

April 11, 2008

Mr. Roger P. Cochrane, General Manager  
BWX Technologies, Inc.  
P.O. Box 785  
Lynchburg, VA 24505-0785

SUBJECT: INSPECTION REPORT NO. 70-0027/2008-202

Dear Mr. Cochrane:

The U.S. Nuclear Regulatory Commission (NRC) conducted a routine announced nuclear criticality safety (NCS) inspection at your facility in Lynchburg, Virginia, March 10 - 13, 2008. The purpose of the inspection was to determine whether activities involving special nuclear materials were conducted safely and in accordance with regulatory requirements. An exit meeting was held on March 13, 2008, during which time the inspection observations and findings were discussed with members of your staff.

The inspection, which is described in the enclosure, focused on: (1) the most hazardous activities and plant conditions; (2) the most important controls relied on for safety and their analytical basis; and (3) the principal management measures for ensuring controls are capable, available, and reliable to perform their functions relied on for safety. The inspection consisted of analytical basis review, selective review of related procedures and records, examinations of relevant NCS-related equipment, interviews with NCS engineers and plant personnel, review of recent criticality safety-related events, and facility walkdowns to observe plant conditions and activities related to safety basis assumptions and related NCS controls. Throughout this inspection, observations were discussed with your managers and staff.

Based on the results of this inspection, the NRC has determined that one Severity Level IV violation of NRC requirements occurred. This violation is being treated as Non-Cited Violation (NCV), consistent with Section VI.A of the Enforcement Policy. The NCV is described in the subject inspection report. If you contest the violation or its significance, you should provide a response within 30 days of the date of this inspection report, with the basis for your denial, to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington DC 20555-0001, with copies to the Chief, Technical Support Branch, Division of Fuel Cycle Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001 and the Director, Office of Enforcement, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001.

In addition, three apparent violations of NRC requirements were identified and are being considered for escalated enforcement action in accordance with the NRC Enforcement Policy. The first apparent violation involved the failure to comply with fill and level check procedures for raschig ring vacuum cleaners (RRVCs). This apparent violation is based on multiple cases of RRVCs in your facility with insufficient raschig rings. Failure to adequately establish and maintain raschig ring level in nonfavorable geometry vessels seriously undermines the protection offered by raschig rings. The second and third apparent violations are related to the discovery that vacuum pumps on RRVCs are capable of drawing solution above the level of the raschig

rings. These apparent violations involved the failure to establish double contingency for RRVCs and the failure of RRVCs to comply with the national standard for raschig ring use as a criticality safety control, ANSI/ANS 8.5. Operation of raschig ring filled nonfavorable geometry equipment in a mode capable of increasing the fissile solution level above the raschig ring level poses an unacceptable risk of inadvertent criticality, particularly when coupled with inadequate processes for filling and checking raschig ring level prior to use. Since the NRC has not made a final determination in this matter, no Notice of Violation is being issued for these inspection findings at this time. 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. No response regarding the apparent violations is required at this time.

In accordance with 10 CFR 2.390 of NRC's "Rules of Practice," a copy of this letter and the enclosure will be made publicly available in the public electronic reading room of the NRC's Agency-Wide Document Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at <http://www.nrc.gov/reading-rm/ADAMS.html>.

If you have any questions concerning this report, please contact Dennis Morey, of my staff, at (301) 492-3112.

Sincerely,

/RA/

Deborah Jackson, Chief  
Technical Support Branch  
Division of Fuel Cycle Safety  
and Safeguards, NMSS

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

Enclosure: Inspection Report No. 70-0027/2008-202

cc: Barry Cole  
Licensing Officer  
BWX Technologies, Inc.

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

Docket No.: 70-27

License No.: SNM-42

Report No.: 70-0027/2008-202

Licensee: BWX Technologies, Inc.

Location: Lynchburg, VA

Inspection Dates: March 10 – 13, 2008

Inspectors: Dennis Morey, Senior Criticality Safety Inspector  
Thomas Marenchin, Criticality Safety Inspector

Approved by: Deborah A. Jackson, Chief  
Technical Support Branch  
Division of Fuel Cycle Safety  
and Safeguards, NMSS

**Enclosure**

## **EXECUTIVE SUMMARY**

### **BWX Technologies, Inc. NRC Inspection Report 70-27/2008-202**

#### **Introduction**

Staff of the U.S. Nuclear Regulatory Commission (NRC) performed a routine and announced nuclear criticality safety (NCS) inspection of the BWX Technologies Inc. (BWXT), Lynchburg, Virginia facility from March 10 through 13, 2008. The inspection included an on-site review of the licensee NCS program, NCS training, NCS-related inspections, audits and investigations, plant operations and open item review. The inspection focused on risk-significant fissile material processing activities including fuel fabrication and machining, the uranium recovery area, and the Research Test Reactor and Target (RTRT) area.

#### **Results**

- A Severity Level IV violation was identified regarding the failure to demonstrate the required subcritical margin for an explicitly modeled upset condition.
- An apparent violation was identified regarding the failure to comply with rasching ring filled vacuum cleaner (RRCV) fill and check procedures.
- An apparent violation was identified regarding the failure to establish double contingency for RRVCs.
- An apparent violation was identified regarding the failure to comply with ANSI/ANS 8.5 during operation of RRVCs.
- A weakness was identified regarding the adequacy of the description of the analytical basis for controls in a criticality safety evaluation.
- A weakness was identified regarding the licensee implementation of the level verification procedure for RTRT area RRVCs.
- No safety concerns were identified regarding NCS inspections, audits, and investigations.
- No safety concerns were identified during plant walkdowns.

## REPORT DETAILS

### 1.0 Summary of Plant Status

BWXT manufactures high-enriched uranium fuel, reactor core components and reactor cores at its facility near Lynchburg, Virginia. During the inspection, the licensee conducted routine fuel manufacturing operations and maintenance activities in the fuel fabrication and uranium recovery areas.

### 2.0 Nuclear Criticality Safety Program (IP 88015 & IP 88016)

#### a. Inspection Scope

The inspectors reviewed NCS analyses to determine that criticality safety of risk-significant fissile material operations was assured through engineered and administrative controls with adequate safety margin including preparation and review by qualified staff. The inspectors reviewed selected aspects of the following documents:

#### **Procedure**

- NCSE-02, "Nuclear Criticality Safety Analyses and Quality Assurance Reviews," Revision 34, dated November 30, 2007

#### **NCS Evaluations**

- NCS-2004-284, "Nuclear Criticality Safety (NCS) Analysis Supporting Phase 2 of SER [Safety Evaluation Report] 04-012 HLD [High Level Dissolver] Redesign, dated December 7, 2004
- NCS-2005-093, "NCS Analysis Supporting Revised Phase 2 of SER 04-012 HLD Redesign," dated June 3, 2005
- NCS-2007-258, "NCS Release Supporting Phase 1 of SER 06-042 Specialty Fuels Facility Drum Dryer," dated January 7, 2008
- NCS-2007-262, "Level 3 NCS Analysis Supporting Consolidation of Waste and Scrap Container Rack NCS Postings," dated November 13, 2007
- NCS-2007-270, "NCS Release Supporting Revised Phase 6 Relocation of Component Storage Rack SER 07-059," dated November 28, 2007
- NCS-2007-287, "Safety Concern Analysis for Retention Tank Back-up Spill into Recovery," dated December 12, 2007
- NCS-2008-007, "Safety Concern Analysis for Failed Functional Test of Tank Dump Valve," dated January 15, 2008
- NCS-2008-011, "NCS Analysis for New Routine Operating Limits (ROLs) in the Re-design High Level Dissolver," dated January 24, 2008
- NCS-2008-020, "Nuclear Safety Release for Universal Fixture SER 07-063 Phase 1," dated February 13, 2008
- NCS-2008-032, "Safety Concern Analysis for Floor Scrubbing Vacuum Cleaners with Unacceptable Raschig Ring Level in RTRT Controlled Area," dated March 5, 2008

b. Observations and Findings

The inspectors reviewed new and changed nuclear criticality safety evaluations (NCSE) and supporting calculations for selected operations. The inspectors observed in NCS-2007-262, "Level 3 Nuclear Criticality Safety Analysis Supporting Consolidation of Waste and Scrap Container Rack NCS Postings," that the analytical basis for the analysis was found in previously completed analyses of the system which were referenced. Because the justification of the controls were found in the references, it was difficult to determine if the basis for the controls and justification to change the limit on one of the controls was adequate. The inspectors also observed in NCS-2008-011, "NCS Analysis for New ROLs for the Re-design High Level Dissolver (Zirc Dissolver)," that the analysis did not contain all information required by the licensee administrative procedure for performing Nuclear Criticality Safety Analyses. The inspectors did not identify any immediate safety concern regarding the NCS changed limit. Adequacy of the description of the analytical basis for controls in criticality analysis is **Unresolved Item (URI) 70-27/2008-202-01**.

c. Conclusions

A weakness was identified regarding the adequacy of the description of the analytical basis for controls in a criticality safety evaluation.

**3.0 Nuclear Criticality Safety Event Review and Follow-Up (IP 88015 & IP 88016)**

a. Inspection Scope

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

**Procedures**

- OP-1001099, "Raschig Ring Level Inspections for RTRT Vacuum Cleaners," Revision 0, dated July 19, 2000
- RWP 08-0014, "Use Vacuum Cleaner for Floor Cleaning Only," Revision 1, dated March 10, 2008

**NCS Evaluations**

- XN-530, "Draft Investigative Report," Revision 0, dated February 13, 2008
- NCS-2008-022, "Addendum 2 to Phase 1 of SER 02-095, Replace Top Hat and Level Controller on recovery Extraction Columns," dated February 18, 2008
- NCS-2008-019, "Inconsistencies in SAR Table in SAR 15.10," dated February 13, 2008
- NCS-1996—290, "SER 96-99, Sprinklers for 3-inch Extraction System," dated December 20, 1996
- NCS-2002-266, "NCS for Phase 1 of SER 02-095, Replace Top Hat and Level Controller on Recovery Extraction Columns," dated October 8, 2002

- NCS-2004-191, "Lack of Spacing Control for Raschig Ring Filled Vessels," dated July 12, 2004
- NCS-1997-077, "Addendum to Safety Analysis for Pyrex Columns in 3-inch Solvent Extraction System/SER 96-99," dated March 10, 1997
- NCS-1997-076, "Existing System Pyrex Columns in 3-inch Solvent Extraction System," April 7, 1997
- NCS-2007-285, "Review of SAR Tables in SAR 15.32 and Corresponding NCS Analysis," dated December 19, 2007

b. Observations and Findings

The inspectors determined that licensee internal events were investigated in accordance with written procedures and appropriate corrective actions were assigned. The inspectors reviewed the licensee response to an event involving the 3-inch solvent extraction columns in the uranium recovery area. The BWXT license requires that models of upset conditions used in criticality analysis demonstrate  $k_{\text{eff}}$  less than 0.95. During an audit of the technical safety basis for the 3-inch extraction system, the licensee identified inconsistencies between the integrated safety analysis summary and the NCS controls identified in criticality safety analysis for the 3-inch system. The licensee performed additional criticality analysis to establish the adequacy of controls for the system and determined that the original analysis used an upset condition model (interspersed moderation) which, when used in a computer calculation, gave a calculated result above  $k_{\text{eff}}$  of 0.95 which exceeds the license limit on  $k_{\text{eff}}$  for an upset condition. The 3-inch extraction system was shutdown while the NCS evaluation was revised. This non-repetitive, licensee identified and corrected violation is being treated as a Non-Cited Violation, consistent with Section VI.A of the NRC Enforcement Policy. Failure to demonstrate the required subcritical margin for an explicitly modeled upset condition is **Non-Cited Violation (NCV) 70-27/2008-202-02**.

The inspectors reviewed the licensee response to an NRC-reportable event involving four instances of failure to maintain the designated level of rings in raschig ring filled vessels. During the week preceding the inspection, the licensee had identified three examples of raschig ring filled vacuum cleaners (RRVCs) not being adequately filled with rings. An additional example was identified by the licensee during the inspection. The inspectors observed that the suspect RRVCs were from the six RRCVs kept outside the uranium recovery area. One RRVC was noted to be five inches under the required level of raschig rings. The inspectors noted that daily checks of ring level were required and had been performed. The inspectors concluded that licensee staff outside the uranium recovery area had either not understood or not complied with procedures involving maintenance of raschig ring filled vessels. The inspectors noted that the RRCVs outside of uranium recovery had been taken out of service and there was no immediate safety concern. Failure to comply with RRCV fill and check procedures is **Apparent Violation (APV) 70-27/2008-202-03**.

The inspectors asked for verification of the number of RRVCs in use in the BWXT Lynchburg facility. Near the end of the inspection, the licensee responded that one of the RRVCs in the RTRT area could not be located and was thought to have been destroyed. The inspectors asked whether the missing vacuum had been checked daily as required by procedures which specifically listed it. Licensee staff stated that the

missing RRCV had been marked as out of service. The inspectors were concerned about the possibility that operators might have signed for RRCV ring level checks that had never actually been performed. Because the RRCVs outside of uranium recovery were out of service, the inspectors determined that there was no immediate safety concern. Licensee staff implementation of the level verification procedure for RTRT area RRVCs is **URI 70-27/2008-202-04**.

The licensee procedures called for filling the RRCVs with raschig rings to the bottom of the solution inlet because licensee staff believed that the RRCV vacuum pump would lose suction once solution passed the inlet level. Filling with raschig rings only to the bottom of the solution inlet left 4 to 5 inches of space at the top of the RRCVs. During review of the license event report concerning inadequate ring level in RRCVs, the Region II project inspector for BWXT asked what effect the RRCV vacuum pumps had on solution level in the vessels. Licensee staff performed a test on an uncontaminated vacuum cleaner and determined that the pumps were easily capable of drawing solution in the vessels past the inlet and well above the level of the rings, contrary to ANSI/ANS 8.5. Increasing the level of solution in a raschig ring filled vessel above the level of the rings is a significant criticality concern when the solution normally allowed in the vessels could reach a critical configuration in the available space. In one case observed by the inspectors in the RTRT area, there were 11 inches of free space available in an RRVC due to failure to maintain the procedurally required level. 11 inches is about double what would be required for criticality at authorized solution concentration levels. The licensee took the RRVCs not in the uranium recovery area out of service and limited the uranium recovery RRVCs to floor mop solutions only. The inspectors determined that operating the RRVCs in a configuration that would have allowed the solution level to increase above the rings undermined double contingency protection for the RRCVs. Failure to establish double contingency for the RRVCs is **APV 70-27/2008-202-05**.

The inspectors noted that the U.S. national standard for use of raschig rings as a criticality safety control, ANSI/ANS 8.5, Section 5.1, requires that all regions of the vessel shall be filled with well-settled rings that have been gently manipulated during loading such that they are not likely to settle further during use. The inspectors also noted that ANSI/ANS 8.5, Section 5.5 requires that the level of solution shall not exceed the level of uniformly packed rings. The inspectors determined that licensee procedures for filling vessels with raschig rings did not require settling as described in ANSI/ANS 8.5, Section 5.1, because there were no instructions to manipulate and settle the rings. The inspectors also determined that the pump configuration of the RRVCs violated ANSI/ANS 8.5, Section 5.5 since the pump was capable of increasing the solution level above the raschig rings. Failure to comply with ANSI/ANS 8.5 is **APV 70-27/2008-202-06**.

c. Conclusions

A Severity Level IV violation was identified regarding the failure to demonstrate the required subcritical margin for an explicitly modeled upset condition.

An apparent violation was identified regarding the failure to comply with RRVC fill and check procedures.

An apparent violation was identified regarding the failure to establish double contingency for RRVCs.

An apparent violation was identified regarding the failure to comply with ANSI/ANS 8.5 during operation of RRVCs.

A weakness was identified regarding the licensee implementation of the level verification procedure for RTRT area RRVCs.

#### **4.0 Nuclear Criticality Safety Inspections, Audits, and Investigations (IP 88015)**

##### **a. Inspection Scope**

The inspectors reviewed results of the most recent NCS quarterly audit to assure that appropriate issues were identified and resolved. The inspectors reviewed selected aspects of the following document:

- NCS-2008-005, "Violation and Observation Summary - 4<sup>th</sup> Quarter 2007," dated March 11, 2008
- NCS-2008-019, "Safety Concern Analysis as a Result of Inconsistencies in the SAR [Safety Analysis Report] table in SAR 15.10 and the Referenced NCS Analyses," dated February 13, 2008

##### **b. Observations and Findings**

The inspectors determined that the licensee NCS audits were conducted in accordance with written procedures. The inspectors noted that the audits were performed by NCS engineers who reviewed open NCS issues from previous audits; reviewed new violations that occurred during the audit quarter; reviewed the adequacy of control implementation; reviewed plant operations for compliance with license requirements, procedures, and postings; examined equipment and operations to determine that past evaluations remained adequate; and analyzed non-compliances for potential trends.

##### **c. Conclusions**

No safety concerns were identified regarding NCS inspections, audits, and investigations.

#### **5.0 Plant Operations (IP 88015)**

##### **a. Inspection Scope**

The inspectors performed plant walkdowns to review activities in progress and to determine whether risk-significant fissile material operations were being conducted safely and in accordance with regulatory requirements. The inspectors interviewed operations staff and NCS engineers both before and during walkdowns. The inspectors reviewed selected aspects of the following documents prior to performing the walkdowns:

- OP-0061138, "Raschig Ring Installing, Removing, Replacing and Washing Operation," Revision 23, dated December 7, 2007
- OP-0061155, "Raschig Ring Level Operation," Revision 11, dated March 10, 2008
- OP-0061265, "Control of Borosilicate Glass Raschig Rings," Revision 8, dated December 6, 2004

b. Observations and Findings

The inspectors performed walkdowns in the RTRT area and the uranium recovery area. Also, the inspectors observed a test of a new, favorable geometry vacuum cleaner for HEU solutions. The inspectors verified that controls identified in NCS analyses were installed or implemented and were adequate to ensure safety. The inspectors also verified that safety was maintained for observed facility operations. The cognizant, NCS engineers were knowledgeable and interacted regularly with operators on the process floors.

c. Conclusions

No safety concerns were identified during plant walkdowns.

**6.0 Open Item Review**

**VIO 70-27/2007-205-01**

This item tracks the licensee's corrective actions for the failure to conduct operations according to administrative limits (e.g., quantity of containers and moderating materials) outlined in the nuclear criticality safety posting. During a previous inspection, the inspectors observed a 2.5 liter container and a zip lock bag in the Cyclone Glovebox in the Specialty Fuels Facility. The NCS posting on the Cyclone Glovebox limits the glovebox to a maximum of one container with a volume less than or equal to 2.5 liters and also limits the moderating materials permitted in the glovebox to only materials that are necessary for normal operations. The licensee committed to remove the unauthorized bad from the glovebox, train operators to inspect gloveboxes that are rarely used for compliance to NCS postings, and inspection of all gloveboxes in Recovery to ensure compliance with NCS postings. During this inspection, the inspectors determined that the licensee has performed all of the corrective actions. This item is closed.

**7.0 Exit Meeting**

The inspectors presented the inspection scope and results to members of the licensee's management and staff during an exit meeting on March 13, 2008. The licensee acknowledged and understood the findings as presented.

## **SUPPLEMENTARY INFORMATION**

### **1.0 List of Items Opened, Closed, and Discussed**

#### **Items Opened**

<b>URI 70-27/2008-202-01</b>	Adequacy of description of the analytical basis for controls in criticality analysis
<b>NCV 70-27/2008-202-02</b>	Failure to demonstrate the required subcritical margin for an explicitly modeled upset condition
<b>APV 70-27/2008-202-03</b>	Failure to comply with fill and check procedures for RRVCs
<b>URI 70-27/2008-202-04</b>	Adequacy of level verification procedure for RTRT area RRVCs
<b>APV 70-27/2008-202-05</b>	Failure to establish double contingency for RRVCs
<b>APV 70-27/2008-202-06</b>	Failure to comply with ANSI/ANS 8.5 during operation of RRVCs

#### **Items Closed**

<b>VIO 70-27/2007-205-01</b>	Failure to conduct operations according to administrative limits (e.g., quantity of containers and moderating materials) outlined in the nuclear criticality safety posting.
<b>NCV 70-27/2008-202-02</b>	Failure to demonstrate the required subcritical margin for an explicitly modeled upset condition.

### **2.0 Inspection Procedures Used**

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

### 3.0 Partial List of Persons Contacted

#### **BWXT**

R. Cochrane	Manager, BWXT NPD-Lynchburg
J. Creasey	Manager, Uranium Processing
D. Faidley	Manager, Nuclear Criticality Safety
C. Goff,	Engineer, Licensing and Safety Analysis
B. Morcum	Manager, Assembly Operations
B. Cole	Manager, Licensing and Safety Analysis
T. Nicks	Manager, Security
C. Yates	Manager, Nuclear Safety & Licensing

#### **NRC**

T. Marenchin	Criticality Safety Inspector, NRC Headquarters
D. Morey	Senior Criticality Safety Inspector, NRC Headquarters
S. Subosits	Senior Resident Inspector, NRC Region II
M. Thomas	Senior Fuel Facility Inspector, NRC Region II

### 4.0 List of Acronyms

APV	Apparent Violation
BWXT	BWX Technologies, Inc. (Licensee)
HLD	High Level Dissolver
IP	inspection procedure
NCS	nuclear criticality safety
NCSE	nuclear criticality safety evaluation
NCV	Non-Cited Violation
NRC	U.S. Nuclear Regulatory Commission
ROs	Routine Operating Limits
RRVCs	raschig ring filled vacuum cleaners
RTRT	Research Test Reactor and Target
SAR	Safety Analysis Report
SER	Safety Evaluation Report
URI	Unresolved Item