UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
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ATLANTA, GEORGIA 30303-1257

February 27, 2017

EA-16-173

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

SUBJECT: WESTINGHOUSE ELECTRIC COMPANY – NUCLEAR REGULATORY COMMISSION – INSPECTION REPORT NO. 70-1151/2017-007

Dear Mr. Annacone:

This letter refers to a follow-up inspection conducted by the U.S. Nuclear Regulatory Commission (NRC), both onsite and in-office, which was completed on January 27, 2017, regarding events associated with your S-1030 scrubber system at your Westinghouse Columbia Fuel Fabrication Facility in Hopkins, SC. The purpose of this inspection was to determine whether activities authorized under your license were conducted safely and in accordance with NRC requirements. The enclosed report presents the results of this inspection. The inspectors discussed the preliminary inspection findings with you and your staff at the conclusion of the on-site portion of the inspection. A final exit briefing was conducted (telephonically) with you on January 27, 2017.

Based on the results of this inspection, four apparent violations (AVs) were identified, and are being considered for escalated enforcement action in accordance with the NRC Enforcement Policy. The current Enforcement Policy is included on the NRC's Web site at http://www.nrc.gov/about-nrc/regulatory/enforcement/enforce-pol.html.

On September 27, 2016, the NRC completed an Augmented Inspection at your Westinghouse Electric Company facility. The details of this inspection are documented in inspection report 70-1151/2016007 (ML16301A001). The Augmented Inspection Team (AIT) was established to inspect and assess the facts and circumstances surrounding the failure to meet the performance requirements of 10 CFR 70.61 due to exceeding the nuclear criticality safety (NCS) mass limit in a conversion process off-gas scrubber. This event was reported to the NRC on July 14, 2016, via a twenty-four hour report (EN #52090) based on Title 10 of the *Code of Federal Regulations* (10 CFR) 70 Appendix A(b)(2), "Loss or degradation of IROFS that results in failure to meet the performance requirements of 10 CFR 70.61." On July 26, 2016, Westinghouse updated the EN to confirm that the mass limit for the scrubber inlet transition section was exceeded. On July 31, 2016, Westinghouse updated the event notification to report that clean-out material found in the S-1030 scrubber packing and floor also exceeded the uranium mass limit for the scrubber criticality safety evaluation (CSE). At that time Westinghouse also upgraded the EN to a one hour EN based on 10 CFR 70 Appendix A(a)(4).

On October 19, 2016, the NRC completed inspections of restart commitments confirmed in a Confirmatory Action Letter (CAL) (ML16224B082) issued August 11, 2016. The intent of these inspections was to verify completion of commitments by Westinghouse to take certain actions prior to restart of the S-1030 scrubber system and conversion process equipment at the Columbia Fuel Fabrication Facility (CFFF). The NRC conducted inspections of those CAL items from September 7 to October 19, 2016, as documented in inspection report 70-1151/2016-008 (ML16323A011). 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.

The first apparent violation involved the failure to ensure that high consequence accident sequences remain highly unlikely as required by 10 CFR 70.61(b). This violation is further discussed in Section A.1 of this inspection report. The second apparent violation involved the failure to assure that under normal and credible abnormal conditions, all nuclear processes were subcritical including use of an approved margin of subcriticality as required by 10 CFR 70.61(d). This violation is further discussed in Section A.2 of this inspection report. The third apparent violation involved the failure to establish adequate management measures to ensure that items relied on for safety (IROFS) perform their function when needed, as required by 10 CFR 70.62(d). This violation is further discussed in Section A.3 of this inspection report. The fourth apparent violation involved the failure to make a one hour report as required by Appendix A(a)(4) of 10 CFR 70. This violation is further discussed in Section A.4 of this inspection report.

Additionally, this report will administratively close the four unresolved items (URIs) identified in Inspection Report 07-1151/2016-007.

Before the NRC makes its enforcement decision, we are providing you an opportunity to, (1) request a Pre-decisional Enforcement Conference (PEC), or (2) request Alternative Dispute Resolution (ADR). If a PEC is held, it will be open for public observation and the NRC will issue a press release to announce the time and date of the conference. If you decide to participate in a PEC or pursue ADR, please contact Eric Michel at 404-997-4555 within 10 days of the date of this letter. A PEC should be held within 30 days and an ADR session within 45 days of the date of this letter.

If you choose to request a PEC, the conference will afford you the opportunity to provide your perspective on these matters and any other information that you believe the NRC should take into consideration before making an enforcement decision. The decision to hold a predecisional enforcement conference does not mean that the NRC has determined that a violation has occurred or that enforcement action will be taken. This conference would be conducted to obtain information to assist the NRC in making an enforcement decision. The topics discussed during the conference may include information to determine whether a violation occurred, information to determine the significance of a violation, information related to the identification of a violation, and information related to any corrective actions taken or planned. In presenting your corrective action, you should be aware that the promptness and comprehensiveness of your actions will be considered in assessing any civil penalty for the apparent violations. The guidance in NRC Information Notice 96-28, "Suggested Guidance Relating to Development and Implementation of Corrective Action," may be helpful.

In lieu of a PEC, you may also request ADR with the NRC in an attempt to resolve this issue. ADR is a general term encompassing various techniques for resolving conflicts using a third party neutral. The technique that the NRC has decided to employ is mediation. Mediation is a voluntary, informal process in which a trained neutral (the “mediator”) works with parties to help them reach resolution. If the parties agree to use ADR, they select a mutually agreeable neutral mediator who has no stake in the outcome and no power to make decisions. Mediation gives parties an opportunity to discuss issues, clear up misunderstandings, be creative, find areas of agreement, and reach a final resolution of the issues. Additional information concerning the NRC's program can be obtained at http://www.nrc.gov/about-rc/regulatory/enforcement/adr.html. The Institute on Conflict Resolution (ICR) at Cornell University has agreed to facilitate the NRC's program as a neutral third party. Please contact ICR at 877-733-9415 within 10 days of the date of this letter if you are interested in pursuing resolution of this issue through ADR.

In addition, please be advised that the number and characterization of apparent violations described in the enclosed inspection report may change as a result of further NRC review. You will be advised by separate correspondence of the results of our deliberations on this matter.

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter, its enclosure, and your response, if you choose to provide one, will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's Agency-wide Documents Access and Management System (ADAMS), accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html. To the extent possible, your response should not include any personal privacy, proprietary, or safeguards information so that it can be made available to the Public without redaction.

If you have any questions concerning this matter, please contact Eric Michel of my staff at 404-997-4555.

Sincerely,

/RA/

Mark S. Lesser, Director
Division of Fuel Facility Inspection

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

Enclosure:
NRC Inspection Report 70-1151/2017-007
w/Supplemental Information

cc: See page 3

cc:
John Howell
Manager
Environment, Health and Safety
Electronic Mail Distribution

Nancy Parr
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Electronic Mail Distribution

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SUBJECT: WESTINGHOUSE ELECTRIC COMPANY – NUCLEAR REGULATORY COMMISSION – INSPECTION REPORT NO. 70-1151/2017-007

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U. S. NUCLEAR REGULATORY COMMISSION
REGION II

Docket No.:	70-1151
License No.:	SNM-1107
Report No.:	70-1151/2017-007
Licensee:	Westinghouse Electric Company
Facility:	Columbia Fuel Fabrication Facility
Location:	Hopkins, SC 29061
Dates:	September 28, 2016 to January 27, 2017
Inspectors:	T. Vukovinsky – Senior Fuel Facility Inspector J. Munson – Fuel facility Inspector N. Pitoniak – Senior Fuel Facility Inspector
Approved by:	Mark Lesser, Director Division of Fuel Facility Inspection

Enclosure

EXECUTIVE SUMMARY

Westinghouse Electric Company - Columbia Fuel Fabrication Facility
NRC Inspection Report 70-1151/2017-007

This announced and follow-up inspection was conducted to review the four unresolved items (URIs) that were identified during a separate U.S. Nuclear Regulatory Commission (NRC) Augmented Inspection Team (AIT) report and documented in report No. 70-1151/2016-007, dated October 26, 2016. Four apparent violations were identified during this inspection.

1. An apparent violation (AV) was identified for failure to ensure criticality accident sequences remain highly unlikely, as required by Title 10 of the *Code of Federal Regulations* (10 CFR) 10 CFR 70.61(b). (Paragraph A.1)

2. An AV was identified for failure to assure that under normal and credible abnormal conditions, all nuclear processes were subcritical including use of an approved margin of subcriticality, as required by 10 CFR 70.61(d). (Paragraph A.2)

3. An AV was identified for failure to establish adequate management measures to ensure that items relied on for safety (IROFS) perform their function when needed, as required by 10 CFR 70.62(d). (Paragraph A.3)

4. An AV was identified for failure to make a one hour report, as required by Appendix A(a)(4) of 10 CFR Part 70. (Paragraph A.4)

REPORT DETAILS

Summary of Plant Status

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. 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:

The S-1030 scrubber was installed in 2001, and began operations in 2002. The S-1030 scrubber replaced the S-1056 scrubbing system and combined vents that previously fed scrubbers S-1056 and 3A/B. In 2009, the feed streams that previously fed the 7A scrubber were routed to the S-1030 scrubber. The S-1030 scrubber operates as a cross flow horizontal packed bed scrubber where a recirculating scrubbing liquid is used to absorb soluble gas molecules and knock down suspended solids including uranium bearing particles vented from several processes in the conversion area. The scrubber was originally designed to scrub acidic off-gas, however, many of the current feed streams contain ammoniated (basic) off-gas. The main process systems that vent to the S-1030 scrubber include: two nitrate storage columns, calciner off-gas scrubber condensers and various vent lines, decontamination room wet cleaning hood, scrap cage dissolver hood and filter press, S-1030 sump tanks, Blue-M oxidation hoods/sifter enclosures, scrap cage washing machine, flexible hoses for the ADU holding tank, and various drain lines for conversion process equipment.

The feed streams all tie together through a network of duct work of various diameters to a large diameter section before entering the transition into the S-1030 scrubber. The large surface area of the transition region reduces the linear velocity of the incoming stream as it enters the scrubber body. This speed reduction allows for greater reaction time between the scrubber solution and the incoming streams. The scrubber body contains a specialized packing to increase the surface area of the scrubber liquid. The increase in surface area allows for more absorption of gaseous contaminants into the scrubber liquid.

Inspection Scope:

A. The inspection included a review of each unresolved item (URI) identified during the Nuclear Regulatory Commission's (NRC) Augmented Inspection Team (AIT) report 70-1151/2016007 (ML16301A001). (Inspection Procedures 88015, 88020, 88025, 88070, 92703)

1. <u>Failure to Ensure Criticality Accident Sequences Remain Highly Unlikely.</u>

<u>Introduction</u>: An apparent violation (AV) was identified for the failure to implement adequate controls to the extent needed to reduce the likelihood of occurrence of a criticality so that, upon implementation of such controls, the event is highly unlikely as required by 10 CFR 70.61(b). Specifically, the licensee failed to ensure IROFS for two criticality accident sequences associated with the S-1030 inlet transition area and vessel packing were sufficient to ensure a criticality was highly unlikely.

<u>Description</u>: On May 28, 2016, the licensee started the S-1030 scrubber inspection and cleanout activities which resulted in the removal of approximately seven popcorn buckets of material from the right and left sides of the inlet transition section. The licensee also pressure washed the inlet transition section and some of the bottom of the packing. The licensee completed the S-1030 scrubber cleanout activities on June 1, 2016, and removed a total of 197 kilograms of material for a total of 36 popcorn buckets and an additional popcorn bucket from the inlet elbow. The scrubber was subsequently restarted on June 2, 2016. On July 13, 2016, the preliminary results of samples taken from the 36 buckets all indicated a concentration of uranium (U) between 40-50% with an average of 47.8%. This equates to approximately 100 kg of U in the scrubber, which is an unsafe geometry vessel. The mass limit in the criticality safety evaluation (CSE) is 29 kg U. The scrubber was shut down on July 14, 2016 when the determination was made by the licensee that the mass limit in the CSE had been exceeded. The licensee reported this event as EN 52090, a twenty-four hour report due to a high consequence event being “unlikely.” The licensee subsequently conducted another inspection of the transition piece and clean out of the scrubber. Material collected weighed 23.88 kg and was 21.2% U, resulting in a mass of 5.06 kg U after six weeks of operation. On July 31, 2016, as part of the extent of condition investigation, the scrubber packing section was inspected, and it was determined that clean-out material in the scrubber packing and floor also potentially exceeded the uranium mass limit for the scrubber CSE. Over years of operations, the same mass prevention and inspection/clean-out IROFS did not prevent exceedance of the mass limit.

<u>Analysis:</u> The inspectors determined that CSE-1-E, Revision (Rev.7) , “Criticality Safety Evaluation for the S-1030 Scrubber” incorrectly assumed that only minor amounts of uranium powder were expected to accumulate in the S-1030 transition and scrubber vessel packing; that low uranium concentration would be present within the scrubber vessel; minimal amounts of small uranium particles were entrained within the intake ductwork; and that the scrubber constantly diluted the uranium concentration with the addition of makeup water during normal operation and anticipated upsets. Additionally, the inspectors noted that CSE-1-E established the following criticality safety limits for the S-1030 scrubber from June 2009 until present:

a) 20.82 kg of uranium in the packing
b) 263 g/liter of uranium in the recirculating spray water
c) 29 kg of uranium in the transition
d) 36.5 kg of uranium in the inlet elbow.

The primary contingency of CSE-1-E was that significant amounts of uranium can enter the ductwork leading to S-1030. The licensee established IROFS to prevent the primary contingency from occurring. The secondary contingency assumed the primary contingency had been challenged and additional measures were needed to prevent a criticality. Therefore, IROFS based on the secondary contingency assumed that significant amounts of uranium have entered the inlet to the S-1030 scrubber. The IROFS based on the secondary contingency were established to prevent the uranium from accumulating in a configuration with the mass, moderator, and geometry needed for a criticality. CSE-1-E listed seven credible criticality accident scenarios derived from the criticality hazard evaluation. Each of these seven accident scenarios identified the upset scenario and evaluated the resulting upset conditions for double contingency. Additionally, the upset evaluations identified any Safety Significant Controls (SSCs) necessary to provide double contingency and acceptable risk against a criticality accident. The IROFS for Double Contingency Protection listed in CSE-1-E were a combination of passive engineered controls and administrative controls. The IROFS for primary contingency protection were passive features and IROFS for secondary protection were active and administrative. The license required that controls are verified to be reliable and effective as described below:

a) Passive engineered controls are verified at time of installation and, where appropriate, are entered into the management measures programs for routine inspections and maintenance to ensure their reliability and availability.
b) Administrative controls are implemented through approved procedures. The reliability and effectiveness of administrative controls are assured through procedure reviews, training, experience, and compliance audits.
c) Active engineered controls undergo an operational verification process prior to first use in any system, to assure reliability of intended function, and are entered into the management measures programs for routine testing and maintenance to assure continued availability.

Based on the mass of material removed from the scrubber inlet, packing area, and scrubber vessel, two accident scenarios included in CSE-1-E were identified by the inspectors to have controls which were inadequately implemented to prevent exceeding a mass limit in S-1030. These include:

a) Uranium Accumulation in Scrubber Vessel Packing or Demister Section
b) Uranium Accumulation in Scrubber Inlet Transition

The above referenced accident scenarios all credited four IROFS as the primary contingency to ensure that sufficient uranium was not available for a criticality accident. These IROFS were VENT-S1030-101, -102, -103, and -104. These IROFS included vacuum breaks prior to non-favorable ventilation ducts, passive overflows at lower elevations than the ventilation ductwork, and a greater than 28 inch vertical rise prior to non-favorable ducts and scrubber vessel. These IROFS were credited to prevent uranium bearing liquid entrainment into non-favorable ducts and the scrubber (VENT-S1030-101, 102, and 104). Another passive IROFS (VENT-S1030-103) was credited to prevent uranium particulate entrainment by physically separating the process and the ventilation ducts. As evidenced by the large accumulation of mass in the S1030 scrubber inlet transition and vessel packing, these IROFS were inadequate to prevent a significant amount of uranium from entering the ductwork leading to the S1030 scrubber.

The secondary contingencies for the above referenced accident sequences were as follows:

a) Uranium Accumulation in Scrubber Vessel Packing. The first IROFS was Vent-S1030-105 which required that the packing section have a continuous liquid spray when the scrubber is operating. The assumption was that the spray would prevent material from accumulating on the packing both from the force of impacting water and because the uranium bearing material is mostly water soluble. The second IROFS was VENT-S1030-106 which consisted of a visual inspection of the vessel, packing, and demister and significant uranium concentration (greater than a surface coating) removed on an annual basis. Following the event, it was determined that the uranium bearing material was mostly insoluble in water and that the visual inspections were inadequate in detecting and removing a significant uranium concentration from the scrubber vessel and packing areas which resulted in exceeding the mass limit in the CSE.

b) Uranium Accumulation in Scrubber Inlet Transition. The first IROFS was Vent-S1030-109 which required that the inlet transition section have a continuous liquid spray when the scrubber was operating. The assumption was that the spray would prevent material from accumulating in the transition area both from the force of impacting water and because of the uranium bearing material is mostly water soluble. The second IROFS was VENT-S1030-110 which consisted of a visual inspection of the inlet transition and significant uranium concentration (greater than a surface coating) removed on an annual basis. Following the event, it was determined that the uranium bearing material was mostly insoluble in water and that the visual inspections were inadequate in detecting and removing significant uranium concentration from the scrubber transition area which resulted in exceeding the mass limit as stated in the CSE.

Provisional Assessment of Risk from the Apparent Violation (Manual Chapter 2606)

A risk assessment was performed in accordance with Inspection Manual Chapter (IMC) 2606 based on the licensee's Integrated Safety Analysis (ISA). As detailed in the licensee's Criticality Safety Evaluation (CSE) for the S-1030 Scrubber System (CSE-1-E, Revisions 7), several credible accident sequences involving inadvertent criticality in the S-1030 scrubber were identified. These accident sequences included, but were not limited to, uranium accumulation in various areas of the scrubber, related components and ductwork; uranium concentration in the scrubber vessel; and solution backflow into the process water system. For the purposes of this assessment, the primary focus was the accident sequences involving uranium accumulation in the inlet transition and vessel packing sections.

Although the as-found conditions represented a subcritical configuration, this was based on several incidental, uncontrolled factors. Key incidental, uncontrolled factors included the geometrical configuration of the material, interstitial moderation, and reflection conditions. The inspectors determined that under certain conditions criticality was possible. The S-1030 inlet transition and packing section are large, unfavorable geometries with sufficient moderator available. The inspectors evaluated the likelihood of criticality for the applicable accident sequences involving uranium accumulation in the inlet transition and packing section, with specific focus on the likelihood of accumulating a minimum critical mass of AUF, the effectiveness of the designated controls at limiting AUF accumulations, accumulation rate, and likelihood of discovery prior to a critical mass being achieved. The inspectors determined that the controlled parameter credited with preventing both the primary and secondary contingencies for criticality (mass) was not adequately controlled by the licensee, and that the risk of criticality was unacceptable. The NRC's provisional evaluation of likelihood of criticality for each accident sequence assessed in listed below in Table 1.

Accident Sequence	Overall Likelihood (Numeric)	Overall Likelihood
AUF Accumulation – Inlet Transition	[-1]	Not Unlikely
AUF Accumulation – Packing Section*	[+1]	Not Unlikely

Uranium Accumulation in the Inlet Transition (CSE-1-E, Rev 7, Accident Sequence 4.1.3)

Sufficient moderator is present within the inlet transition due to the continuous water spray into the transition section. The inlet transition is a non-favorable geometry. Therefore, the primary contingency for this accident sequence is to prevent an unsafe mass from accumulating within the inlet transition. The credited controls for the primary contingency included: 1) vacuum breaks prior to non-favorable geometry ventilation ducts for the scrubber sump tanks and calciner scrubber slab tanks, 2) passive overflows at lower elevations than the ventilation ducts for the scrap cage washing machine and conversion lines 1 and 5 nitrate columns, 3) physical separation between the process and the ventilation ducts for the scrap cage Blue M oven/hoods and dissolver hood, scrap cage standpipe, scrap cage filter press, nitrate cream can addition, line 4 mixing station, and conversion decontamination room wet cleaning hood, and 4) greater than a 28 inch vertical rise for the scrap cage washing machine flex hose and standpipe flex hose, ADU slurry tank floor level flex hose and decanter platform level flex hose, calciner scrubber rod-out flex hose, calciner vent line rod-out flex hoses, precipitation tank flex hose, nitrate tank flex hose, and conversion decontamination room wet cleaning flex hose. Controls 1 through 4 are hereafter referred to as "upstream controls." Additionally, the licensee performed periodic pressure washing of the inlet transition; however, this was not designated as an IROFS until Revision 8 of CSE-1-E.

The upstream controls credited for the primary contingency in this accident sequence were not effective at limiting AUF accumulations within the inlet transition in a meaningful way as demonstrated by the event. Therefore, the inspectors assigned a [1] score to this set of controls for Frequency of Initiating Event per the licensee's ISA methodology as the upstream controls' prevention involved "prevention ineffective." Periodically, the inlet transition was pressure washed to remove accumulation. The periodic pressure washing of the inlet transition credited for the primary contingency had limited effectiveness at limiting AUF accumulations, namely in the top of the inlet transition. Although the periodic pressure washing of the inlet transition allowed significant quantities of AUF accumulation to still occur, it did provide limited protection in terms of the accumulation rate as it periodically removed mass from the inlet transition. Additionally, this control was designated an IROFS in Revision 8 of the CSE.

IMC 2606, Paragraph b, states, in part, that the staff should consider and credit all formally established and documented controls applicable to the situation and commensurate with their availability and reliability, depending on the management measures applied to them. In a document titled, "Safety Significance Determination for

S-1030 Scrubber As-Found Condition" (Westinghouse Reference LTR-EHS-16-94), the licensee stated that the management measures to ensure the availability of the IROFS credited were sufficient; however, the management measures to ensure their reliability were insufficient. For designated controls involving a trained operator performing a routine task, the licensee's ISA allows a score of [-1]; however, the periodic pressure washing was not as effective as designed or intended. The periodic pressure washing was not designated as an IROFS until Revision 8 of CSE-1-E, although it was informally being performed on a periodic basis. Additionally, the periodic pressure wash was determined to be subject to potentially inadequate management measures, and the defined frequency of "periodic" was not objective. Therefore, the inspectors assigned a reduced score to this control of [0] as the initiating event was "[e]xpected to occur occasionally during plant lifetime; prevention by a trained operator performing a non-routine task," commensurate with the control's availability and reliability.

Combining the scores discussed above for the primary contingency, for AUF accumulations within the inlet transition the NRC assigned a [0] for Frequency of Initiating Event per the licensee's ISA methodology as the limiting factor, the periodic pressure washing, involved the initiating event being "expected to occur occasionally during plant lifetime."

The secondary contingency for this accident sequence is also to prevent an unsafe mass from accumulating within the inlet transition. Two controls were credited for the secondary contingency: 1) a liquid spray of the inlet transition during operation and 2) an inspection and clean-out of the inlet transition performed on an annual basis.

The controls credited for the secondary contingency in this accident sequence had limited effectiveness at limiting AUF accumulations. As demonstrated by the event, the liquid spray of the inlet transition was not effective at preventing significant quantities of AUF from accumulating undetected. Therefore, the inspectors assigned a [0] score to this control for Effectiveness of Protection as it involved "[n]o or extremely weak protection." Although the annual inspection and clean-out of the inlet transition allowed significant quantities of AUF accumulation to still occur, it did provide limited protection in terms of the accumulation rate as it periodically removed mass from the inlet transition. Additionally, this control was a designated IROFS. For designated controls involving a trained operator performing a routine task, the licensee's ISA allows a score of [-2]; however, the annual inspection and clean-out was not as effective as designed or intended. Additionally, the annual inspection and clean-out was determined to be subject to potentially inadequate management measures, and the defined frequency of "annual" was too infrequent to prevent significant accumulation. Therefore, the inspectors assigned a reduced score to this control of [-1] for Effectiveness of Protection per the licensee's ISA methodology, commensurate with the control's availability and reliability.

In LTR-EHS-16-94, the licensee stated that an annual inspection and clean-out of the scrubber would have slowed the accumulation rate. In addition, the design of the trough area would have restricted large amounts of material from entering the scrubber bed during the cleaning process. The licensee also stated that as more accumulation occurred, it would become increasingly visible and self-revealing. As demonstrated by the event, significant quantities of material were allowed to accumulate in a chronic fashion in various areas of the inlet transition and packing section. Specifically, significant AUF accumulations were allowed to occur undetected in the top of the inlet transition. Therefore, although the inspectors acknowledged that the annual clean-outs would slow the accumulation rate, the inspectors did not have reasonable assurance that significant quantities could not accumulate undetected in areas of the inlet transition and packing section. Therefore, the inspectors did not consider these factors to be reliable at preventing a critical mass from accumulating.

Combining the Frequency of Initiating Event with the Effectiveness of Protection Indices per the licensee's ISA methodology results in this accident sequence being "not unlikely" (i.e., [0] + [-1] = [-1] > [-4]).

Uranium Accumulation in the Vessel Packing Section (CSE-1-E, Rev 7, Accident Sequence 4.1.1)

Sufficient moderator is present within the packing section due to the continuous water spray impacting the packing and the material composition of the packing material (polypropylene). The packing section is a non-favorable geometry. Therefore, the primary contingency for this accident sequence is to prevent an unsafe mass from accumulating within the packing section. With the exception of the periodic pressure wash of the inlet transition, the credited controls for the primary contingency included the same controls for the primary contingency discussed above for CSE-1-E, Rev 7, Accident Sequence 4.1.3, and will not be repeated here for brevity.

The upstream controls credited for the primary contingency in this accident sequence were not effective at limiting AUF accumulations within the packing section in a meaningful way as demonstrated by the event. Therefore, the inspectors assigned a [1] score to this set of controls for Frequency of Initiating Event per the licensee's ISA methodology as the upstream controls' prevention involved "prevention ineffective."

The secondary contingency for this accident sequence is also to prevent an unsafe mass from accumulating within the packing section. The credited controls for the secondary contingency included: 1) continuous liquid spray of the scrubber vessel and packing section when the system is operating, and 2) an inspection and clean-out of the scrubber vessel, demister, and packing performed on an annual basis.

The controls credited for the secondary contingency in this accident sequence had limited effectiveness at limiting AUF accumulations. The spray of the packing section was not effective at limiting AUF accumulations within the packing section in a meaningful way as demonstrated by the event. Therefore, the inspectors assigned a [0] score to this control for Effectiveness of Protection as it involved "[n]o or extremely weak protection." The annual inspection and clean-out of the packing section provided limited protection to limit AUF accumulations in the packing section as demonstrated by the event. Although the annual inspection and clean-out of the packing section limited the accumulation rate as it removed mass from the packing section, its annual frequency was too infrequent to be effective at preventing an unsafe mass from accumulating. Therefore, the NRC assigned a [0] score to this control for Effectiveness of Protection as it involved "[n]o or extremely weak protection."

As stated in the previous section, although the inspectors acknowledge that annual clean-outs would slow the accumulation rate, the inspectors did not have reasonable assurance that significant quantities could not accumulate undetected in areas of the inlet transition and packing section. Therefore, the NRC does not consider these factors to be reliable at preventing a critical mass from accumulating.

Combining the Frequency of Initiating Event with the Effectiveness of Protection Indices per the licensee's ISA methodology results in this accident sequence being "not unlikely" (i.e., [1] + [0] + [0] = [1] > [-4]).

Enforcement: 10 CFR 70.61(b) requires, in part, that the risk of each credible high consequence event must be limited. Engineered controls, administrative controls, or both, shall be applied to the extent needed to reduce the likelihood of occurrence of the event so that, upon implementation of such controls, the event is highly unlikely. The above two accident sequences are potential criticality sequences, and as such, are required to have controls in place to ensure they are highly unlikely.

Section 4.0 of the License Application states, in part, "An ISA Summary (1) presents key aspects of the ISA in sufficient detail to enable an independent overview of the subject systems, and (2) provides reasonable assurance that operation of these systems will not lead to situations that would exceed the performance requirements specified in Section 70.61 of the 10 CFR Part 70 regulations." Additionally, this section states, in part, "All accident sequences identified in the process hazard analysis (PHA) that have an unmitigated consequence that is high are carried forward for evaluation. This evaluation determines the severity of an accident's consequence on a linear scale from 0 (low) to 6 (high), and the overall likelihood of the accident's occurrence on a logarithmic (base 10) scale from 1 (not unlikely) to -4 (highly unlikely). A criticality accident sequence has a severity rating of 6 (high) and therefore requires the likelihood to be less than or equal to -4 (highly unlikely)."

Contrary to the above, on or before July 2016, the licensee failed to apply sufficient controls to the extent needed to reduce the likelihood of occurrence of a high consequence event to highly unlikely. Specifically, for two accident sequences associated with CSE-1-E, the licensee failed to limit the likelihood of a high consequence event (inadvertent criticality) to highly unlikely by not maintaining overall likelihood of the accident's occurrence to ≤ -4. The failure to prevent or limit chronic accumulation resulted in the likelihood of criticality being not unlikely based on the licensee's integrated safety analysis.

Actual Consequence: None. The as-found material remained in a subcritical state. There was no actual safety consequence to the public.

Potential Consequence: High. The licensee failed to assure that the likelihood of a high consequence event was highly unlikely.

The licensee has taken corrective actions and implemented compensatory measures as detailed in the confirmatory action letter (CAL) dated August 11, 2016 (ML 16224B082). Restart inspections were conducted to verify the commitments made in the CAL prior to restarting the S-1030 scrubber system and conversion process equipment were completed, and ensured the actions taken provided reasonable assurance of Westinghouse's ability to safely operate the Columbia Fuel Fabrication Facility (CFFF).

These inspections are detailed in inspection report 70-1151/2016-008 (ML16323A011). Additional corrective actions were identified prior to startup in addition to long term corrective actions described in the licensee's root cause analysis (RCA).

The licensee's failure to ensure that the likelihood of each credible high consequence event was maintained "highly unlikely" will be tracked as AV 70-1151/2017-007-01, Failure to ensure criticality accident sequences remain highly unlikely. URI 70-1151/2016-001 is administratively closed. This issue will require additional NRC review and will be further evaluated in accordance with the NRC's Enforcement Policy to determine severity level.

2. Failure to Assure that all Nuclear Process were Subcritical

Introduction: An AV was identified for the failure to assure that under normal and credible abnormal conditions, all nuclear processes were subcritical, including use of an approved margin of subcriticality, as required by 10 CFR 70.61(d). Specifically, the licensee failed to assure that nuclear processes related to the S-1030 scrubber were controlled such that during operations, both normal and abnormal conditions were reasonably assured to remain subcritical.

Description: In June 2009, the licensee implemented CSE 1-E, Rev. 0 which established a new safety basis for the S-1030 scrubber. In September 2015, the licensee revised CSE-1-E to reflect a change in the scrubber supply water from the use of deionized water to process (city) water. This marked the seventh revision to CSE-1-E. From Rev. 0 through Rev. 7, there were no changes to the safety basis mass limits or assumptions used by the licensee. The CSE outlined multiple mass limits that were applied to various sections of the S-1030 scrubber (e.g. 20.82 kg of uranium in the scrubber vessel packing and 29 kg of uranium in the scrubber inlet transition). The mass limit of 20.82 kg is the minimum critical mass for a sphere of UO_2/C_3H_6 (uranium dioxide - polypropylene mixture) that is optimally moderated and fully reflected. The mass limit of 29 kg is the minimum critical mass required for a sphere of UO_2/H_2O (uranium dioxide - water mixture) that is optimally moderated and fully reflected. Following the event, samples from removed material contained a non-homogenous compound ammonium uranyl fluoride, AUF ($(NH_4)3UO_2F_5$), which is sparingly soluble in water. The CSE did not address the potential for non-soluble compounds to accumulate.

Analysis: As part of the CSE development, the licensee conducted a "what-if criticality hazard analysis" to identify scenarios that have a potential criticality concern which would require some type of safeguard(s) to preclude a nuclear criticality. Through the process the licensee explored various scenarios that could lead to a criticality (i.e., changes in vessel packing spray, changes in transition spray, transition and vessel leaks, changes in pH level, acute uranium accumulation, etc.). The licensee's analysis never considered that mass could accumulate in a chronic fashion within the scrubber.

The CSE documented the normal operating conditions and process flow that outlined pathways of the process off-gas to the S-1030 scrubber. For the normal case of the S-1030 scrubber, specifically the scrubber vessel, inlet transition, and vessel packing, the CSE repeatedly stated that "low uranium accumulation (<1 gU/L) and/or minor amounts of uranium powder accumulation" were the normal condition. In regard to anticipated upsets, the CSE stated that minor concentration increases and/or minor uranium accumulation was anticipated; however, any mass accumulation was assumed to remain below the safety limit for the respective sections (e.g. transition, scrubber vessel, and packing, etc.). For scenarios identified with a potential for criticality, the licensee conducted an analysis to identify all normal and credible abnormal conditions. The licensee imposed IROFS intended to ensure that, under all normal and credible abnormal conditions identified, subcriticality was assured.

However, in identifying all normal and credible abnormal conditions potentially leading to criticality, the licensee incorporated several incorrect technical assumptions that were fundamental to the assurance of subcriticality. Specifically, the licensee incorrectly assumed that only minor amounts of uranium powder were expected to accumulate in the S-1030 inlet transition and scrubber vessel packing; that low uranium concentration would be present within the scrubber vessel; that minimal amounts of small particle entrainment of uranium would be present within the intake ductwork; and that the scrubber constantly dilutes the uranium concentration with the addition of makeup water during normal operation and anticipated upsets. Section 6.1.3.c, “Controlled Parameters” of the License Application states, in part, that “all assumptions related to process, equipment, material theory, function and operation (including credible upset conditions) are justified, documented, and independently reviewed.”

The inspectors reviewed the licensee’s nuclear criticality safety analysis, Atkins-NS-WDN-16-01, dated September 8, 2016, based on the “S-1030 Chemistry Analysis” White Paper, dated August 31, 2016. The analysis concluded that a realistic modeling of the as-found condition for the S-1030 scrubber event resulted in a k_{eff} value of ~0.89. The licensee also determined that an additional 310 kg of uranium accumulation would be needed to exceed the k_{eff} license limit of 0.98. The inspectors noted that there was large uncertainty in the calculation and did not agree that it properly characterized the event. The inspectors performed independent calculations and modeling and determined that there was sufficient material present in the as-found condition to support a criticality. The inspectors also determined that the material remained in a subcritical state due to the geometrically favorable configuration of a trough in the scrubber, where the majority of the material from the transition area was found. Given that sufficient moderator was also present, the as-found accumulation only needed to be configured in a different orientation to produce an environment where a criticality event was possible in the S-1030 scrubber.

The inspectors reviewed the uncertainties and assumptions used in the licensee’s as-found model. The licensee used an independent chemical laboratory to analyze the chemical composition of material found in the scrubber. As supported by the chemical analysis, the licensee assumed that the accumulated material in the S-1030 scrubber was ammonium uranyl fluoride (AUF) and used AUF as the chemical composition in the as-found NCS model. However, the margin to criticality for the as-found model is uncertain, primarily because of incomplete and/or conflicting data related to the composition of the fissionable material (e.g. chemical composition, density). For example, AUF is ~57 wt% uranium, but samples taken of the scrubber material averaged 41 wt% uranium. Additionally, AUF is 23 wt% fluorine, but the samples taken of the scrubber material averaged 11 wt%. Additionally, the energy dispersive x-ray spectroscopy (EDS) results of several samples showed that the material composition was variable. A variable composition is consistent with the stratified physical appearance of the material found in the S-1030 scrubber.

The inspectors noted that the modeled geometry in the as-found model was conservative. However, the material was likely originally in a different configuration and was rearranged into the as-found configuration by power washing. Therefore, it is likely that the material fell or was incidentally pushed into the trench and not by design resulting in a favorable geometric configuration for the as-found condition. The licensee used an enrichment of 4.1 wt% ^{235}U, which was lower than the documented plant nominal enrichment for 2016 of 4.391%. In addition, the facility is authorized to possess and process material up to 5 wt% ^{235}U (which is normally assumed in their safety basis analyses.)

Lastly, the inspectors reviewed the latest NCS validation report at the facility and noted that AUF was not included in the report. Whether it was validated after the scrubber event is unknown, but there was no indication of this. A lack of validation calls into question the results of the model, given potentially non-validated nuclear cross sections used in the Monte Carlo code calculations. The inspectors concluded that the material in the scrubber was subcritical in the as-found configuration, and would remain subcritical as long as most of it remained in the trench. There was sufficient material present that it could have gone critical if the material was removed from the trench and rearranged into a more compact configuration. (i.e. if mounded into a hemisphere)

Enforcement: 10 CFR 70.61(a) requires, in part, that the licensee shall evaluate, in the integrated safety analysis performed in accordance with 10 CFR 70.62, its compliance with the performance requirements in paragraphs (b), (c), and (d) of this section.

10 CFR 70.61(d) requires, in part, that the risk of nuclear criticality accidents must be limited to assure that under normal and credible abnormal conditions, all nuclear processes are subcritical including use of an approved margin of subcriticality.

Section 6.0 of the License Application states, in part, "For each process within a system, a defense of one or more controlled parameters is employed and is documented within the process Criticality Safety Evaluation (CSE). The defense consists of the bounding assumptions, criticality safety limits, and criticality safety constraints that, as a set, are uniquely sufficient to maintain the minimum subcritical margin against an initiating event."

Contrary to the above, on or before July 2016, the licensee failed to assure that under normal and credible abnormal conditions, all nuclear processes were subcritical including use of an approved margin of subcriticality for safety. Specifically, the licensee used incorrect assumptions in the identification of normal and credible abnormal conditions, did not adequately identify and characterize chronic accumulation with the S-1030 scrubber system, and did not impose sufficient controls to limit the risk of criticality.

Although there was no actual safety consequence to the public, there was sufficient material available in the S-1030 scrubber for a criticality to occur. There were no other controls and/or processes identified to provide additional barriers or defense-in-depth to prevent a criticality.

The licensee's corrective actions are detailed in Paragraph A.1 above.

The failure to assure subcriticality is identified as AV 70-1151/2017-007-002. URI 70-1151/2016-002 is administratively closed. This issue will require additional NRC review and will be further evaluated in accordance with the NRC's Enforcement Policy to determine severity level.

3. Failure to Establish Adequate Management Measures to Ensure that IROFS to Perform Their Function When Needed

   Introduction: The NRC identified an AV for the failure to establish adequate management measures to ensure that IROFS were designed, implemented, and maintained such that they were available and reliable to perform their function when needed as required by 10 CFR 70.62(d). Specifically, the configuration management program, procedures, training, audits, and corrective actions were not adequate to ensure that IROFS related to S-1030 and ventilation ductwork were available and reliable.

   Description: During the inspection, the inspectors independently reviewed the causal factors in reference to the S-1030 scrubber event. In the course of reviewing the management measures for the associated S-1030 scrubber the inspectors determined that Westinghouse did not establish adequate management measures (i.e., configuration management program, procedures, training, audits, and corrective actions) to ensure that IROFS related to ventilation systems were designed, implemented, and maintained such that they were available and reliable to perform their function when needed.

   Analysis: The inspectors reviewed the management measures associated with the ventilation system and determined that in the areas of Configuration Management (CM), Procedures, Training and Qualification, Compliance Audits, and the Corrective Action Program, the licensee failed to provide reasonable assurance that IROFS were available and reliable to perform their intended functions as required by 10 CFR 70.62(d). Specific details in each area are documented below:

   The inspectors determined that the CM program did not ensure that facility changes and IROFS were properly designed and implemented to prevent adverse impact to the S-1030 safety basis. Those changes included the following:

   - On June 2005, per CCF 05-334, Blue-M Vent Modification, Blue M Oven filters were removed without evaluating the potential impact on the S-1030 safety basis.

   - On February 13, 2009, per COP-815020, Rev. 4, the continuous bleed directly to the Q-tanks was discontinued without considering impact on scrubber operations.

   - On June 19, 2009, per CCF 09-505, Scrap Cage Blue M Oven Ventilation Modifications, the plenum hoods of the Blue M ovens were designed using a baseline document for particle carryover that was in error. This document incorrectly under predicted particle size carryover. An evaluation was not done regarding the potential for significant uranium entrainment.

   - The S-1030 water spray system for transition piece was inadequate to prevent material uranium buildup because the nozzles were not pointing towards the transition as required by CSE-1-E and there was no documentation regarding the change in orientation of the nozzles.

   The ventilation system at Westinghouse contained multiple administrative IROFS for ductwork inspection. In general, the requirements included visual inspections to ensure against fissile material build-up and gamma surveys to detect uranium accumulation.

Material build up greater than a light dusting was required to be removed and the weight of the removed material needed to be reported to the NCS group. To accomplish these administrative IROFS, preventative maintenance (PM) and/or operating and maintenance procedures were established. These controls were established on a periodic frequency dependent on the system (i.e. 13-week, 26-week, or annual inspections). The inspectors noted that there were discrepancies on how the implementing procedures instituted the above requirements. Specifically, it was noted that the requirement to notify NCS when accumulation was found was either not incorporated into the procedure or was not being performed by the operators. Most procedures reviewed required a 50 - 60 gram sample be collected to determine %U, %U235, and moisture content. These sample results were for Material Control & Accountability (MC&A) purposes and were not provided to the NCS department. The inspectors also noted that the procedures only required NCS notification if a quantity in excess of 19 kg U was discovered. This amount was considerably more than a "light dusting" which is specified in the administrative IROFS.

Additionally, the 13-week, 26-week and annual PMs required CFs to be filled out at each inspection location. These CFs provided the inspection location, who inspected it, date inspected, amount of material found, and its location within the ductwork. The inspectors noted that on multiple occasions, material was identified by these inspections and was correctly annotated on the CFs, however, NCS was not notified of the amount of material identified and site management was not tracking and trending the information provided during these inspections. Specific examples are listed below:

- Quarterly PM of roof ventilation ducts/viewports per MCP-108218, documented on CF-84-007:
    - 5-20-15 – ¼ inch dusting on inlet duct to S-1030 scrubber
    - 2-19-15 – ¼ to 1 inch coating green crystals on inlet duct to S-1030 scrubber
    - 11-21-14 – Heavy build up dark green, yellow and white crystals on bottom of duct on inlet to S-1030 scrubber.
    - 8-19-14 – Wet green puddle 1.5 inches deep on bottom of inlet duct to S-1030 scrubber

- Quarterly PM for ventilation inspection in the Conversion area in accordance with COP-814321 and CF-81-922:
    - 3-9-15 – 64 kg material build up in ductwork leading to S-1030 scrubber
    - 8-25-14 – Sludge and build up (no specific amount) in ductwork leading to S-1030 scrubber
    - 8-27-13 – Build up (no specific amount) in ductwork leading to S-1030 scrubber

Westinghouse also uses periodic gamma surveys as a safety control to identify uranium buildup in the ventilation system. IROFS VENT-901 is an administrative control to conduct periodic gamma survey of ducts, piping, and equipment to detect uranium accumulations. A cleanout shall be performed for accumulations greater than a slight dusting. The inspectors reviewed the quarterly gamma survey results and noted that although these controls were being performed, they never tripped the threshold for required actions. The gamma surveys were dependent upon who was conducting the inspection and how they performed the survey. In addition, the results are only indicative of uranium being present and cannot be used to quantify the amount being accumulated. Corrective actions were taken following the S-1030 scrubber event to more readily identify where and how to conduct gamma surveys to enhance this IROFS.

The above PM results illustrate that a significant amount of material was being transported in the ventilation ductwork leading to the S-1030 scrubber. The PMs, procedures, and operator actions were not adequate in that the requirements of the CSEs and the administrative IROFS were not being accomplished. Material buildup was being identified; however, the CSE safety basis that little or no transportation of material to the S-1030 should be occurring was not being identified and corrected, and NCS was not being notified of the accumulation of material in the ductwork as required by the administrative IROFS.

The inspectors determined that procedures and training for the ventilation related administrative IROFS were inadequate because of the following:

- The inspections, cleanouts and gamma surveys did not prevent significant uranium accumulation.

- Based upon interviews and a review of procedures, the training program did not assure that process engineers understood the S-1030 scrubber and ventilation safety basis as required by procedure RA-120-7, Regulatory Policy - Communicating Safety Significant Control Information.

The inspectors determined that audits and corrective actions for the S-1030 scrubber and related ventilation were inadequate because of the following:

- Formal Compliance Audits and NCS Facility Walkthrough did not ensure that IROFS were available and reliable. The audits failed to ensure that CSE assumptions were valid and failed to verify that administrative IROFS were correctly implemented. As an example, the inspectors reviewed EHS-Audit-14-1, Formal Compliance Audit, dated January 15, 2014, which audited, in part, the plant ventilation system. The inspectors noted that for the ventilation IROFS that were audited, the licensee only verified that the IROFS were properly transcribed from the CSE to the ISA and to the procedures. The licensee did not verify that the IROFS were being properly implemented to validate effectiveness and reliability. The inspectors also reviewed NCS Facility Walkthrough Assessment (FWA), dated March 31, 2016, which reviewed CSE-1-D, -E, -G, -H, -I, and -P. The inspectors noted that the audit did not specify which IROFS were audited and did not specify what the responses were provided by the operators to verify that the operators understood the safety function of the IROFS. Also, the FWA did not provide any pass/fail criteria.

- The corrective action program (CAP) did not ensure the effectiveness of corrective actions related to the 2004 Incinerator event, which involved mass accumulation and higher than expected concentration of uranium material in the incinerator system. In addition, accumulation of mass in ductwork was not consistently reported or documented correctly and not entered into the CAP, which resulted in no trending of the issues.

- On May 28, 2016, a Redbook item (71195) was created documenting the material found in the center part of the transition piece (5 - 7 popcorn buckets), and Criticality Safety evaluated (5/31/16) this accumulation and determined it did not challenge the safety basis. However, the organization did not follow up to ensure that total material removed did not challenge the safety basis.

- A December 2009 CAP item documented a significant accumulation in the duct before the S-1030 scrubber. However, actions were not taken to ensure that S-1030 safety basis was not exceeded.

Enforcement: §70.61(a) requires, in part, that the licensee shall evaluate, in the integrated safety analysis performed in accordance with §70.62, its compliance with the performance requirements in paragraphs (b), (c), and (d) of this section.

§70.62(d) requires, in part, that the licensee shall establish management measures to ensure compliance with the performance requirements of 10 CFR 70.61. The measures applied to a particular engineered or administrative control or control system may be graded commensurate with the reduction of the risk attributable to that control or control system. The management measures shall ensure that engineered and administrative controls and control systems that are identified as items relied on for safety pursuant to §70.61(e) of this subpart are designed, implemented, and maintained, as necessary, to ensure they are available and reliable to perform their function when needed, to comply with the performance requirements of §70.61 of this subpart.

Section 3.0 of the License Application states, in part, “management measures are applied to Safety Significant Controls (SSCs) designated as Items Relied On For Safety (IROFS) to provide reasonable assurance that they are designed, implemented, and maintained, as necessary, to ensure they are available and reliable to perform their intended functions when needed.”

Contrary to the above, on or before July 2016, the licensee failed to establish adequate management measures to ensure that IROFS were designed, implemented, and maintained such that they were available and reliable to perform their function when needed as required by §70.62(d). Specifically, the NRC determined that Westinghouse did not establish adequate management measures (i.e., configuration management program, procedures, training, audits, and corrective actions) to ensure that IROFS related to ventilation systems were designed, implemented, and maintained such that they were available and reliable to perform their function when needed as required by 10 CFR 70.62(d).

Actual Consequence: None. The as-found material remained in a subcritical state. There was no actual safety consequence to the public.

Potential Consequence: High. The management measures applied to the selected controls were not applied to the extent needed to reduce the likelihood of occurrence of the event so that, upon implementation of such controls, the event was highly unlikely, and there was sufficient material available in the S-1030 scrubber for a criticality to occur.

The licensee’s corrective actions are detailed in Paragraph A.1 above.

The licensee’s failure to establish adequate management measures on or before July 2016 is identified as AV 70-1151/2017-007-03, Failure to establish adequate management measures to ensure that IROFS to perform their function when needed as required by 70.62(d). URI 70-1151/2016-003 is administratively closed. This issue will require additional NRC review and will be further evaluated in accordance with the NRC's Enforcement Policy to determine severity level.

4. Failure to make a 1 Hour Report

Introduction: The NRC identified an AV for the failure to report, within one hour, an event such that no IROFS, as documented in the ISA summary, remained available and reliable, to perform their function, and which resulted in the failure to meet the performance requirements of 10 CFR 70.61. Specifically, the licensee failed to report, within one hour, that it had exceeded the S-1030 scrubber inlet transition uranium mass limit and that IROFS were not sufficient to ensure a criticality was highly unlikely.

Description: On May 28, 2016, the licensee started the S-1030 scrubber inspection and cleanout activities which resulted in the removal of approximately seven popcorn buckets of material from the right and left side of the inlet transition section. As part of the activities, the licensee identified a buildup of material in the center section of the inlet transition that needed to be cleaned out. Redbook Item 71195 was created to document that accumulation was found in the center transition section of the S-1030 scrubber and it was estimated that the amount of material was approximately enough to fill an additional five to seven of the popcorn buckets. The Redbook item also stated that a plan was being developed to remove the inlet elbow to provide access to clean out the material. On May 30, 2016, a process engineer received the results from the grab samples taken from the material removed from the right and left side of the inlet transition section. The results ranged from 40.72 - 61.78% U. The process engineer provided these results and the weights of the buckets of material (43.2 kilograms total) to the NCS engineer responsible for the scrubber system. He also stated that this was only the material from the left and right sections, and not the center section which was scheduled to be cleaned out on May 31.

On May 31, 2016, the responsible NCS engineer responded to the Redbook Item 71195 by stating that the inspection was performed as required and the accumulated material did not challenge the safety basis of 29 kg U. However, the NCS engineer did not consider the material that had already been removed from the left and right sections of the inlet transition, which the grab sample results indicated that the material ranged from 40.72 - 61.78% U. After completion of cleanout activities on June 1, 2016, the NCS engineer communicated to the process engineer that the NCS group did not have any issues with restarting the S-1030 scrubber. Based on interviews and reviews of available information, the inspectors noted that the licensee took grab samples and weighed the popcorn buckets throughout the cleaning activities.

Analysis: Based on interviews and review of available information, the inspectors determined that the licensee incorrectly assumed that the material removed from the inlet transition had a low uranium and high fluoride content, even though the grab samples taken from the left and right section of the inlet transaction showed that the assumption of low uranium content was incorrect. As a result, the licensee did not perform a detailed evaluation to determine whether the material discovered in the S-1030 scrubber could have exceeded the safety basis as documented in CSE-1-E, Criticality Safety Evaluation for the S-1030 Scrubber, Rev. 7 and ISA 01, Plant Ventilation System Summary, Rev. 10.

The inspectors determined that on June 2, 2016, the process engineer was knowledgeable of the grab sample and weight results from all the material that was removed from the S-1030 scrubber inlet transition. These results clearly indicated that the uranium mass limit for the S-1030 scrubber inlet transition had been exceeded and that a detailed evaluation of the credited IROFS needed to be performed to determine the reason that the IROFS did not prevent uranium accumulation in excess of the mass limit. However, the licensee did not use these results to evaluate the as- found condition in the scrubber and the response to Redbook Item 71195. Consequently, the licensee failed to realize that no IROFS, as documented in the ISA, were remained available and reliable to perform their safety function which requires a report be made to the NRC within one hour of discovery. Additionally, had this report been made, it would likely have caused the NRC to reconsider a regulatory position to respond to the event.

Enforcement: Appendix A(a)(4) of 10 CFR Part 70 requires, in part, a one hour report of any event or condition such that no IROFS, as documented in the ISA summary, remain available and reliable, in an accident sequence evaluated in the ISA, to perform their function, and which results in failing to meet the performance requirements of §70.61.

Section 3.7.2.3 of the License Application states, in part, "The NRC Operations Center is notified of the following types of occurrences … (a) 1-Hour Notifications … An unusual occurrence such that no Items Relied on for Safety (IROFS) in the Integrated Safety Analysis (ISA) Summary remain available and reliable to control an accident sequence evaluated in the ISA *[10CFR70 Appendix A, (a)(4)].*"

Contrary to the above, on or before June 2, 2016, the licensee failed to report an event such that no IROFS, as documented in the ISA summary, remained available and reliable, for two accident sequences evaluated in the ISA, to perform their functions, and which resulted in failing to meet the performance requirements of §70.61. Specifically, the licensee failed to report a condition identified with the S-1030 scrubber inlet transition annual inspection in which no IROFS, as documented in the ISA summary, remained available and reliable to perform their function, and which resulted in not meeting the performance requirements of §70.61.

The licensee made a 24-hour report on July 14, 2016 (EN 52090), for a loss or degraded IROFS which results in failure to meet performance requirements, however this was approximately six weeks following the event. Had the one hour report been made, it would likely have caused the NRC to reconsider a regulatory position to respond to the event.

The licensee's failure to make a one hour report on June 2, 2016, is identified as AV 70-1151/2017-007-04, Failure to make a one hour report per Appendix A(a)(4) of 10 CFR Part 70. URI 70-1151/2016-004 is administratively closed. This issue will require additional NRC review and will be further evaluated in a subsequent inspection to determine the severity level.

5. Conclusion

Four apparent violations of NRC requirements were identified.

EXIT MEETING:

During the course of the inspection, the team provided members of the plant staff and management summaries of inspection findings. 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 inspectors presented the inspection results to M. Annacone and members of staff management on January 27, 2017. The plant staff acknowledged the findings presented.

SUPPLEMENTAL INFORMATION

Key Points of Contact

M. Annacone	Vice President, Columbia Recovery
G. Byrd	Licensing Engineer
J. Coleman	Measurement Control Coordinator
C. Gantt	Senior Engineer, Pellet Operations
T. Graves	Conversion Engineer
J. Howell	Environment, Health and Safety (EH&S) Manager
F. Jackson	Director of Manufacturing, Standardization and Major Products
M. Krissinger	Senior Chemist
R. Likes	Safeguards Coordinator
G. McGehee	Senior NCS Engineer
C. Miller	Senior NCS Engineer
J. Nimmo	Conversion Team Manager
N. Parr	Licensing Manager
B. Phillips	Vice-President
B. Waskey	Analytical Services and Chemical Quality Control Manager
S. Weathers	Conversion Engineer
H. Whitaker	Principal Quality Engineer, Product Assurance Chemical Operations
J. Vining	Senior NCS Engineer

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

List of Items Opened

Item Number	Status	Type/Description
URI 70-1151/2016-007-01	Closed	Failure to ensure criticality accident sequences remain highly unlikely
URI 70-1151/2016-007-02	Closed	Failure to assure that under credible normal and abnormal conditions, all nuclear processes were subcritical including use of an approved margin of subcriticality
URI 70-1151/2016-007-03	Closed	Failure to establish adequate management measures to ensure that IROFS to perform their function when needed
URI 70-1151/2016-007-04	Closed	Failure to make a 1 hour report.
AV 70-1151/2017-007-01	Open	Failure to ensure a high-consequence accident sequence remained highly unlikely

AV 70-1151/2017-007-02	Open	Failure to assure that under credible normal and abnormal conditions, all nuclear processes were subcritical including use of an approved margin of subcriticality
AV 70-1151/2017-007-03	Open	Failure to establish adequate management measures to ensure that IROFS to perform their function when needed
AV 70-1151/2017-007-04	Open	Failure to make a 1 hour report.

Inspection Procedures Used

IP 88015 Nuclear Criticality Safety
IP 88020 Operational Safety
IP 88025 Maintenance and Surveillance of Safety Controls
IP 88070 Plant Modifications
IP 92703 Follow-up of Confirmatory Action Letters or Orders

Key Documents Reviewed

Procedures:
COP-801016, Inspection of Building Ventilation Ducts with Boroscope, Rev. 9
COP-814321, Inspection of Ventilation Ducts, Rev. 15
COP-815020, Scrap Recovery Scrubber S-1030, Rev(s). 0, 5, 6, and 7
COP-815021, S-1030 Inspection and Clean Out, Rev(s). 0, 1, 2, 3, 4, 5, 6, 7, and 8
COP-815023, S-2A and S-2B Inspection and Clean Out, Rev. 0
COP-874086, Inspection of Ventilation Ducts, Rev. 3
COCL-U01, Determination of Uranium by Potentiometric Titration, Rev. 35
COCL-U02, Preparation of Samples for Uranium Analysis by Potentiometric Titration, Rev. 14
MCP-108104, Changing Roof-Top (HEPA) Intermediate and Pre-Filters, Rev. 30
MCP-108218, Inspection of Roof Ventilation Ducts with Boroscope, Revs. 7 and 8
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List of Acronyms Used

ADU	Ammonium Diuranate
ADR	Alternative Dispute Resolution
AIT	Augmented Inspection Team
AUF	Ammonium Uranyl Fluoride
AV	Apparent Violation
CAP	Corrective Action Program
CAPR	Corrective Action to Prevent Reoccurrence
CF	Control Form
CFFF	Columbia Fuel Fabrication Facility
CFR	Code of Federal Regulations
CM	Configuration Management
CSE	Criticality Safety Evaluation
EA	Enforcement Action
EDS	Energy Dispersive X-ray Spectroscopy
EH&S	Environment, Health and Safety
EN	Event Notification
FAW	Facility Walkthrough Assessment
IFBA	Integral Fuel Burnable Absorber
IROFS	Items Relied on for Safety
ISA	Integrated Safety Analysis
Kg	Kilogram
MCL	Materials & Chemistry Laboratory, Inc.
NCS	Nuclear Criticality Safety
NRC	Nuclear Regulatory Commission
PEC	Pre-decisional Enforcement Conference
PM	Preventive Maintenance
RCA	Root Cause Analysis
Rev.	Revision
RWP	Radiation Work Permit
SNM	Special Nuclear Material
SSC	Safety Significance Controls
U	Uranium
URI	Unresolved Item
WT	Percent by Weight