



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

December 21, 2017

EA-17-190

Mr. B. Joel Burch
Vice President and General Manager
BWXT Nuclear Operations Group, Inc.
P.O. Box 785
Lynchburg, VA 24505-0785

**SUBJECT: BWXT NUCLEAR OPERATIONS GROUP – NUCLEAR REGULATORY
COMMISSION – INSPECTION REPORT NO. 70-27/2017-008**

Dear Mr. Burch:

This letter refers to the inspections conducted by the U.S. Nuclear Regulatory Commission (NRC), both onsite and in-office, which were completed on December 11, 2017, regarding events associated with accumulation of uranium in desiccant vessels in the Research and Test reactor (RTR) area. The purpose of these inspections 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 these inspections. A final exit briefing was conducted (telephonically) with you on December 11, 2017.

Based on the results of these inspections, three 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 August 30, 2017, the NRC completed a Special Inspection at your BWXT NOG Lynchburg facility. The details of this inspection were documented in Inspection Report 70-27/2017-007 (ML17251A001). The Special Inspection Team (SIT) was established to inspect and assess the facts and circumstances surrounding accumulation of uranium in desiccant vessels in the Research and Test Reactor (RTR) area. This event was reported to the NRC on July 4, 2017, via a one hour report (EN #52840) based on Title 10 of the *Code of Federal Regulations* (10 CFR) 70 Appendix A(a)(4), "An event or condition such that no items relied on for safety, as documented in the Integrated Safety Analysis summary, remain available and reliable, in an accident sequence evaluated in the Integrated Safety Analysis (ISA), to perform their function."

The first AV 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 AV involved the failure to assure that under normal and credible abnormal conditions, the UAl_x glovebox air purifier system was subcritical as required by 10 CFR 70.61(d). This violation is further discussed in Section A.2 of this inspection report. The third AV involved the failure to maintain adequate process safety information for process systems associated with the UAl_x glovebox systems as required by

10 CFR 70.62(b). This violation is further discussed in Section A.3 of this inspection report. Additionally, this report will administratively close the three unresolved items (URIs) identified in Inspection Report 07-27/2017-007.

Before the NRC makes its enforcement decision, we are providing you an opportunity to: (1) respond in writing to the apparent violations addressed in this inspection report within 30 days of the date of this letter, (2) request a Pre-decisional Enforcement Conference (PEC), or (3) 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 provide a written response, it should be clearly marked as a "Response to Apparent Violations in NRC Inspection Report 70-27/2017-008" and should include for each AV: (1) the reason for the apparent violation or, if contested, the basis for disputing the apparent violation; (2) the corrective steps that have been taken and the results achieved; (3) the corrective steps that will be taken; and (4) the date when full compliance will be achieved. Your response may reference or include previously docketed correspondence, if the correspondence adequately addresses the required response. Additionally, your response should be sent to the NRC's Document Control Center, with a copy mailed to Mark Lesser, U.S. Nuclear Regulatory Commission Region II- Marquis One Tower, 245 Peachtree Center Avenue North East, Suite 1200, Atlanta, GA 30303-1257, within 30 days of the date of this letter. If an adequate response is not received within the time specified or an extension of time has not been granted by the NRC, the NRC will proceed with its enforcement decision or schedule a PEC.

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 PEC 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 actions, you should be aware that the promptness and comprehensiveness of your actions will be considered in assessing any civil penalty for the AVs. The guidance in NRC Information Notice (IN) 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-nrc/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 AVs 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 and Procedure," 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 Agencywide 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. 70-27
License No. SNM-42

Enclosure:
NRC Inspection Report 70-27/2017-008
w/Supplemental Information

cc:
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SUBJECT: BWXT NUCLEAR OPERATIONS GROUP – NUCLEAR REGULATORY COMMISSION – INSPECTION REPORT NO. 70-27/2017-008

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ADAMS: Yes
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U. S. NUCLEAR REGULATORY COMMISSION
REGION II

Docket No.: 70-27

License No.: SNM-42

Report No.: 70-27/2017-008

Licensee: BWXT Nuclear Operations Group, Inc. (BWXT)

Location: Lynchburg, VA

Dates: August 30, 2017 to December 11, 2017

Inspectors: N. Pitoniak, Senior Fuel Facility Inspector
P. Glenn, Fuel Facility Inspector
T. Sippel, Fuel Facility Inspector

Approved by: M. Lesser, Director
Division of Fuel Facility Inspection

Enclosure

EXECUTIVE SUMMARY

BWXT NUCLEAR OPERATIONS GROUP NRC INSPECTION REPORT 70-27/2017-008

This announced and follow-up inspection was conducted to review the three unresolved items (URIs) that were identified during a separate U.S. Nuclear Regulatory Commission (NRC) Special Inspection Team (SIT) report and documented in Inspection Report 70-27/2017-007, dated September 7, 2017. Three apparent violations (AVs) were identified during this inspection.

1. An 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 maintain adequate process safety information for Process Systems, as required by 10 CFR 70.62(b). (Paragraph A.3)

Attachment
Supplemental Information

REPORT DETAILS

Summary of Plant Status

BWXT Nuclear Operations Group (BWXT) is authorized to receive, possess, use, store, and ship special nuclear material pursuant to Title 10 of the Code of Federal Regulations (10 CFR) Part 70. The primary activity on the BWXT site is the production of fuel material containing highly enriched uranium (HEU) for naval reactors. In addition, BWXT has other operations including the production of uranium fuel for research reactors in the area of the plant known as Research and Test Reactors (RTR).

Background:

On July 4, 2017, during the licensee's summer maintenance shutdown, the licensee was performing maintenance work on the glovebox air purification system of the uranium aluminum (UAl_x) powder production line in RTR. The glovebox line operated under an inert argon atmosphere that was maintained using the air purification system that housed the two desiccant vessels that unknowingly accumulated uranium. The purification system utilized a vacuum pump to maintain the glovebox line at a negative pressure for radiological control purposes. The purification system was connected to the glovebox line through a network of 3/8" to 5" ducts. The purification system recirculated the atmosphere to remove any oxygen and water that may have leaked in. The vacuum pump exhausted glovebox atmosphere through an air gap to the building ventilation system when it was removing atmosphere from the glovebox line.

Filters were present on the inlets and outlets of the five inch purification lines leading to and from the purifier system. Two type of filters were used inside the glovebox line for the purification lines: a carburetor type and a nine inch HEPA type. These filters were collectively referred to as pre-filters by the licensee. The crushing and blend gloveboxes, in which the most dust is mobilized, had a nine inch HEPA pre-filter on the inlet to the recirculation line. The crushing box had an extra six inch filter (the auxiliary filter) outside the glovebox on the purification line immediately after the nine inch HEPA.

During the removal of the two desiccant vessels attached to the air purification system, the licensee identified an accumulation of uranium bearing material within the vessels. After contacting nuclear criticality safety (NCS) to evaluate the situation, the licensee estimated that a potentially greater than critical mass of uranium-235 (²³⁵U) may have accumulated within one of the vessels. The licensee subsequently declared an alert and made a one hour report to the NRC, per 10 CFR 70 Appendix A, due to having no controls, as documented in the integrated safety analysis (ISA), for the accumulation of material within the desiccant vessels.

The licensee later determined that this upset condition had been analyzed in a 1986 NCS Evaluation as a result of an event in which they had discovered material missing. However, this NCS evaluation was not referenced in the ISA, nor were the controls that were established at that time maintained. The 1986 NCS evaluation had required a total system cleanout, including emptying the desiccant vessels, when the inventory difference exceeded a certain threshold. The licensee did not continue to monitor for accumulation and perform cleanouts, instead the licensee modified the UAl_x glovebox line to include nine inch HEPA 'pre-filters' on the outlets heading to the purification system. Over the years the original purpose of these filters was lost and they were not included in the ISA as items relied on for safety (IROFS) when Subpart H was issued. In a later revision of the ISA the licensee included these filters as IROFS, however, they erroneously considered them to be preventing an accumulation in the HVAC system.

A. Inspection Scope:

The inspection included a review of each unresolved item (URI) identified during the Nuclear Regulatory Commission's (NRC's) Special Inspection Team (SIT) Inspection Report 70-27/2017-007 (ML1725A001). Three apparent violations (AVs) were identified as part of the URI review and are described below.

1. Failure to Ensure Criticality Accident Sequences Remain Highly Unlikely.

Introduction: An 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 accident sequences associated with the RTR UAl_x glovebox line were sufficient to ensure a criticality was highly unlikely.

Description: On July 4, 2017, during the licensee's summer maintenance shutdown, the licensee was performing maintenance work on the glovebox air purification system of the UAl_x powder production line in the RTR controlled area. This glovebox line took HEU alloy 'buttons' and crushed them into a powder that was used to make fuel. The key operation for the glovebox line occurred in the "crushing box" that housed a jaw crusher and a hammer mill which were used in series to pulverize the alloy buttons into a powder and then sieve the powder into the right particle size, an operation that mobilizes a lot of material within the box. The next step in the process occurred in the blend glovebox, in which the licensee blended the powder coming from the crushing box into the right mixture for the fuel they were making.

The licensee identified an unexpected accumulation of approximately 900 grams of ²³⁵U that had leaked past the 9-inch HEPA filters. These filters were designated as IROFS in the licensee's ISA, however, based on the accumulation of material in excess of a minimum critical mass, these IROFS were not effective. The licensee identified the cause of the deficient filters to be leakage as a result of improper alignment and sealing during installation. The licensee replaced the filters following each material processing campaign.

Analysis: On August 10, 2017, the licensee submitted its 60-day written report (60-Day Written Report for Event Notification Number 52840, dated August 9, 2017). The 60-Day written report provided information for review and consideration on assessing the actual and potential safety significance of the identified condition. The actual safety significance was none, because no criticality occurred. Based on information provided by the licensee and the NRC inspectors' risk assessment performed in accordance with Inspection Manual Chapter (IMC) 2606 to determine the potential safety significance, the NRC inspectors determined that criticality was *unlikely* at the time of the event based on the licensee's ISA methodology. Therefore, it aligns with the example in Section 6.2.c.1 of the Enforcement Policy, which states, "Under 10 CFR Part 70, Subpart H, a high-consequence event is 'unlikely' based on a licensee's ISA." The information provided by the licensee and the inspectors' assessment of the potential safety significance is discussed below.

This credible abnormal condition was not evaluated in the licensee's ISA, but a credited control, a 9-inch HEPA 'pre-filter' IROFS, was applicable to this sequence. The licensee credited this IROFS in their 60-day written report and also identified a double walled heat exchanger as an uncredited control (a non-IROFS) that was available and reliable to prevent the accident sequence by preventing the introduction of moderator. At the time of discovery of the

accumulation the cooling water for the heat exchanger was supplied from an IROFS borated water supply. However, the heat exchanger was not required to be supplied with borated water and the amount of boron (275 ppm ^{10}B) would be insufficient to prevent a criticality in the desiccant vessels.

The licensee calculated a mass accumulation of at least 126 kg of ^{235}U would be required to exceed the criticality safety limit ($.95 k_{\text{eff}}$) for an unmoderated accumulation of material. Additionally, the licensee calculated a mass accumulation of at least 2.25 kg of ^{235}U would be required to exceed the criticality safety limit ($.95 k_{\text{eff}}$) when moderated with borated water.

The licensee considered the initiating event to be an accumulation of uranium large enough for a criticality during a moderation upset. BWXT assigned it a score of -2¹ for an event that is not expected, but might occur during plant lifetime because of “the extended time (171 years) necessary to accumulate the mass of ^{235}U .” The degraded IROFS of the glovebox pre-filters is not credited as preventing this accumulation. The pathway created by the inadequate installation of the pre-filter allowed the uranium fuel material to bypass the pre-filter and, therefore, the NRC inspectors consider this control to be failed. The boron concentration in the cooling water is an IROFS for another accident sequence, although one that does not prevent this sequence. The licensee used the boron concentration to increase the masses in its calculation, and therefore the time to reach a critical mass. However, the licensee never required the heat exchangers to be connected to the IROFS borated water supply, nor has the licensee demonstrated that the heat exchangers were always connected to the borated water. Based on this, the NRC inspectors provided no credit for the heat exchanger being supplied from a borated water source.

The licensee assigned an Effectiveness of Protection score of 3 to the uncredited moderator control provided by the double walled heat exchanger. The heat exchanger was of a robust design that was originally intended as a chemical safety control by the manufacturer. As such, for water to leak from the cooling water supply into the desiccant vessels, the wall of the cooling line and gas lines must be failed simultaneously at adjacent points. The licensee leak tested the heat exchangers to verify the integrity of the tubing. No leaks were identified. X-ray evaluation of the heat exchangers confirmed the interior configuration and detected no signs of degradation in the tube walls.

Taken together the licensee assigned this sequence an Overall Accident Likelihood of -5. This correlates to Highly Unlikely as per the licensee’s ISA methodology (see Table 3.2.4-4 from Chapter 3 of the licensee’s License Application, below).

¹ The licensee’s ISA methodology uses negative numbers for initiating events, and positive numbers for effectiveness of protection.

Table 3.2.4-4: Risk Assessment Table

		Overall Likelihood of Accident					
		Highly Unlikely	Unlikely		Not Unlikely		
		≤ -4	-3	-2	-1	0	1
Severity of Consequences	High	6					
		5					
	Intermediate	4					
		3					
	Low	2	BELOW SEVERITY THRESHOLD				
		1					
		0					

	= Risk Zone 1 (Does not meet performance criteria, immediate corrective action required)
	= Risk Zone 2 (Does not meet performance criteria, corrective action required within time limited waiver)
	= Risk Zone 3 (Meets performance criteria, no corrective action required or acceptable for startup of new operation)

In their 60-day Report, the licensee considered two accident sequences. Sequence #1 being a unmoderated criticality due to a mass upset, in which sufficient uranium accumulates to cause a criticality without the presence of additional moderator. Sequence #2, involves a smaller amount of uranium accumulation, followed by a moderator upset due to failure of the double walled heat exchanger. The licensee considered Sequence #1 to be not credible due to the amount of time it would take that much uranium to accumulate.

For Sequence #1, the licensee used the observed accumulation rate (the 0.9 kgs in 30 years) to calculate the time needed to accumulate enough material for an unmoderated criticality. However, the inspectors note that this credits the as found condition (i.e., the licensee's determination of the partial functionality of the pre-filter IROFS, as well as the historical throughput). It is not known if the observed accumulation occurred evenly over the 30 years or as a result of filter misalignments lasting for a much shorter period. Therefore, the NRC inspectors consider the initiating event frequency to align with either the licensee's ISA methodology for an initiating event that would be scored at -3 or -2 (i.e., one that is "Not expected to occur during plant lifetime" or "Not expected, but might occur during plant lifetime"). However, it should also be noted that for the initiating event to occur it could also require missed opportunities to detect, since the accumulation rate would probably have to be significantly greater than the observed accumulation rate and may constitute the loss of a large fraction of the glovebox through put. This is demonstrated by the fact that the existing accumulation was

discovered during maintenance activities, and by the fact that the unfiltered accumulation rate (in 1986) triggered an investigation. In summary, the inspectors disagree with the licensee's conclusion that Sequence #1 is not credible, because that is based on the observed accumulation rate which credits the partial functionality of the pre-filter IROFS. Instead, the inspectors consider the overall likelihood to be either -3 or -2 as discussed above.

For Sequence #2, the NRC inspectors disagree with the licensee, and in light of the fact that the desiccant vessels had accumulated roughly 0.9 kilograms of HEU, the NRC considers that no credit should be given for the initiating event as more than a minimum critical mass was already present in the system. The NRC inspectors determined that 0.9 kilograms of HEU is more than a critical mass based on a fully moderated (no borated water source) condition with no credit provided for a borated water source as previously discussed, based on the lack of the licensee's configuration and control of the borated water source with regards to the glovebox purification system. While an initiating event credit of -2, which the licensee proposed, may be appropriate for a clean system with a known leak rate (thus allowing periodic cleanouts), the NRC inspectors do not consider this credit appropriate for a system which had already accumulated more than a minimum critical mass. With regards to the credit that could be applied to the non-IROFS heat exchanger the inspectors acknowledge that this double walled exchanger is extremely robust and was available and reliable to prevent this accident sequence. However, the licensee's ISA methodology requires that for an Effectiveness of Protection score of 3, the IROFS be "an inspected passive safety device." The NRC inspectors acknowledge that this type of double walled heat exchanger is a robust barrier, and when this specific heat exchanger was inspected following the event, it did not appear to have any degradation. Although the heat exchanger appears to show no signs of degradation, the licensee performed no periodic inspection or testing of the heat exchanger to meet the minimum threshold for inspecting an "inspected passive safety device." The licensee's typical inspection management measure for heat exchangers is a yearly inspection, and not one that would occur after approximately 30 years. Annual inspection is a required management measure for a score of 3 so the inspectors propose a reduced credit of 2 for this non-IROFS in accordance with IMC 2606. IMC 2606 Section 06.01(b) states, "It is prudent for the staff to always err on the side of conservatism when assessing risk not based on the licensee's own safety analysis, because the licensee is primarily responsible for safety. However, if the licensee did not apply management measures sufficient to ensure 'high reliability' then it would be appropriate to reduce the score to greater than -3 (e.g. -2)." In this case, the heat exchangers were installed as chemical safety controls by the manufacture and were in place for about 30 years each for a combined operating time of about 60 years, after which they were found not to have leaked or degraded. Therefore, the inspectors determined that it is appropriate to apply a score of 2 for this non-credited control. Applying this partial credit for the heat exchanger results in a likelihood of *unlikely* per the ISA methodology.

Although there was no actual safety consequence to the public, there was sufficient material available in the UAI_x glovebox air purifier system desiccant vessels for a criticality to occur. The potential safety consequence to the public is assessed as high since the licensee failed to assure that the likelihood of a high consequence event was highly unlikely.

Enforcement: 10 CFR 70.61(a) requires, in part, that the licensee evaluate, in its ISA performed in accordance with 70.62, its compliance with 10 CFR 70.61(b).

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.

Contrary to this requirement, on or before July 4, 2017, the licensee failed to apply sufficient controls to reduce the likelihood of occurrence of a high consequence event to *highly unlikely*. Specifically, the licensee failed to limit the likelihood of an inadvertent criticality to highly unlikely in the RTR when an accumulation of material was identified in two unfavorable geometry desiccant vessels. The engineered IROFS (filters) failed to limit mass accumulation of material, rendering them unreliable to perform the intended function.

The licensee took immediate corrective actions to restore compliance including ensuring adequate spacing was established between the two desiccant vessels to preclude interaction of material within the vessels. The site Emergency Operations Center (EOC) was activated and an Alert declaration was declared in accordance with the Mt. Athos Emergency Plan. Initial NDA measurements were obtained to estimate the material loading of each desiccant vessel. The licensee conducted a root cause investigation that was completed on August 14, 2017. The licensee documented the results in their corrective action program under CA201700895.

The licensee's failure to ensure that the likelihood of each credible high consequence event was maintained highly unlikely will be tracked as AV 70-27/2017-008-001, "Failure to ensure criticality accident sequences remain highly unlikely." URI 70-27/2017-003 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.

2. Failure to Assure that all Nuclear Processes 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 the desiccant vessels remained subcritical under normal and credible abnormal conditions.

Description: As previously discussed in Section A.1, the licensee had not considered accident sequences related to the purifier systems, including an accumulation of material in desiccant vessels, in the ISA. As a result the licensee had not evaluated potential accident sequences for compliance with 10 CFR 70.61(d). Although, IROFS and others controls existed, and prevented a criticality, the resulting likelihood of criticality was not assessed using the licensee's ISA methodology.

Analysis: As discussed previously in the background section, the licensee had analyzed the accumulation of uranium in the desiccant vessels in the 1986 NCS Evaluation. However, due to the loss of process safety information, which led to the failure to include the accumulation sequence in the ISA, they failed to assure that under normal and credible abnormal conditions, all nuclear processes are subcritical, as required by 10 CFR 70.61(d).

Although there was no actual safety consequence to the public, there was sufficient material available in the UAl_x glovebox air purifier system desiccant vessels 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 failure to assure that under normal and credible abnormal conditions all nuclear processes are subcritical as required by 10 CFR 70.61(d) is considered to be more-than-minor as addressed by NRC IMC 0616, "Fuel Cycle Safety and Safeguards Inspection Reports," Appendix B screening question #11, "Does the violation result in the failure to ensure that all nuclear processes are subcritical with an approved margin of sub-criticality for all normal and credible abnormal conditions as required by 10 CFR 70.61(d)?"

Enforcement: 10 CFR 70.61(d) requires, in part that, in addition to complying with paragraph (b) of this section, the risk of nuclear criticality accidents must be limited by assuring that under normal and credible abnormal conditions, all nuclear processes are subcritical.

Contrary to this requirement, on or before July 4, 2017, the licensee failed to assure that under normal and credible abnormal conditions, the UAl_x glovebox air purifier system desiccant vessels were subcritical. This failure to assure subcriticality (prevent a criticality) resulted from the failure of the pre-filters to limit mass accumulation, and the licensee's failure to continue to monitor for accumulation of material or perform periodic cleanouts or inspection of the system.

The licensee shutdown all process areas and performed an extent of condition. Based on the extent of condition, all areas affected completed a detailed engineering review and required senior management approval prior to restart. The licensee conducted a root cause investigation with resulting corrective actions documented in corrective action CA201700895.

The failure to assure subcriticality is identified as AV 70-27/2017-008-002, "Failure to assure that under credible normal and abnormal conditions, all nuclear processes were subcritical including use of an approved margin of subcriticality." 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. **Introduction:** An AV was identified for the adequacy of the licensee's documentation of process safety information needed in order to conduct and maintain the ISA.

Description: Over the course of the operating history of the system since procurement in 1985, the licensee developed gaps in information related to configuration control, analysis of hazards, and equipment modifications associated with the system. The UAl_x glovebox system commenced operation in 1986 with small carburetor type filters used as pre-filters on piping connected to the desiccant vessels. After a few lots of material were processed a loss of material was identified by the licensee. NCS issued NCS-1986-075 which considered the possibility that the fuel was accumulating within ducts or within the gas purification system. NCS issued NCS-1986-087 which established actions to remove accumulations in the purification system when cumulative losses approached 600 grams ²³⁵U. The system was cleaned up and the desiccant media replaced. New nine inch HEPA Filters were put into place for the crushing and blend gloveboxes as it appeared that the carburetor filters were not effective in preventing the accumulation of material. The licensee monitored accumulation for about six months then stopped once they found no accumulation. These controls were not included in the ISA when it was first being developed in 1998.

In 2005, the licensee established mass limits on ductwork accumulations that had not been formally considered before; and the existing nine inch HEPA pre-filters were credited as IROFS. NCS was not aware of the desiccant vessels. Starting in 2013, the UAI_x glovebox line was moved from one location in RTR area to another. The change package noted that there were no piping and instrumentation drawings (P&IDs) of the glovebox line. A contractor was contaminated during the move of the UAI_x glovebox line. The licensee discovered that no P&IDs were available, however, no corrective actions were assigned to address the source of the contamination or to generate P&IDs.

The NRC inspectors reviewed the licensee's ISA documents and the series of nuclear criticality safety evaluations (NCSEs) that are referenced in the SAR for that glovebox line. The inspectors noted that the SARs and NCSEs did not identify the purification system tied into the UAI_x glovebox line; and did not evaluate or consider the unfavorable geometry collection point that the desiccant vessels represented.

Analysis: There was no actual safety consequence to the public because the as-found material remained in a subcritical state, however, the potential safety consequence to the public is high as the licensee failed to maintain adequate process safety information that lead to an accumulation of material that resulted in the licensee not meeting the performance requirements of 10 CFR 70.61(b) for a high consequence event with a likelihood of *highly unlikely*.

The licensee's inadequate maintenance of process safety information (a violation of 10 CFR 70.62(b)), including information pertaining to the hazards (i.e., that contamination was accumulating in the desiccant vessels), and information pertaining to the technology and equipment (i.e., how the purification system worked, the intended function of the 9-inch HEPA pre-filters, the presence of the unfavorable geometry desiccant vessels) resulted in them being unable to perform a proper ISA in accordance with 10 CFR 70.62(c), which resulted in a failure to meet 10 CFR 70.61(b). Therefore, it aligns with the example in Section 6.2.c.1 of the Enforcement Policy, which states, "Under 10 CFR Part 70, Subpart H, a high-consequence event is "unlikely" based on a licensee's ISA."

Enforcement: 10 CFR 70.62(b) requires, in part, that each licensee shall maintain process safety information to enable the performance and maintenance of an ISA. This process safety information must include information pertaining to the hazards of the material used or produced in the process, information pertaining to the technology of the process, and information pertaining to the equipment in the process.

Contrary to this requirement, on or before July 4, 2017, the licensee failed to maintain adequate process safety information, including information pertaining to the hazards and information pertaining to the technology and equipment. Specifically, the licensee failed to identify the potential accumulation of material in the two non-safe geometry desiccant vessels. The licensee failed to fully understand the process for a potential buildup of material as previously identified in a 1986 Nuclear Criticality Safety Analysis. Additionally, the licensee failed to fully understand the design of the purification system and the design and function of the 9-inch HEPA pre-filters installed. Following installation of the HEPA pre-filters, the licensee did not continue to monitor for accumulation of material or perform periodic cleanouts or inspection of the system. The potential hazards of the system were not maintained, and therefore, not adequately evaluated for inclusion in the ISA resulting in an inability to adequately address the

hazard in the ISA as required by part 10 CFR 70.62(c). As a result, an accumulation of material was identified and resulted in a failure to maintain the performance requirements of 10 CFR 70.61(b) for a high consequence event.

The licensee immediately performed non-destructive analysis (NDA) measurements and gamma spectroscopy measurements to determine the quantity of material present. An immediate extent of condition was conducted, all areas were shut down, and a detailed engineering review conducted on all processing areas with senior management approval required for restart. The licensee completed a root cause investigation and corrective actions are documented in corrective action CA201700895.

The licensee's failure to maintain an adequate process safety information for process systems as required by 10 CFR 70.62(b) is identified as AV 70-27/2017-008-003, "Inadequacy of Process Safety Information for Process Systems." URI 70-27/2017-002 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.

4. Conclusion

Three AVs of NRC requirements were identified.

The licensee's failure to ensure that the likelihood of each credible high consequence event was maintained "highly unlikely" is identified as AV 70-27/2017-008-001. The failure to assure subcriticality is identified as AV 70-27/2017-008-002. The licensee's failure to maintain an adequate process safety information for process systems as required by 10 CFR 70.62(b) is identified as AV 70-27/2017-008-003.

EXIT MEETING:

The inspectors presented the inspection results to B. Joel Burch and members of staff management on December 11, 2017. The plant staff acknowledged the findings presented.

SUPPLEMENTAL INFORMATION

Key Points of Contact

<u>Name</u>	<u>Title</u>
J. Burch	Vice President and Plant General Manager
D. Faidley	Unit Manager, Nuclear Criticality Safety
T. Faix	Operations Engineer
R. Johnson	Licensing Engineer
J. McNeel	Health Physicist
B. Thilking	NCS Engineer
B. O'Donnell	NCS Engineer
G. Pritchett	NMC Engineer
L. Ragland	Unit Manager, Recovery
D. Spangler	Manager, Nuclear Safety and Licensing
C. Terry	Unit Manager, Licensing and Safety Analysis
R. Vohden	Recovery Engineer
D. Ward	Department Manager, Environmental, Safety, Health and Safeguards

List of Items Opened, Closed, and Discussed

<u>Item Number</u>	<u>Status</u>	<u>Type/Description</u>
URI 70-27/2017-007-001	Closed	Evaluate the Adequacy of the Licensee's Long-Term Corrective Actions
URI 70-27/2017-007-002	Closed	Adequacy of Process Safety Information for Process Systems
URI 70-27/2017-007-003	Closed	Assess the Likelihood of Criticality with Respect to 10 CFR 70.61
AV 70-27/2017-008-001	Open	Failure to ensure a high-consequence accident sequence remained highly unlikely
AV 70-27/2017-008-002	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 70-27/2017-008-003	Open	Inadequacy of Process Safety Information for Process Systems

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 88075 Follow-up

Key Documents ReviewedProcedures

E41-134, Annual Ductwork Survey, Revision (Rev.) 15
 OP-0006506, Crushing and Blending UA_x, Rev. 9
 OP-1001087, Safety Procedures for Boxline Operations/Repairs, Rev. 14
 Maintenance Plan 2265
 RWP 17-0045, Replace Dri-Train Media and DP Gauge Installation, Rev. 0

Records

CR-1042792, Fuel Fabrication Glove Box Hammer Mill Shaft Seal, Rev. 0
 NCS-1986-075, Fuel Deficit in the UA_{I_x} Powder Line, dated September 29, 1986
 NCS-1986-087, Fuel Deficit in the UA_{I_x} Powder Line, dated October 15, 1986
 NCS-2007-012, Level Two Criticality Safety Analysis to Determine the Safety of Pre-Filters in the RTR gloveboxes that Protect Ductwork from the Dispersible Forms of Uranium, dated January 25, 2007
 NCS-2016-128, NCS Review of Ventilation Systems in Response to the Westinghouse S-1030 Scrubber Uranium Build-up Event, dated November 2, 2016
 NCS-2017-108, NCS Calculations for RTR Desiccator Unit – 1050g U235 cylinder geometry, dated July 4, 2017
 NCS-2017-109, NCS Calculations for RTR Desiccator Unit – 715g U235 cylinder geometry, dated July 5, 2017
 NCS-2017-110, Safety Concern Analysis for RTR UA_{I_x} Glovebox Purification System – Desiccator Unit Uranium Accumulation (CA201700895), dated July 6, 2017
 NCS-2017-118, NCS Calculations for RTR Purifier Unit – 2 cylindrical units in Cabinet, dated July 31, 2017
 NCS-2017-120, RTR Desiccant Unit U235 Accumulation Flow Path Review, dated August 9, 2017
 PIRT Report 17-01 CA201700895 – July 4th, RTR, dated August 14, 2107
 RPTWR 2017-017, RTR DRI-TRAIN Vessel U-235 Estimation, dated July 6, 2017, and July 9, 2017
 RTR Process Monitoring 2017-002, Process Unit 2 – HEU Jaw Crusher
 RTR Process Monitoring 2017-001, Process Unit 2 – HEU Jaw Crusher
 RTR Process Monitoring 2016-002, Process Unit 2 – HEU Jaw Crusher
 Safety Analysis Report 15.22, RTRT (Research Test Reactor and Targets) Fuel Powder and Compact Processes, Rev. 80, dated September 12, 2016
 SER 13-008 Phase 01

Other Documents

Dri-Train Technical Manual, Model MO-120-2
 Post Incident Statement, by S-1 MBA Custodian, dated July 9, 2017
 Post Incident Statement, by Former MBA Custodian, dated July 10, 2017
 Post Incident Statement, by Former NCS Engineer, dated July 9, 2017

Requisition No. TCF-14-11, dated April 29, 2014

Root Cause Analysis Report 17-01, dated August 14, 2017

60-Day Written Report for Event Notification Number 52840, dated August 9, 2017