

September 6, 2013

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

SUBJECT: BABCOCK AND WILCOX NUCLEAR OPERATIONS GROUP, INC.
U.S. NUCLEAR REGULATORY COMMISSION INSPECTION REPORT
NUMBER 70-027/2013-204

Dear Mr. Burch:

The U.S. Nuclear Regulatory Commission (NRC) conducted a routine, announced Nuclear Criticality Safety (NCS) inspection at your facility in Lynchburg, Virginia, from August 5 – 8, 2013. The purpose of the inspection was to determine whether activities involving special nuclear material were conducted safely and in accordance with your license and regulatory requirements. Throughout the inspection, observations were discussed with your staff. An exit meeting was held on August 8, 2013, during which inspection observations and findings were discussed with your management and staff.

The inspection, which is described in the enclosure, focused on the most hazardous activities and plant conditions; the most important controls relied on for safety and their analytical basis; and the principal management measures for ensuring controls are 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, and facility walk downs to observe plant conditions and activities related to safety basis assumptions and related NCS controls. Based on the inspection, your activities involving nuclear criticality hazards were found to be conducted safely and in accordance with regulatory requirements.

In accordance with Title 10 of the *Code of Federal Regulations* 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 Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Website at <http://www.nrc.gov/reading-rm/adams.html>.

If you have any questions concerning this report, please contact Timothy Sippel, of my staff, at (301) 287-5191, or via email to Timothy.Sippel@nrc.gov.

Sincerely,

/RA/

Michael X. Franovich, Chief
Programmatic Oversight
and Regional Support Branch
Division of Fuel Cycle Safety
and Safeguards
Office of Nuclear Material Safety
and Safeguards

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

Enclosure:
Inspection Report 70-027/2013-204

cc w/encl:
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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.: 70-027/2013-204

Licensee: Babcock and Wilcox Nuclear Operations Group, Inc.

Location: Lynchburg, VA

Inspection Dates: August 5 - 8, 2013

Inspectors: Timothy Sippel, Criticality Safety Inspector
Greg Chapman, Criticality Safety Inspector
Patricia Glen, RII Fuel Facility Inspector

Approved by: Michael X. Franovich, Chief
Programmatic Oversight
and Regional Support Branch
Division of Fuel Cycle Safety
and Safeguards
Office of Nuclear Material Safety
and Safeguards

Enclosure

EXECUTIVE SUMMARY

BABCOCK AND WILCOX NUCLEAR OPERATIONS GROUP, INC. NRC INSPECTION REPORT 70-027/2013-204

Introduction

Staff of the U.S. Nuclear Regulatory Commission (NRC) performed a routine, announced Nuclear Criticality Safety (NCS) inspection of the Babcock and Wilcox (B&W) Nuclear Operations Group (NOG), Inc., facility in Lynchburg, Virginia from August 5 – 8, 2013. The inspection included an onsite review of the licensee's NCS program, NCS training, NCS evaluations, NCS audits, internal NCS event review and follow-up, criticality accident alarm system, plant operations, and open item review. The inspection focused on risk-significant fissile material processing activities and areas including fuel fabrication and machining, the uranium recovery area, the Research Test Reactor and Target (RTRT) area, the Specialty Fuels Facility (SFF), and the Lynchburg Technology Center.

Results

- One concern was identified during the review of the NCS Program. This was in regards to the adequacy of an NCS evaluation; specifically concerning an unanalyzed upset condition of "stacking" and potentially inadequate controls to prevent criticality in the Target Storage Cabinets.
- No safety concerns were identified during review of the NCS event review and follow-up.
- No safety concerns were identified regarding NCS audits and weekly inspections.
- No safety concerns were identified concerning the licensee's criticality accident alarm system.
- No significant safety concerns were identified during walk downs of plant operations.

REPORT DETAILS

1.0 Summary of Plant Status

B&W NOG manufactures high-enriched uranium fuel, reactor core components and reactor cores at its facility near Lynchburg, VA. During the inspection, the licensee conducted routine fuel manufacturing operations and maintenance activities in the fuel fabrication and uranium recovery areas. The licensee was also installing the cabling and conduits for the new criticality accident alarm system; and was in the process of repairing the roof to prevent rainwater intrusion.

2.0 Nuclear Criticality Safety Program (IP 88015 & 88016)

a. Inspection Scope

The inspectors reviewed the licensee's NCS program and analyses. The inspectors evaluated the adequacy of the program and analyses to assure the safety of fissile material operations. The inspectors reviewed selected nuclear criticality safety evaluations (NCSEs), including new and revised NCSEs, to determine that the criticality safety of risk-significant operations was assured through engineered and administrative controls with adequate safety margin and prepared and review by qualified staff. The inspectors interviewed licensee managers and engineers in the safety and production departments, operations engineers, and selected operators. The inspectors reviewed selected NCS-related items relied on for safety (IROFS) to determine that the performance requirements have been met for selected accident sequences. The inspectors accompanied NCS and other technical staff on walk downs of NCS controls in selected plant areas. The inspectors reviewed selected aspects of the documents listed in Section 3.2 of the Attachment.

b. Observations and Findings

The inspectors observed that the licensee had an NCS program which was independent from production and was implemented through written procedures. The inspectors also observed that the licensee NCS program reviewed process changes affecting criticality safety. The inspectors reviewed selected NCS Approvals, NCSEs, and supporting calculations for new, changed, and other selected operations. For the analyses reviewed, the inspectors determined that the analyses were performed by qualified NCS engineers, that independent reviews of the evaluations were completed by qualified NCS engineers, and that the analyses provided for subcriticality of the systems and operations through appropriate limits on controlled parameters, and double contingency was assured, for credible accident sequence leading to inadvertent criticality that was selected for review. The inspectors reviewed selected IROFS supporting NCS controls and determined that the IROFS corresponded to the approved analytical results and designated controls and were adequate to meet performance requirements for the selected accident sequences, with one exception that will be discussed shortly. Other than the exception, NCS analyses and supporting calculations demonstrated adequate identification and control of NCS hazards to assure operations within subcritical limits.

During review of NCS-2013-070, "NCS Safety Analysis Revising the Safety Basis for the Target Storage Cabinets per CR-1038679," dated May 9, 2013, the inspector observed

that the analysis did not evaluate the possible “stacking” of targets. The targets are stored horizontally, up to 20 in a shelf drawer, with 17 drawers per Target Storage Cabinet. Each cabinet has “14 drawers that are $3 \pm \frac{1}{4}$ inches high and 3 drawers that are 4 inches high.” The inspector measured a typical drawer and observed it to be slightly less than 3 inches high, and more than $2 \frac{3}{4}$ inches. The licensee’s NCS engineer modeled the drawer height as $2 \frac{3}{4}$ inches. Using the minimum drawer height is conservative because decreasing the modeled drawer height decreases the spacing between the fuel in the drawers and increases reactivity. The analysis evaluated other spacing upsets but did not address stacking targets within a drawer, and did not impose any controls to prevent stacking. The targets have an outer diameter of 15.2 mm (0.598 inches) so “stacking” does not seem to be physically precluded by the geometry of the drawer. There is an administrative control to limit a drawer to 20 targets, but the control doesn’t address stacking. The posting states that moderation is “Permitted as necessary” and the analysis performs a moderator sweep as per the licensee’s guidance. The configuration of the Target Storage Cabinets is sufficiently reactive that the licensee also had to credit some of the steel in the cabinets as a neutron absorber to maintain subcriticality. Based on the results of the other spacing upset analyses and knowledge of neutron physics the inspector concluded that this upset would increase k_{eff} and should have been analyzed, however, without an actual analysis it is difficult to determine how much k_{eff} would be increased by stacking, and whether or not the existing controls are sufficient to maintain subcriticality for this upset. Therefore, Unresolved Item (URI)

70-27/2013-204-01 is being opened to track this issue; the results of the licensee’s analysis of a ‘stacking’ upset will need to be reviewed in a future inspection to close this URI.

The inspectors reviewed the N517 forms for the Change Requests (CRs) and Safety Evaluation Requests (SERs) listed in Section 3.2 of the Attachment. The licensee utilizes N517 forms to document the Title 10 of the *Code of Federal Regulations* (10 CFR) 70.72 reviews for facility changes and has each safety discipline fill out a form for the change being reviewed. It was observed that, in one instance, the review for NCS was filled out by a licensing representative such that it was not evident that an NCS reviewer had performed the evaluation. However, this instance occurred for the facility change documented in SER 12-037, Phase 1 “Complex Column Check Valve Installation,” completed February 25, 2013, which included a NCSE in its documentation. The N517 form was consistent with the NCSE and is most likely the basis used by the licensing representative. The licensee’s licensing manager stated the original N517 form was most likely lost or inadvertently destroyed. Inspectors considered this to be of minor significance as it was apparent that the change received additional scrutiny and evaluation under the licensee’s SER process.

The inspectors reviewed maintenance plans #3500, #3501, and #3502 for IROFS identified in SER 12-037, Phase 1. During the review the inspectors observed that monthly maintenance was being performed consistent with Quality Work Instruction 9.1.7., “Preventive/Predictive Maintenance and Safety Related Controls Testing Program,” Rev. 9. Including performing maintenance within the month in which it was planned unless approval had been obtained to extend the maintenance period as documented on a form N353. However, the inspectors observed that this frequency definition is different from the one found in the License Application which defines monthly as being 30 days +/- 10 days. The records the inspectors reviewed showed that, occasionally, maintenance had been done at the beginning of one month and at the

end of the following month such that the maintenance interval exceeded 40 days. Also, the licensee occasionally performed maintenance at the end of one month and the beginning of the following month so that the maintenance interval was less than 20 days. The licensee committed, COM-44621, to review the monthly frequency definitions for maintenance and resolve this inconsistency. The inspectors consider the failure to perform maintenance consistent with the license application definitions of monthly frequency to be of minor significance as the licensee continues to schedule and perform monthly maintenance activities on average 12 times/yr.

c. Conclusions

One safety concern was identified with regards to NCS evaluations and reviews. NRC inspectors identified a credible abnormal condition which had not been evaluated. A URI was opened concerning an unanalyzed upset condition of 'stacking' and potentially inadequate controls to prevent criticality in the Target Storage Cabinets. No other safety concerns were identified regarding development, review, or approval of NCS calculations or resulting NCS controls.

3.0 Nuclear Criticality Safety Inspections, Audits, and Investigations (IP 88015)

a. Inspection Scope

The inspectors reviewed licensee internal audit procedure, and results of the most recent NCS quarterly audit to assure that appropriate issues were identified and resolved. The inspectors accompanied a licensee NCS engineer on a routine weekly NCS inspection of the RTRT Area. The inspectors reviewed selected aspects of the documents listed in Section 3.3 of the Attachment.

b. Observations and Findings

The inspectors observed that the licensee's weekly NCS inspections were conducted in accordance with written procedures. The licensee's weekly NCS inspection observed by the NRC inspectors was performed by a qualified NCS engineers who reviewed open NCS issues and new violations that occurred during the audit quarter for that area; reviewed the adequacy of control implementation; reviewed plant operations for compliance with license requirements, procedures, and postings; examined selected equipment and operations to determine that past evaluations remained adequate; and identified NCS-related non-compliances. The NCS engineer conducting the inspection selected an operation that was being performed at the time of the weekly inspection as the focus of the inspection. He observed the operation, discussed it with the front line manager and the operators, questioned the operators about NCS controls and postings, and reviewed the postings.

The inspectors confirmed that non-compliances identified during audits were appropriately captured in the licensee's corrective action program. The NCS engineer documented a discrepancy between the operation observed during the weekly inspection and the discussion of the operation in the Safety Analysis Report (SAR). He opened CA201301601, dated August 6, 2013 to track and resolve this discrepancy by improving the SAR's discussion of the criticality safety limits.

c. Conclusions

No safety concerns were identified regarding NCS audits.

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

a. Inspection Scope

The inspectors reviewed the licensee's response to a selection of recent NCS related internally-reported events. No NCS related reportable events occurred since the last inspection. The inspectors reviewed the progress of investigations and interviewed licensee staff regarding immediate and long-term corrective actions. The inspectors reviewed selected aspects of documents identified in Section 3.4 of the Attachment.

b. Observations and Findings

The inspectors reviewed select licensee internally reported criticality safety related events that occurred since the last NCS inspection. The inspectors also reviewed the safety concern analyses and corrective actions for the selected events. The majority of the events reviewed were identified as a result of Unusual Incident Reports related to posting violations and one related to change management. The safety concern analysis provided additional detail about the events and documented the licensee's analysis for determining whether an event met NRC reporting requirements. The inspectors did not identify any safety concerns related to incorrect reportability determinations for the events reviewed during this inspection. The inspectors observed that internal events were investigated in accordance with written procedures and appropriate corrective actions were assigned and tracked.

c. Conclusions

No safety concerns were identified during a review of recent licensee investigation of internal events; and corrective actions were adequately tracked by the licensee.

5.0 Criticality Alarm Systems (IP 88017)

a. Inspection Scope

The inspectors discussed the new criticality accident alarm system detector coverage with engineering and maintenance staff, and performed facility walk downs to determine the adequacy of the licensee criticality alarm system.

b. Observations and Findings

The inspectors reviewed the status of the new Criticality Incident Detection and Alarm Systems (CIDAS) manufactured by Pajarito Scientific that are being installed. The licensee is installing two systems as the electrical load for the number of detectors and speakers exceeds the capacity for just one system. CIDAS' installation is scheduled for completion by the end of 2013. The number of detectors installed in the facility will

increase significantly with the CIDAS systems and all cabling is being installed in rigid conduit. The licensee's engineers stated that installation is being performed consistent with the National Electric Code and manufacturer's instructions.

The two CIDAS systems will interface such that they monitor each other's functions and will sound evacuation alarms whichever unit goes into alarm. These units will also be tied into the old system for some time such that the alarms will activate through both systems. The old E-berline RMS-2 system will continue to operate until such time as sufficient confidence has been achieved that the new systems are acceptably robust before being removed. No CIDAS system is currently planned to be installed in the Lynchburg Technology Center which will continue to utilize an E-berline RMS-2 system. The licensee anticipates the new installation will eliminate false alarms due to lightning strikes allowing the system to operate without modification during storms.

c. Conclusions

No safety concerns were identified during a review of the licensee's criticality accident alarm system.

6.0 Plant Activities (IP 88015)

a. Inspection Scope

The inspectors performed plant walk downs 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 reviewed documents, and interviewed operations staff and NCS engineers both before and during walk downs. The inspectors reviewed selected aspects of the documents listed in Section 3.6 of the Attachment.

b. Observations and Findings

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. The inspectors verified the adequacy of management measures for assuring the continued availability, reliability, and capability of safety-significant controls relied upon by the licensee for controlling criticality risks.

During walk downs and as part of other activities the inspectors took the opportunity to question operators on what constitutes moderating material, and on the implementation of controls on moderation. The inspectors especially questioned operators who are responsible for implementing the "permitted as necessary" limit on moderation to verify their understanding of the control.

All personnel the inspectors interviewed were familiar with the concept of moderation and able to explain how they implemented the moderator controls in their area.

c. Conclusions

No safety concerns were identified during a review of the licensee's plant activities.

7.0 Open Item Review

Inspector Follow-up Item 70-27/2013-201-02

This item tracks the licensee's corrective actions with regards to operator understanding of moderating materials and "permitted as necessary" moderation limits. During a previous inspection, the inspectors observed that operators were unclear on what moderating materials were and what the "permitted as necessary" limits meant. The licensee committed to revise the training to clarify what moderating materials were and has also taken other initiatives to establish an understanding as to what moderating materials and "permitted as necessary" mean. During this inspection, the inspectors reviewed the revised training material (Nuclear Criticality Safety Training, Annual Refresher), and the NCS calendar for moderating materials that the NCS unit created to promote understanding and discussion of moderator and the controls on moderator. As discussed above the inspectors also interviewed multiple operators in different areas about what moderating materials are and what moderator "permitted as necessary" means for their operation. The inspectors concluded that a general understanding is present amongst operators at this time and the training program will be adequate to foster continued understanding. Therefore, Inspector Follow-up Item (IFI) 70-27/2013-201-02 is closed.

URI 70-27/2013-202-01

This item tracks the licensee's lack of a detailed justification for why facility changes do not require a SER or a license amendment. During this inspection, inspectors reviewed the N517 forms for five CRs and two SERs. The N517 form is what the licensee uses to document its 10 CFR 70.72 reviews for facility changes. It was noted that all utilized a check sheet methodology for documenting the reviews which is consistent with what had previously been observed. This item remains open.

8.0 Exit Meeting

The inspectors presented the inspection scope and results to members of the licensee's management and staff, including Joel Burch, during an exit meeting on August 8, 2013. The licensee acknowledged and understood the findings as presented.

SUPPLEMENTARY INFORMATION

1.0 List of Items Opened, Closed, and Discussed

Items Opened

URI 70-27/2013-204-01 Unanalyzed upset condition of “stacking” and potentially inadequate controls to prevent criticality in the Target Storage Cabinets.

Items Closed

IFI 70-27/2013-201-02 Corrective actions with regard to operators’ understanding of moderating materials and “permitted as necessary” moderation limits.

Items Discussed

URI 70-27/2013-202-01 Lack of a detailed justification for why changes do not require a safety evaluation request or a license amendment.

2.0 Event Reports Reviewed

None

3.0 Key Documents Reviewed:

The inspectors reviewed selected aspects of the following documents. Documents may apply to multiple sections but were placed in the section that is most applicable.

3.1 Plant Status

None

3.2 Nuclear Criticality Safety Program (IP 88015 & 88016)

- SER 12-037, Phase 1 “Complex Column Check Valve Installation,” completed February 25, 2013.
- Quality Work Instruction (QWI) 9.1.7., “Preventive/Predictive Maintenance and Safety Related Controls Testing Program,” Rev. 9.
- Maintenance Plans (MP’s), #3500, #3501 and #3502.
- SER 10-005, Phase 1, “Contactor Inline Filter Enclosure Relocation,” completed February 9, 2013.
- NCS-2012-003, “NCS Safety Analysis for SER 11-042 Phase 1” ‘Stationary Annular Tank Modification to Stainless Steel,’ SER 10-005 Phase 1, ‘Contactor Inline Filter Enclosure Relocation,’ and SER 12-007 Phase 1, ‘Stainless Steel and Kyner Filter Housing Modification in Recover,’ dated March 3, 2012.

- NCS-2012-041, "NCS Safety Analysis Supporting the Temporary NCS Posting for Heat Treating TDC Elements per CR-1038120," dated March 21, 2012.
- NCS-2012-158, "NCS Safety Analysis to Return the Recovery Trough Dissolvers to Normal Operation per SER 12-037, Phase 1," dated October 3, 2012.
- NCS-2012-160, "NCS Safety Analysis Supporting Update to SAR 15.12 – Poison Racks (CA200901284, CR-1040636)," dated May 15, 2013.
- NCS-2013-043, "NCS Safety Analysis of Recovery Top Hats per Commitment COM-38678," dated July 30, 2013.
- NCS-2013-070, "NCS Safety Analysis Revising the Safety Basis for the Target Storage Cabinets per CR-1038679," dated May 9, 2013.
- NCS-2013-091, "NCS Safety Analysis Supporting SER 13-017 Phase 01 – Shutdown of Conversion Area Equipment," dated June 5, 2013.
- NCS-2013-092, "Scoping Calculations for Stacked Horizontal Columns under Recovery Mezzanine per CR-1040262," dated May 29, 2013.
- Change Request CR-1038637, "Tying together contractor feed lines/adding appropriate isolation valves," dated June 6, 2012, and corresponding N517 forms.
- Change Request CR-1039944, "Replace the SFF Vacuum System Wet Pump and Motor," dated January 29, 2013 and corresponding N517 forms.
- Change Request CR-1039348, "Add check valves between high level trough dissolvers and complexing columns," dated September 26, 2012, and corresponding N517 forms.
- Change Request CR-1040939, "Trough dissolver #2 Process Drain Modification," dated July 11, 2013, and corresponding N517 forms.
- Change Request CR-1039185, "Remove coolant reservoir for Bridgeport and Horizontal Mill from Chop Shop," dated September 5, 2012, and corresponding N517 forms.

3.3 Nuclear Criticality Safety Inspections, Audits, and Investigations (IP 88015)

- CA201301601, dated August 6, 2013.
- SAR 15.22, "RTRT (Research Test Reactor and Targets) Fuel Powder and Compact Processes," Rev. 66, dated August 7, 2012.
- SAR 15.23, "Fuel Plate and Element Fabrication Process RTRT Operation," Rev. 78, dated July 19, 2012.
- NCS-2013-099, "NCS Safety Analysis Supporting Update to SAR 15.22 – RTRT (Research Test Reactor and Targets) Fuel Powder and Compact Processes (CA200800268, CA200900082, CA200900145, CA200900152)," dated July 15, 2013.
- NCS-2013-111, "NCS Violation & Observation Summary – 2nd Quarter 2013," date June 23, 2013.

3.4 Nuclear Critically Safety Event Review and Follow-up (IP 88015 & 88016)

- CA201301145, dated June 3, 2013.
- CA201301252, dated June 11, 2013.
- CA201301408, dated July 10, 2013.
- CA201301405, dated July 10, 2013.
- CA201301456, dated July 17, 2013.
- NOG-L Performance Dashboard-June 2013.

- EPR-01-01 (EP-HS-002), "Emergency Plant Evacuation," Rev. 18, dated June 15, 2012.
- QWI 14.1.1, "Preventive/Corrective Action System," Rev. 26.CR-1039944, dated February 28, 2013.
- CR-1040939, dated July 22, 2013.

3.5 Criticality Alarm Systems (IP 88017)

None

3.6 Plant Activities (IP 88015)

- OP-1016020, "AGR Coating Furnace Scrubber Operation and Maintenance," Rev. 10.
- OP-1015720, "Coating in the Center Furnace for Advanced Gas Reactor Program," Rev. 32. Postings:
 - RECOVERY-034, Rev. 2, CR-1008915.
 - RECOVERY-106, Rev. 0, SER 01-065.
 - Posting 15-05-009, Rev. 4, NCS-2012-158.
 - Posting 15-05-010, Rev. 0, NCS 2012-142.
 - Posting 15-05-017, Rev. 0, NCS-2012-148.
- SAR 15.18, "SFF Dry-End Processing SFF Operation," Rev. 101, dated January 18, 2012.

3.7 Open Items

- Nuclear Criticality Safety Training, Annual Refresher.
- Criticality Safety Calendar

3.8 Exit Meeting

Not Applicable

4.0 Inspection Procedures Used

IP 88015	Nuclear Criticality Safety Program
IP 88016	Nuclear Criticality Safety Evaluations and Analyses
IP 88017	Criticality Alarm Systems

5.0 Key Points of Contact

B&W NOG

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Greg Chapman	Criticality Safety Inspector, NRC HQ
Tim Sippel	Criticality Safety Inspector, NRC HQ
Patricia Glen	Fuel Facility Inspector, NRC RII

6.0 List of Acronyms and Abbreviations

B&W NOG	Babcock and Wilcox Nuclear Operations Group, Inc.
CIDAS	criticality
CR	Change Request
HLD	High Level Dissolution
IFI	Inspector Followup Item
IP	Inspection Procedure
IROFS	item relied on for safety
ISA	integrated safety analysis
NCS	Nuclear Criticality Safety
NCSE	nuclear criticality safety evaluation
NOV	Notice of Violation
RTRT	Research Test Reactor and Target
SAR	Safety Analysis Report
SER	Safety Evaluation Request
SFF	Specialty Fuels Facility
SNM	special nuclear material
QWI	Quality Work Instruction