL item 3.a.vi: Develop a post-startup monitoring plan to validate the effectiveness of the above actions.

a. Inspection Scope and Observations

The post-startup monitoring plan was reviewed and the inspectors noted that the plan includes the requirements associated with the ISA and implements the safety basis in the CSE. The inspectors noted that the plan included pre-operational checks and detailed the testing requirements and inspections as listed in the CSE and the ISA.

b. Conclusion

No violations of significance were identified. The inspection team determined that the requirements of this CAL item were met.

10. CAL item 3.b: Review CSE accident sequences for wet scrubber ventilation systems with non-favorable geometry (NFG) components to ensure double contingency protection and proper IROFS implementation. For each, perform inspections to validate system design and operating parameters as well as items (i) through (iii) described above and for items (iv) through (vi) as needed.

a. Inspection Scope and Observations

The inspectors reviewed the NCS safety bases for other NFG wet scrubbers at the CFFF, which included: 1) the Ammonia Fume Ventilation System (CSE-1-D), 2) the Acid Scrubber S-2A/2B (CSE-1-G), 3) the IFBA Scrubber (CSE-1-AE), 4) and the S-958 Solvent Extraction Scrubber (CSE-1-H). Specifically, the inspectors verified that the licensee identified all normal and credible abnormal conditions; applied sufficient controls to limit the likelihood of criticality to “highly unlikely” and ensure subcriticality with an approved margin under these conditions; and applied sufficient factors of safety to ensure that at least two unlikely, independent, and concurrent changes in process conditions are required before criticality is possible. Additionally, the inspectors verified that the licensee performed inspections to validate system design and operating parameters as well as the adequacy of the management measures applied to any administrative IROFS for these systems. The inspectors verified that an independent NCS expert provided a review.

b. Conclusion

No violations of significance were identified. The inspection team determined that the requirements of this CAL item were met.

11. CAL item 3.c.i and 3.c.ii: For ventilation systems with NFG components that are permanently removed from service:

- i. Verify the adequacy of isolation to ensure the potential does not exist for special nuclear material (SNM) mass accumulation or the potential for moderator addition. Any identified deficiencies will be corrected.
- ii. The following systems will be inspected and cleaned as necessary to ensure no mass build up exists in them: S-1056 Scrubber, Ventilation systems 3A, 3B and 7A filter housings.

a. Inspection Scope and Observations

The inspectors reviewed documentation, conducted walk downs, and interviewed personnel associated with ventilation systems with NFG components to determine if the licensee had completed actions necessary to verify the adequacy of isolations to prevent SNM mass accumulation or moderator addition. The samples selected by the inspectors included the S-1056 Scrubber and 3A/3B filter housings and associated ductwork. Specifically, the inspectors reviewed special procedures used for inspection and cleanout of SNM to verify that the licensee implemented adequate safety controls IROFS used for the prevention of nuclear criticality. The inspectors conducted walk downs to determine if the equipment and ductwork was adequately sealed to prevent moderator intrusion. The inspectors reviewed objective evidence such as photos and sample results to verify that inspections and cleanout were performed as required by the procedure.

The inspectors reviewed documentation and conducted interviews to determine if NCS staff participated in pre-job briefs, hold points, and inspections as specified in the special procedure. The inspectors reviewed the CSE developed for storage of ventilation cleanout containers to determine if the analysis was compliant with license requirements and American Nuclear Society (ANS) standards. The inspectors reviewed completion of inspection records to verify that the licensee implemented safety controls related to the storage of ventilation cleanout containers. The inspectors conducted walk downs of material storage areas to determine if the containers were properly stored in accordance with the CSE and proper postings were in place to communicate criticality controls such as specified spacing, array size, and a requirement to prevent container stacking.

b. Conclusion

No violations of significance were identified. The inspection team determined that the requirements of this CAL item were met.

12. CAL item 3.d: For CSEs with NFG components that have mass limits, ensure IROFS have been flowed down to ISA, sketches and implementing documents. Identified deficiencies will be entered into the CAP and corrected as necessary to meet the safety basis prior to returning the system to operation. Perform a sample of the remaining CSEs.

a. Inspection Scope and Observations

The inspectors reviewed the NCS safety bases, applicable sections of the ISA, sketches, and other implementing documents for NFG wet scrubbers with mass limits to verify proper flow-down. The inspectors verified that any identified deficiencies were entered into the licensee's CAP.

b. Conclusion

No violations of significance were identified. The inspection team determined that the requirements of this CAL item were met.

13. CAL item 3.e: For administrative IROFS satisfied by inspection, review and revise procedures that implement the inspections to ensure administrative limits are properly defined and to ensure inspection methods can be effectively implemented to meet its safety function. Identified deficiencies will be entered in the CAP and corrected.

a. Inspection Scope and Observations

The inspectors reviewed the procedures associated with administrative controls satisfied by inspection to verify that limits were properly defined and that inspection methods could be effectively implemented to meet their intended safety function. The inspectors verified that any identified deficiencies were entered into the licensee's CAP.



b. Conclusion

No violations of significance were identified. The inspection team determined that the requirements of this CAL item were met.

14. CAL item 3.f: Perform a historical review (previous 10 years) of the corrective action program and Red book/Green book entries to identify any recurring or longstanding issues that identify potential challenges to the safety basis of any CSE. Identified issues will be entered into the corrective action program and will either be corrected prior to restart or adequate compensatory measures put in place.

a. Inspection Scope and Observations

The inspectors reviewed the licensee's historical review of the CAP and Red book/Green book entries to identify any recurring or longstanding issues that identify potential challenges to any NCS safety basis. The inspectors verified that any identified issues were entered into the licensee's CAP.

b. Conclusion

No violations of significance were identified. The inspection team determined that the requirements of this CAL item were met.

15. CAL item 3.g: Implement procedure changes to provide an internal escalation protocol to plant management for IROFS violations, including guidance for situations involving uncertainty in compliance to limits.

a. Inspection Scope and Observations

The inspectors reviewed RA-121, "Redbook Internal Reporting System," and verified it was revised to provide an internal escalation protocol in the event of a failed or degraded system, structure or component (SSC). The revised procedure requires plant personnel to immediately contact their supervision (positive contact must be made) upon identification of a failed or degraded SSC.

b. Conclusion

No violations of significance were identified. The inspection team determined that the requirements of this CAL item were met.

16. CAL item 3.h: Revise the "Columbia Plant Safety Event Response Guidelines" to strengthen critical decision making based upon event significance by requiring independence of membership on the Safety Event Management Review Team.

a. Inspection Scope and Observations

The inspectors reviewed RA-134, "Columbia Plant Safety Event Response Guidelines," and noted it was revised to require independent membership on the Safety Event Management Review Team, which would have required an additional layer of review prior to S-1030 restart.

b. Conclusion

No violations of significance were identified. The inspection team determined that the requirements of this CAL item were met.

17. CAL item 3.i: Retain an external nuclear criticality safety expert who will remain on site at Columbia to assist in the oversight of nuclear criticality safety (NCS) functions until corrective actions from the RCA related to this function are complete and an effectiveness review is performed to ensure sustainability of corrective actions. Additionally, Columbia has initiated a search for a permanent new manager for the NCS organization.

a. Inspection Scope and Observations

The inspectors verified that an external NCS expert was retained by Westinghouse to provide oversight of NCS functions. In addition, CFFF has initiated actions to retain a new permanent NCS Manager.

b. Conclusion

No violations of significance were identified. The inspection team determined that the requirements of this CAL item were met.

18. CAL item 3.j: Develop and present training on the lessons learned from this event, including the results of the NSC evaluation, to leadership (front line supervisors and above) and to workers impacted or involved in the control of IROFS and management measures. In addition to this training, senior management of the Columbia Fuels Operations will conduct briefings with each work group to reinforce desired standards, behaviors and expectations regarding their role in nuclear safety.

a. Inspection Scope and Observations

Through observation and documentation review, the inspectors verified the S-1030 scrubber lessons learned training was provided to leadership (front line supervisors and above) and to workers impacted or involved in the control of IROFS and management measures. The inspectors noted that the employees were encouraged to ask questions and provide input to enhance or change behaviors at the site. Senior management reinforced the desired standards, behaviors, and expectations regarding the employees' role in nuclear safety during working group briefings. In addition, the inspectors observed Nuclear Safety Culture Training as it was administered to a mixed grouping of employees including managers, supervisors, engineers, and production workers. The training included discussions of the most recent event and previous events at fuel facilities. The training linked these events to the "Traits of a Healthy Nuclear Safety Culture," using INPO 12-012 as guidance.

b. Conclusion

No violations of significance were identified. The inspection team determined that the requirements of this CAL item were met.

19. CAL item 4: For the NCS organization, conduct a work environment assessment and develop needed corrective actions. Additionally, the Interim Vice President, Columbia Fuels Operations will reinforce desired standards, behaviors, expectations and the lessons learned from this event with all personnel in the NCS organization.

a. Inspection Scope and Observations

The inspectors interviewed the Interim Vice President, CFFF, to discuss and evaluate the reinforcement of standards, behaviors, expectations, and lessons learned from the event that was conducted with all personnel within the NCS organization. Additionally, the inspectors reviewed the work environment assessment conducted for the NCS organization.

b. Conclusion

No violations of significance were identified. The inspection team determined that the requirements of this CAL item were met.

**B. Restart Conclusion**

No violations of significance were identified during the CAL restart inspections. The NRC concluded that the corrective actions implemented to date by Westinghouse are reasonable and have sufficient likelihood of being effective to support a determination that the conversion process equipment and S-1030 scrubber can be operated safely in accordance with the facility license.

**C. EXIT MEETING**

During the course of the inspection, the team provided members of the plant staff and management summaries of inspection findings on a daily basis. During these discussions, licensee representatives identified some of the material examined during the inspection as proprietary. All proprietary information was returned to the licensee. The team presented the inspection results to B. Phillips and other members of the plant staff and management at a meeting conducted on October 19, 2016, in Columbia, SC.

## **SUPPLEMENTAL INFORMATION**

### **Key Points of Contact**

B. Phillips	Interim Vice-President
B. Waskey	Analytical Services and Chemical Quality Control Manager
C. Gantt	Senior Engineer, Pellet Operations
C. Miller	Senior NCS Engineer
F. Jackson	Director of Manufacturing, Standardization and Major Products
G. Byrd	Licensing Engineer
G. McGehee	Senior NCS Engineer
H. Whitaker	Principal Quality Engineer, Product Assurance Chemical Operations
J. Coleman	Measurement Control Coordinator
J. Howell	Environment, Health and Safety (EH&S) Manager
J. Huggett	Senior Manufacturing Engineer
J. Jones	Technical Training Manager
J. Nimmo	Conversion Team Manager
J. Vining	Senior NCS Engineer
K. Barber	Project Engineer
M. Annacone	Vice President, Columbia Recovery
M. Burns	Reliability Engineer
M. Krissing	Senior Chemist
M. Trayers	Reliability Engineering Manager
N. Parr	Licensing Manager
R. Likes	Safeguards Coordinator
R. Rodriguez	Process Engineer
R. Stutts	Principal Engineer
S. Weathers	Conversion Engineer
T. Graves	Conversion Engineer
T. Gregg	URRS Area Manager

Other licensee employees contacted included engineers, technicians, production staff, and office personnel.

### **Items Opened or Closed**

None

### **Inspection Procedures Used**

IP 88003	Reactive Inspection for Events at Fuel Cycle Facilities
IP 88015	Nuclear Criticality Safety
IP 88020	Operational Safety
IP 88070	Plant Modifications
IP 92703	Follow-up of Confirmatory Action Letters or Orders
IP 93800	Augmented Inspection Team

## **Key Documents Reviewed**

### Procedures:

85002-1, Revision (Rev.) 40, Chemical Operating Procedure Sketch Erbia Area  
 COCL-T18, Rev. 0, S-974 Cleaning and Inspection  
 COP-80107, Cleanout of Roof Ventilation Boroscope Viewports, Rev. 0  
 COP-811001, Rev. 56, Fitzmill  
 COP-814201, Rev. 37, Resampling of Line Product Materials  
 COP-815010, Conversion BLU-M Oxidation, Rev. 24  
 COP-815020, Scrap Recovery Scrubber S-1030, Rev. 13  
 COP-815021, S-1030 Inspection and Clean Out, Rev. 10  
 COP-815412, Changing Wet Filters in the Conversion/Scrap Area (CSA), Rev. 23  
 COP-816025, Revision 3, Analytical Services Laboratory Scrubber S-974  
 COP-850453, Revision 8, Blue-M Oxidation System (Clean Scrap)  
 COP-850463, Revision 7, Blue-M Oxidation Systems (Dirty Scrap)  
 CSE-19-A, Revision 3, Oxidation Ovens and Hoods  
 FA-114, Independent Technical Reviews, Rev. 5  
 ISA-5, ISA Summary, ADU Bulk Blending System, Rev. 11  
 ISA-16, ISA Summary, Storage of Uranium Bearing Materials, Rev. 10  
 ISA-18, ISA Summary, Laboratory System, Rev. 10  
 ISA-19, ISA Summary, Hoods and Containment System  
 MCP-108218, Inspection of Roof Ventilation Ducts with Boroscope, Rev. 7  
 MCP-203526, Verification of Interlock VENT-S1030-124: S-1030 Scrubber High Level,  
 QCF-1177, Rev. 1 Chemical Lab Standards Cabinet U235 Inventory  
 QCI-119907, Rev. 10, Analytical Services Laboratory Storage of U-235  
 QCI-310905, Rev. 14, Inspection of Items Relied On For Safety (IROFS) – Common Containers  
 RA-104, Regulatory Review of Configuration Change Authorizations, Rev. 28  
 RA-108-8, Revision 51, Storage of Uranium Bearing Material Safety Significant Controls  
 RA-108-9, Revision 64, Ventilation and Scrubbing Safety Significant Controls  
 RA-120-20, Rev. 7, Regulatory Policy – Safety Significant Controls – Inspection of Procured  
 Items Relied On For Safety, Rev. 0  
 ROP-05-062, Rev. 15, Radiation Survey of Ventilation Equipment  
 SOI-C-0670, Out of Service (O/S) S-1056 Inspection and Cleanout, Rev. 0  
 SOI-C-0670, Out of Service (O/S) S-1056 Inspection and Cleanout, Rev. 0  
 SOI-C-0672, Out of Service (O/S) 3A and 3B System Inspection and Clean Out, Rev. 0  
 SOI-C-0672, Out of Service (O/S) 3A and 3B System Inspection and Clean Out, Rev. 0  
 T20, Revision 1, Annual Special Nuclear Material Inventory  
 TA-500, Columbia Manufacturing Plant Configuration Control, Rev. 30

### Records:

CCF 09516, Scrap Cage Filter Press FP1058 Vent to S1030 for Filter Press Plates  
 CCF 16482, Install new level probes in Scrubber S-1030  
 PSEDoc-0003226, Independent Technical Review 16482-1, Rev. 0  
 PSEDoc-0003241, ADU Common Services Safety Instrumented System (SIS) Safety  
 PSEDoc-0003280, CCF-16509 – Independent Technical Review, Rev. 0  
 PSEDoc-0003348, Calculation – Maintain the Level in the Scrubber S-1030 Below 4” from the  
 Bottom, Rev. 0  
 PSEDoc-0003389, Calculation – Capacity of 8” Drain Line, Rev. 0  
 Requirement Specification (SRS), Rev. 0  
 VR-005 (3A/3B), Verification Review of Out of Service Ventilation Systems with NFG  
 Components Permanently Removed from Service, Rev. 0  
 VR-005 (S-1056), Verification Review of Out of Service Ventilation Systems with NFG  
 Components Permanently Removed from Service, Rev. 0

Condition Report Written as a Result of the Inspection:

100421674, Documented Comments Identified by NRC inspectors during IP 92703 inspection, dated October 14, 2016.

Condition Reports Reviewed:

100416419, SE RC-SYS: Process Ventilation Gamma Scan Program Improvements  
 100418489, RC-DI: Floor Storage of SNM,  
 100418662, SE RC: Process Ventilation Visual Inspection Program Improvements  
 100420832, SE RC-DI: Inspection and Clean-Out of Out of Service 3A/3B Filterhouse

Work Orders:

741759 [S-1030 Scrubber SIS Controllers – Electrical Installation Instructions]  
 742752 [Verification of Proper Operation of the new S-1030 level probes]

Diagrams:

Electrical DWG No. 333A02LS03, Sheet No. 11, Rev. C3, Loop No. LSH-S-1030-1  
 Electrical DWG No. 333A02LS03, Sheet No. 12, Rev. C3, Loop No. LSH-S-1030-2  
 Electrical DWG No. 333A02LS03, Sheet No. 13, Rev. C3, Loop No. LSH-S-1030-3  
 P&ID No. 333F02P103, Scrubber S-1030 & Filter House Systems 1030A & 1030B, Rev. C1  
 Sketch No. 815417-9, Chemical Operating Procedure Sketch Conversion Area, Rev. 63

Nuclear Criticality Safety Evaluations:

CSE-1-AE, "CSE for the IFBA Scrubber," Rev. 4  
 CSE-1-D, "CSE for the Ammonia Fume Ventilation System," Rev. 9  
 CSE-1-E, "CSE for the S-1030 Scrubber System," Revs. 9 and 10  
 CSE-1-G, "CSE for the Acid Scrubber S2-A/2B," Rev. 7  
 CSE-1-H, "CSE for the S-958 Solvent Extraction Scrubber," Rev. 7  
 CSE-1-I, "Critical Safety Analysis for Analytical Services Laboratory Scrubber," Rev. 4  
 CSE-3-I, "CSE for the CFFF ADU Conversion Calciner," Rev. 6  
 CSE-16-1, Criticality Safety Evaluation (CSE) for Ventilation Clean-Out Containers, Rev. 1  
 CSE-16-B, "Critical Safety Evaluation for Storage of Uranium Bearing Materials," Rev. 7  
 CSE-18-B, "Critical Safety Evaluation for the Analytical Services Laboratory," Rev. 15  
 CSE-19-A, "CSE for the Oxidation Ovens and Hoods," Rev. 3

Calc Notes:

CN-CRI-16-006-001  
 CN-CRI-16-007-000  
 CN-SB-11-012-007

Other Documents:

ATKINS-NS-ANH-16-01, September 1, 2016, Independent Criticality Safety Engineer Review of  
 Columbia Fuel Fabrication Facility (CFFF) Chemical Laboratory Scrubber CSE-1-I  
 CAF-206-4, "Management Measures Self Assessment"  
 CAPAL 100413751, Improper Removal from Service for Wet Scrubber Ventilation Systems at  
 CFFF  
 CCF 05334, Blue – M Vent Mod, Rev. 0  
 CCF 07282, S-1030 Clean Out Port, Rev. 0  
 CCF 08059, ADU Line 5 "M" Vent, Rev. 0  
 CCF 09307, Ventilation View Ports on Roof Mounted Systems, Rev. 0  
 CCF 09471, S-1030 Additional Inspection Port  
 CCF 09505, Scrap Cage Blue M Oven, Rev. 0  
 CCF 09516, Scrap Cage Filter Press FP1058 Vent to S-1030 for Filter Press Plate, Rev. 0  
 CCF 16459, Add Drain holes in Baffles Inside Scrubber S-1030, Rev. 0

CCF 16482, Install New Level Probes in Scrubber S-1030, Rev. 0  
CCF 16486, S-1030 Scrubber Body Demo Work,  
CCF 16487, S-1030 Scrubber Body Mods, Rev. 0  
CCF 16493, Passive Overflow for 1030 Scrubber, Rev. 0  
CCF 16500, S-1030 Scrubber Inlet Transition Replacement, Rev. 0  
CCF 16509, S-1030 Modify Blowdown Line, Rev. 0  
CCF 16509-0-CCR-03, Air gap S-1030 to V-1016 blowdown line, Rev. 0  
CCF 16510, Install 8" Drain on S-1030 Scrubber, Rev. 0  
CCF 16522, Scrubber 1030 Inlet Transition Spray Nozzle Installation, Rev. 0  
FSS-012, Control System Design for Safety Significant Control Applications, Rev. 7  
PSEDOC-3270, "S-1030 Chemistry Analysis," Rev 0  
Root Cause Analysis, Uranium Mass Exceedance in S-1030 Scrubber at Columbia Fuel  
Fabrication Facility (CFFF), dated October 5, 2016  
S-1030 Scrubber Event Recovery Plan, dated October 12, 2016

## WESTINGHOUSE ELECTRIC COMPANY COMMITMENTS

Pursuant to the letter from Westinghouse dated August 9, 2016, and the telephone call between Nuclear Regulatory Commission (NRC) management and Westinghouse management (David J. Precht and Bruce Phillips) on August 8, 2016, it is our understanding that Westinghouse has taken, or will complete the following actions prior to restart:

1. Complete a Root Cause Analysis (RCA) investigation for this event. In accordance with the RCA Charter, the RCA will include an assessment of the nuclear safety culture (NSC) contributors to the event and identify necessary corrective actions to address gaps noted in the NSC at Columbia.
2. If the RCA investigation identifies additional actions necessary to assure safe operations, then Westinghouse will revise its restart plan to include those actions. Additional immediate or compensatory actions will be identified and put in place for any corrective action to prevent recurrence that is not completed prior to restart.
3. The following immediate actions will be taken:
  - a. The design, operating and maintenance history of the S-1030 scrubber system, including changes to influents to the scrubber system, will be reviewed to understand the impacts on the mass build up noted in this event. Based upon this review, the safety basis for the scrubber system will be revised. Additionally, the following will be performed for the S-1030 scrubber system:
    - i. Review and revise procedures that implement administrative items relied on for safety (IROFS) to ensure administrative limits are properly defined and to ensure inspection methods that validate compliance to the administrative IROFS can be effectively implemented to meet its safety function.
    - ii. Review the adequacy of the management measures applied that support the availability and reliability of the administrative IROFS and correct any identified deficiencies.
    - iii. Review and approval of the above actions and the identified corrective actions will be performed by independent criticality safety experts.
    - iv. Complete the installation of physical modifications needed to support the revised safety basis.
    - v. Conduct training on the changes with personnel impacted or involved in the revised IROFS and management measures for this system.
    - vi. Develop a post-startup monitoring plan to validate the effectiveness of the above actions.
  - b. Review Criticality Safety Evaluation (CSE) accident sequences for wet scrubber ventilation systems with non-favorable geometry (NFG) components to ensure double contingency protection and proper IROFS implementation. For each, perform inspections to validate system design and operating parameters as well as items (i) through (iii) described above and for items (iv) through (vi) as needed.



- c. For ventilation systems with NFG components that are permanently removed from service:
  - i. Verify the adequacy of isolation to ensure the potential does not exist for special nuclear material (SNM) mass accumulation or the potential for moderator addition. Any identified deficiencies will be corrected.
  - ii. The following systems will be inspected and cleaned as necessary to ensure no mass build up exists in them: S-1056 Scrubber, Ventilation systems 3A, 3B and 7A filter housings.
- d. For CSEs with NFG components that have mass limits, ensure IROFS have been flowed down to Integrated Safety Analyses (ISA), sketches and implementing documents. Identified deficiencies will be entered into the corrective action program (CAP) and corrected as necessary to meet the safety basis prior to returning the system to operation. Perform a sample of the remaining CSEs.
- e. For administrative IROFS satisfied by inspection, review and revise procedures that implement the inspections to ensure administrative limits are properly defined and to ensure inspection methods can be effectively implemented to meet its safety function. Identified deficiencies will be entered in the CAP and corrected.
- f. Perform a historical review (previous 10 years) of the corrective action program and Red book/Green book entries to identify any recurring or longstanding issues that identify potential challenges to the safety basis of any CSE. Identified issues will be entered into the corrective action program and will either be corrected prior to restart or adequate compensatory measures put in place.
- g. Implement procedure changes to provide an internal escalation protocol to plant management for IROFS violations, including guidance for situations involving uncertainty in compliance to limits.
- h. Revise the "Columbia Plant Safety Event Response Guidelines" to strengthen critical decision making based upon event significance by requiring independence of membership on the Safety Event Management Review Team.
- i. Retain an external nuclear criticality safety expert who will remain on site at Columbia to assist in the oversight of nuclear criticality safety (NCS) functions until corrective actions from the RCA related to this function are complete and an effectiveness review is performed to ensure sustainability of corrective actions. Additionally, Columbia has initiated a search for a permanent new manager for the NCS organization.
- j. Develop and present training on the lessons learned from this event, including the results of the NSC evaluation, to leadership (front line supervisors and above) and to workers impacted or involved in the control of IROFS and management measures. In addition to this training, senior management of the Columbia Fuels Operations will conduct briefings with each work group to reinforce desired standards, behaviors and expectations regarding their role in nuclear safety.

4. For the NCS organization, conduct a work environment assessment and develop needed corrective actions. Additionally, the Interim Vice President, Columbia Fuels Operations will reinforce desired standards, behaviors, expectations and the lessons learned from this event with all personnel in the NCS organization.
5. Upon completion of items (1) through (4) above, the Interim Vice President, Columbia Fuels Operations will determine readiness for restart of the S-1030 scrubber system, with concurrence by the Recovery Manager and approval by the Oversight Board. Westinghouse will then request restart approval from the NRC Region II Administrator.

In addition, to ensure continued safe operations after restart, Westinghouse further commits to take the following actions:

1. Complete all corrective actions to prevent recurrence identified in the RCA that are not completed prior to restart.
2. Implement the remaining corrective actions identified in the RCA or the recovery plan, including those resulting from the evaluation of NSC contributors to this event.
3. In accordance with Westinghouse CAP procedures, conduct effectiveness reviews of corrective actions specified in the RCA.
4. Complete corrective actions identified in the NCS organization work environment assessment.
5. Within nine months, an independent third party nuclear safety culture assessment will be performed at Columbia and any identified deficiencies will be entered into the CAP to track to completion.
6. Implement the post-startup monitoring plan described in item (3) of the list of actions to be taken prior to restart.
7. Upon completion of the foregoing actions, Westinghouse will notify the NRC Region II Administrator.