



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

March 8, 2018

EA-17-190
EN-52840

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, INC. - NUCLEAR REGULATORY
COMMISSION INSPECTION REPORT 70-27/2018-006 AND NOTICE OF
VIOLATION**

Dear Mr. Burch:

This letter refers to a Nuclear Regulatory Commission (NRC) special inspection completed on August 30, 2017, as well as additional inspections completed on December 11, 2017, regarding your July 2017 discovery of accumulation of uranium in desiccant vessels in the Research and Test Reactor (RTR) area, at the BWXT Nuclear Operations Group (BWXT) facility, located in Lynchburg, VA. The details of the special inspection are documented in NRC Inspection Report 70-27/2017-007 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17251A001).

Additionally, NRC Inspection Report 70-27/2017-008 (ADAMS Accession No. ML17355A206) was issued on December 21, 2017, and documented the identification of three apparent violations that were considered for escalated enforcement. The inspection report provided BWXT with the opportunity to address the apparent violations by attending a predecisional enforcement conference, by attending alternative dispute resolution, or by providing a written response before we made our final enforcement decision.

In a letter dated January 19, 2018, BWXT provided a written response to the three apparent violations. The response acknowledged the three apparent violations, provided the circumstances resulting in your identification of accumulation of uranium in the desiccant vessels, the causes of the violations, and described corrective actions taken to preclude recurrence. In your written response, you detailed the bases for your conclusion that the violations were not risk significant to warrant escalated enforcement action (i.e., an inadvertent criticality remained "highly unlikely").

Based on the information developed during the inspections, and the information that you provided in your response dated January 19, 2018, the NRC has determined that three violations of NRC requirements occurred. The violations are cited in the enclosed Notice of Violation (Notice) (Enclosure 1) and the circumstances surrounding them are fully described in

detail in NRC Inspection Report 70-27/2017-008. In summary, the first violation involves the failure to ensure that high consequence accident sequences remain highly unlikely as required by 10 CFR 70.61(b). The second violation involves the failure to assure that under normal and credible abnormal conditions, the UAI_x glovebox air purifier system was subcritical as required by 10 CFR 70.61(d). The third violation involves the failure to maintain adequate process safety information for process systems associated with the UAI_x glovebox systems as required by 10 CFR 70.62(b).

The NRC recognizes that the violations did not result in any actual consequences to the workers, the public, or the environment, since no criticality occurred. In this case, the as-found accumulation of uranium in desiccant vessels did not represent an actual critical mass of material for either a dry or fully moderated postulated condition.

BWXT's written response of January 19, 2018, provided a risk assessment in support of its conclusion that a criticality remained "highly unlikely." The NRC carefully evaluated BWXT's additional information, and concluded that the accumulation of uranium in desiccant vessels represented a substantial increase in risk, as an inadvertent criticality was no longer "highly unlikely." Enclosure 2 provides the basis for the NRC's conclusion.

The NRC considers the potential consequences of the violations to be significant because the accumulation of uranium in desiccant vessels represented a substantial increase in risk, as an inadvertent criticality was no longer "highly unlikely." Additionally, BWXT's failure to adequately maintain process safety information, including hazards associated with the system, equipment configuration control of the system, and adequate evaluation and monitoring of controls associated with the system, allowed for the unidentified chronic accumulation of material throughout a lengthy period of time (i.e., from potentially 1986 to the time of discovery on July 4, 2017). In light of the above, and because the three violations are interrelated, the violations have been categorized together as a Severity Level III Problem in accordance with the NRC Enforcement Policy.

In accordance with the NRC Enforcement Policy, a base civil penalty in the amount of \$72,500 is considered for a Severity Level III problem. Because your facility has been the subject of escalated enforcement actions within the last two years¹, the NRC considered whether credit was warranted for *Identification* and *Corrective Action* in accordance with the civil penalty assessment process in Section 2.3.4 of the Enforcement Policy.

The accumulation of material was discovered by BWXT during troubleshooting maintenance activities on July 4, 2017. The NRC recognizes that prior opportunities may have existed for BWXT to identify the condition during the many years of potential accumulation of uranium material in the desiccant vessels. However, on the balance, the NRC concluded that credit is warranted for the civil penalty assessment factor of *Identification*, because BWXT staff were cognizant of the potential presence of material, and upon discovery, immediately took appropriate corrective actions.

As documented in your written response of January 19, 2018, the NRC recognizes that your immediate and long-term corrective actions included but were not limited to the following: (1) the immediate Emergency Operations Center (EOC) activation and declaration of an ALERT in accordance with the Mt. Athos Emergency Plan; (2) establishment of safe conditions of the affected system to ensure subcritical conditions and limit personnel access; (3) execution of an

¹ A Severity Level III violation was issued to BWXT NOG, Inc. on December 30, 2015 (EA-15-214).

extent of condition review including immediate suspension of operations outside the affected RTR area that used similar purification systems pending further investigation; (4) development of revised Probabilistic Hazard Analysis and Integrated Safety Analysis (ISA) procedures to ensure appropriate design information is reviewed to allow for the assessment of fuel accumulation; (5) establishment of division level requirements for the installation and maintenance of pre-filters installed on ventilation and ancillary systems to adequately limit material entry into these systems by addressing minimum design requirements, establishing replacement schedules, and monitoring for material loading to identify upset conditions; (6) implementation of a program to identify all penetrations in gloveboxes and ventilation hoods for ventilation and ancillary systems to require the change management program to be used for all new and modified penetrations and field markings to be provided for all penetrations; and (7) improvement of safety design basis documentation by implementing revision controlled nuclear criticality safety evaluations. Based on the above, the NRC determined that credit is warranted for the factor of *Corrective Action*.

Therefore, to encourage the prompt identification and comprehensive correction of violations, I have been authorized, after consultation with the Director, Office of Enforcement, not to propose a civil penalty in this case. However, significant violations in the future could result in a civil penalty.

The NRC has concluded that information regarding (1) the reason for the violations, (2) the corrective actions that have been taken and the results achieved, and (3) the date when full compliance will be achieved is already addressed on the docket in your letter dated January 19, 2018. Therefore, you are not required to respond to this letter unless the description therein does not accurately reflect your corrective actions or your position. In that case, or if you choose to provide additional information, you should follow the instructions specified in the enclosed Notice.

Administratively, apparent violations 70-27/2017-008-01, 70-27/2017-008-02, and 70-27/2017-008-03 are closed. The following violations are opened: 70-27/2018-006-01, failure to ensure that high consequence accident sequences remain "highly unlikely" as required by 10 CFR 70.61(b), 70-27/2018-006-02, 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), and 70-27/2018-006-03, 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).

In accordance with 10 CFR 2.390 of the NRC's "Agency Rules of Practice and Procedure," a copy of this letter, and its enclosures will be made available electronically for public inspection in the NRC Public Document Room and in the NRC's ADAMS, accessible from the NRC Web site at <http://www.nrc.gov/reading-rm/adams.html>.

B. Burch

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If you have any questions, please contact Eric C. Michel, Chief, Projects Branch 2 at (404) 997-4555.

Sincerely,

/RA/

Catherine Haney
Regional Administrator

Docket No. 70-27
License No. SNM-42

Enclosures:

1. Notice of Violation
2. NRC Evaluation of BWXT Written Response Regarding Significance

cc:

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SUBJECT: BWXT NUCLEAR OPERATIONS GROUP, INC. - NUCLEAR REGULATORY COMMISSION INSPECTION REPORT 70-27/2018-006 AND NOTICE OF VIOLATION

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SIGNATURE	/RA/	/RA/	/RA/	/RA/	/RA/	/RA/
NAME	NPitoniak	Derivative Classifier	EMichel	MKowal	SPrice	MLesser
DATE	3/8/2018	3/8/2018	3/8/2018	3/8/2018	3/8/2018	3/8/2018
E-MAIL COPY	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
OFFICE	OE	NMSS	RII:ORA			
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DATE	3/7/2018	3/8/2018	3/8/2018			
E-MAIL COPY	YES NO	YES NO	YES NO			

NOTICE OF VIOLATION

BWXT Nuclear Operations Group, Inc.
Lynchburg, VA

Docket No. 70-27
License No. SNM-42
EA-17-190

During NRC inspections conducted from July 5 – December 11, 2017, three violations of NRC requirements were identified. In accordance with the NRC Enforcement Policy, the violations are described below:

- A. Title 10 of the *Code of Federal Regulations* (10 CFR) 70.61(a) requires, in part, that the licensee evaluate, in its Integrated Safety Analysis (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 the above, prior to July 4, 2017, the licensee failed to limit the risk of a credible high consequence event and apply engineered controls, administrative controls, or both, to the extent needed to reduce the likelihood of its occurrence so that, upon implementation of such controls, the event was *highly unlikely*. Specifically, the licensee failed to apply sufficient controls to limit the likelihood of an inadvertent criticality to highly unlikely in two unfavorable geometry desiccant vessels located in the the Research and Test Reactor (RTR) area.

- B. 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 the above, prior to July 4, 2017, the licensee failed to assure that under normal and credible abnormal conditions, all nuclear processes were subcritical. Specifically, the licensee failed to assure that two unfavorable geometry desiccant vessels located in the RTR area remained subcritical under normal and credible abnormal conditions.

- C. 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 the above, prior to July 4, 2017, the licensee failed to maintain process safety information to enable the performance and maintenance of the ISA. Specifically, the licensee failed to maintain process safety information pertaining to the hazards, and information pertaining to the technology and equipment, of an air purification system servicing a glove-box line in the RTR area. This failure resulted in a failure to identify potential accumulation of fissile material in two unfavorable geometry desiccant vessels, an inability to adequately perform and maintain the licensee's ISA, and a failure to identify the potential accumulation in the desiccant vessels as a credible accident sequence in the development of the licensee's ISA

This is a Severity Level III Problem (Enforcement Policy Section 6.2.c.1).

The NRC has concluded that information regarding the reason for the violations, the corrective actions taken and planned to correct the violations and prevent recurrence, and the date when full compliance will be achieved, is already adequately addressed on the docket in your letter dated January 19, 2018. However, you are required to submit a written statement or explanation pursuant to 10 CFR 2.201 if the description therein does not accurately reflect your corrective actions or your position. In that case, or if you choose to respond, clearly mark your response as a "Reply to a Notice of Violation, EA 17-190", and send it to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, DC 20555-0001 with a copy to the Regional Administrator, Region II, within 30 days of the date of the letter transmitting this Notice of Violation (Notice).

If you choose to respond, your response will be made available electronically for public inspection in the NRC Public Document Room or in 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>. Therefore, to the extent possible, the response should not include any personal privacy, proprietary, or safeguards information so that it can be made available to the Public without redaction.

In accordance with 10 CFR 19.11, you may be required to post this Notice within two working days.

Dated this 8th day of March, 2018

NRC EVALUATION OF BWXT WRITTEN RESPONSE REGARDING SIGNIFICANCE

Summary of Information Provided

BWXT's written response of January 19, 2018, provided its risk assessment in support of its conclusion that a criticality remained "highly unlikely." In summary, BWXT provided additional information in three areas:

(1) BWXT provided additional information and requested consideration for additional initiating event credit. The licensee provided updated calculations for safety limits and critical mass requirements for both the unmoderated and fully moderated conditions. BWXT also provided calculations regarding the 'as found' accumulation rate of material and proposed bounding conditions that would limit the accumulation rate.

(2) BWXT provided information for applying additional credit to uncredited controls (heat exchanger). The licensee requested consideration of additional credit for configuration control as a management measure.

(3) BWXT provided updated analysis and calculations to assess their position that a critical mass of material was not present in the desiccant filters at the time of discovery.

The NRC performed a risk assessment in accordance with Inspection Manual Chapter (IMC) 2606, Assessment of the Change in Risk Resulting From a Violation at a Fuel Cycle Facility, based on the BWXT Integrated Safety Analysis (ISA) methodology. The following provides the NRC's conclusions related to each area.

Evaluation of Information Provided

1. Initiating Event Credit:

The NRC concluded that the credit requested by the licensee for the accumulation rate is not appropriate. The NRC acknowledges that the accumulation rate is limited to a chronic buildup rather than an acute buildup as an acute buildup would be detected by periodic inventory activities that would require investigation and resolution. The NRC concluded that the observed accumulation rate should not be credited as a bounding assumption as stated in your response letter of January 19, 2018. This would inappropriately credit the 'as found condition' because of the partial functionality of the failed item relied on for safety (IROFS) filters and the number of campaigns that happened to be processed through the UAI_x glovebox line. Neither of these constraints were adequately controlled as a means to limit the accumulation rate. Therefore, the accumulation rate would be more appropriately bound by the threshold of the ability to detect an acute buildup as described below.

The licensee performed additional calculations to support the proposed likelihood of "highly unlikely". The NRC considers the fully moderated condition (scenario #2 in your response letter) to be the more bounding condition. The BWXT revised calculations references a safety limit of 1.40 kg U235 per desiccant vessel with a total mass of 2.8 kg U235 for the two vessels combined. The licensee calculated an accumulation rate of 0.03044 kg U235 per year based on the discovered mass of 913g U235 in the two vessels accumulated over 30 years. Based on the provided buildup rate and the total "as found" U235 material, the

licensee determined that the Safety Limit of 1.40 kg per vessel for both vessels would require 92 total years to achieve and, therefore should be credited with a “-1” initiating event frequency per the ISA methodology. This equates to 1/10 years occurrence and is qualitatively described as “expected to occur sometime during plant lifetime.”

The NRC acknowledges this accumulation as a chronic buildup over the 30 year period and not an acute accumulation as an acute accumulation would be immediately identified during semi-annual inventories during the 30 year period. The NRC agrees with the observed accumulation of material at a rate of 0.03044 kg U235 per year, however, the licensee assumed an equal distribution of material to each desiccant vessel over the accumulation period. In fact, the “as found” condition identified 250.5 g U235 in desiccant vessel #1 and 662.7 g U235 in desiccant vessel #2. This equates to 27%/73% distribution of material in the two desiccant vessels, therefore, an equal distribution cannot be assumed as the distribution is not controlled. The amount of material distribution cannot be definitively determined over the future accumulation period. As such, the NRC concluded that all future accumulations could be deposited into a single desiccant vessel. Assuming the worst case scenario based on the observed accumulation rate calculated, all future accumulation could be deposited into desiccant vessel #2. With a starting value of 662.7 g U235 at an accumulation rate of 0.03044 kg U235 per year, desiccant vessel #2 would reach the safety limit of 1.4 kg U235 in an additional 24 years for a total time of 54 years vice the proposed 92 years calculated by the licensee. The NRC also concludes that the accumulation rate assessed by the licensee is based on the “as found” condition. Although the rate of the unidentified accumulation of material would be limited by semi-annual inventories, an accurate assessment of future buildup rates cannot be determined based on the past accumulation rate as the factors directly related to future accumulation rates (frequency of processing campaigns, the amount of material processed during a campaign, and the effectiveness of the IROFS filters) are not controlled with enough specificity to determine the future accumulation rate.

Therefore, because these factors of filter effectiveness and material processing were not being controlled by the licensee as it relates to the buildup rate, it is not appropriate to credit them as controlling the potential buildup rate to the observed buildup rate. The NRC acknowledges that the ‘as found’ accumulation was not large enough to cause a criticality in its ‘as found’ condition (i.e., in the desiccant vessels, with the desiccant beads present). However, a larger, still undetected accumulation could have caused a critical mass accumulation in a much shorter timeframe than calculated by the licensee and was not being prevented by the licensee through control of the frequency of material processing campaigns, the amount of material processed during campaigns, or periodically evaluating the effectiveness of IROFS filters in controlling the buildup rate of material. These factors are directly related to the accumulation rate of material. Without specific controls bounding the accumulation rate, the accumulation rate is subject to vary and cannot accurately be determined. Therefore, for risk assessment purposes the NRC considers a critical mass could have been present for the fully moderated condition. The NRC concludes that credit should not be given for initiating event frequency preventing a mass accumulation for the fully moderated scenario.

2. Crediting applicable to controls:

The NRC maintains that a credit of “2” for the non-IROFS heat exchanger for the fully moderated condition is appropriate. As discussed below, the NRC does not consider the management measures applied to the heat exchanger sufficient to warrant a credit of “3.”

The licensee provided additional information regarding NRC assessed credit for borated water and the installed heat exchanger. The licensee proposed a credit of “3” protection factor based on the robust design of the heat exchanger and indicate that management measures in the form of periodic inspections were not required to ensure availability and reliability, and that the stated inspection of a passive control as indicated in ISA Tables 3.2.4-1 and 3.2.4-3 are guidance and not requirements. The licensee provides examples of passive features such as design spacing between solution columns utilized as safety controls. The spacing of these columns is not specifically inspected, but maintained available and reliable via configuration control processes. BWXT establishes management measures for all safety features at the facility per license application section 11.1, “Configuration Management,” which states, in part, “The Configuration Management Process described in this chapter shall apply to all processes that have accident scenarios requiring Items Relied on for Safety to assure an acceptable risk profile.” The licensee acknowledges that there was no requirement for cooling to be provided by the heat exchanger as a control, and therefore, no documented analysis of the robust safety provided by the component.

The NRC identified a lack of detail provided in site drawings related to the desiccant purification system, a lack of engineering review and/or testing of installed equipment to include motor enclosures, HEPA pre-filters, and cooling water systems that exhibit an inadequate level of configuration control of the system. The HEU UAI_x glovebox line was relocated between February 2013 and May 2014 with the change package noting that there were no piping and instrument drawings (P&IDs) of the glovebox line available. In the absence of a documented evaluation and established heat exchanger periodic inspection determination, the availability and reliability would require robust configuration management as stated by the licensee. The NRC disagrees that the established configuration management process related to the desiccant filter purification system meets the threshold of management measures required under 10 CFR 70.62(d) to ensure the safety components are available and reliable to perform their function when needed.

Per the ISA methodology this results in this accident sequence being “unlikely” (i.e., -2) per the ISA risk assessment table.

3. Critical mass of material was not present:

The NRC notes that the accumulation rate of material can vary based on factors not specifically controlled by the licensee, but can only be bounded periodically by the thresholds established during semi-annual inventories. The specific distribution of material also cannot be accurately predicted. Nonetheless, the NRC agrees with BWXT’s assessment that a critical mass of material was not present in the desiccant vessels at the time of discovery of the material accumulation.

Based on the above, the NRC concluded that the accumulation of uranium in desiccant vessels represented a substantial increase in risk, as an inadvertent criticality was no longer “highly unlikely.”