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

June 29, 2011

EA-11-095
EN 46650

Ms. Nicole Holmes
Chief Operating Officer, Facility Manager
Global Nuclear Fuel – Americas, L.L.C.
P.O. Box 780, Mail Code J20
Wilmington, NC 28402

SUBJECT: NRC SPECIAL INSPECTION REPORT NO. 70-1113/2011-006 AND NOTICE OF VIOLATION

Dear Ms. Holmes:

This refers to the onsite inspection conducted March 14 through 18, 2011, and the subsequent in-office review of your causal analysis documentation. The special inspection team was established to inspect and assess the facts and circumstances surrounding the failure to maintain mass control within the uranium dioxide ($UO_2$) sinter test grinding station high efficiency particulate air (HEPA) filter enclosure. The preliminary results of this inspection were discussed with you and members of your staff on March 18, 2011, and in subsequent exit meetings on April 27, 2011 and June 3, 2011.

The inspection was performed in accordance with NRC Inspection Procedures (IP) 88003, 88020, and 93812. The objectives of the inspection were to: 1) review the facts surrounding the failure to maintain mass control within the $UO_2$ sinter test grinding station HEPA filter enclosure; 2) assess Global Nuclear Fuel – Americas (GNF-A)'s response to the higher than anticipated $UO_2$ mass in the HEPA enclosure; and 3) evaluate GNF-A's immediate and long term corrective actions to prevent recurrence. A copy of the special inspection charter is included as Enclosure 2. Enclosure 3 is the special inspection team report that presents the results of this inspection.

On March 2, 2011, the NRC was notified through Event Notification 46650 that GNF-A had failed to maintain mass control of $UO_2$ powder in the sinter test grinding station HEPA filter enclosure. Specifically, on March 1, 2011, your staff identified that approximately 46 kilograms of $UO_2$ powder had been present in the sinter test grinder filter housing, which was greater than the analyzed safe mass to prevent a criticality. Both mass and moderation control are required for maintaining double contingency to prevent a criticality accident in the HEPA filter housing. The failure of mass control is a loss of double contingency for the subject filter housing. Your staff took immediate actions to put the equipment into a safe condition and reestablished mass control by removing the mass accumulation.

Your staff performed a root cause analysis and identified six casual factors and twelve root causes. The team found that the root cause analysis adequately identified the casual factors associated for this specific event but did not explore the underlying latent organizational issues that allowed this event to occur. The team's review of the proposed corrective actions concluded that they were narrowly focused on the specific event and did not adequately address the prevention of similar events.

Based on the results of this inspection, the NRC has determined that two Severity Level IV violations of NRC requirements occurred. These violations were evaluated 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).

The violations are cited in the enclosed Notice of Violation (Notice) and the circumstances surrounding them are described in detail in Sections 3 and 4 of the subject inspection report. The violations are being cited in the Notice because the NRC identified the violations. The NRC determined that the two Severity Level IV violations were not directly related to the root causes of the event but instead correlated to the contributing causes of management oversight, accountability, and enforcement of expectations.

You are required to respond to this letter and should follow the instructions specified in the enclosed Notice when preparing your response. For your consideration, the guidance described in NRC Information Notice 96-28, "Suggested Guidance Relating to Development and Implementation of Corrective Actions," may be helpful. If you have additional information that you believe the NRC should consider, you may provide it in your response to the Notice. The NRC review of your response to the Notice will also determine whether further enforcement action is necessary to ensure compliance with regulatory requirements. 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

The NRC identified additional performance issues that will require further review to determine what enforcement action, if any, is appropriate. These performance issues involved: 1) failure to ensure that a process design incorporated sufficient margins of safety to require at least two unlikely, independent, and concurrent changes in process conditions before a criticality accident was possible; 2) failure to apply sufficient controls to the extent needed to reduce the likelihood of occurrence of a criticality in the sinter test grinder HEPA filter enclosure; 3) failure to conduct a criticality safety analysis for the sinter test grinder; 4) failure to notify maintenance department and the area manager, and request a clean out of the affected sinter test grinder primary HEPA filter housing transition when survey results exceeded the action limit of 0.5 milliRoentgen/hour above background; and 5) failure to assure that controls selected and installed fulfilled the requirements identified in criticality safety analysis – No. 2310.00, "Primary HEPA Filter Systems." These performance issues are identified in the enclosed inspection report as unresolved items (URI) 70-1113/2011-006-01 through 05. No response to these URIs is required at this time.

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

Should you have any questions, please feel free to contact Marvin Sykes at (404) 997-4629.

Sincerely,

***/RA/***

Anthony T. Gody, Director
Division of Fuel Facility Inspection

Docket No. 70-113
License No. SNM-1097

Enclosures:
1. Notice of Violation
2. Special Inspection Team Charter
3. Special Inspection Team Report No. 70-1113/2011-006

cc w/encls: (See page 4)

Should you have any questions, please feel free to contact Marvin Sykes at (404) 997-4629.

Sincerely,

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Anthony T. Gody, Director
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Docket No. 70-113
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cc w/encls: (See page 4)

X PUBLICLY AVAILABLE ☐ NON-PUBLICLY AVAILABLE ☐ SENSITIVE X NON-SENSITIVE
ADAMS: X Yes ACCESSION NUMBER: ML111810118 X SUNSI REVIEW COMPLETE

| OFFICE | RII:DFFI | RII:DFFI | RII:DFFI | RII:DFFI | RII:DFFI | RII/EICS |
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| SIGNATURE | /RA/ | /RA/ | /RA/ | /RA/ | /RA/ | /RA/ |
| NAME | OLopez | CFisher | NCoovert | MToth | MSykes | CEvans |
| DATE | 5/25/2011 | 5/11/2011 | 5/11/2011 | 5/25/2011 | 5/25/2011 | 5/27/2011 |
| E-MAIL COPY? | YES NO | YES NO | YES NO | YES NO | YES NO | YES NO |

OFFICIAL RECORD COPY DOCUMENT NAME: G:\DNMSII\FFBII\REPORTS\DRAFT INSPECTION REPORT FOLDER\GLOBAL\DRAFT GNF-A SIT IR 2011006 rev4.DOCX

cc w/encls:
Scott Murray, Manager
Facility Licensing
Global Nuclear Fuels – Americas, L.L.C.
Electronic Mail Distribution

Lee Cox, Chief
Radiation Protection Section
N.C. Department of Environmental
Commerce and Natural Resources
Electronic Mail Distribution

Letter to Ms. Nicole Holmes from Anthony T. Gody dated June 29, 2011

SUBJECT: NRC SPECIAL INSPECTION REPORT NO. 70-1113/2011-006 AND NOTICE OF VIOLATION

Distribution w/encls:
M. Sykes, RII
M. Thomas, RII
O. López, RII
R. Johnson, NMSS
C. Ryder, NMSS
PUBLIC

NOTICE OF VIOLATION

Global Nuclear Fuels-Americas
Wilmington, NC

Docket No. 70-1113
License No. SNM-1097

During an NRC inspection conducted on March 14 through 18, 2011, violations of NRC requirements were identified. In accordance with the NRC Enforcement Policy, the violations are listed below:

A. Safety Condition S-1 of Special Nuclear Material License 1097 requires that material be used in accordance with statements, representations, and conditions of application dated and supplements dated April 2, 2007; June 29, 2007; February 14, 2008; November 25, 2008; January 8, 2009; August 13, 2010; and December 2, 2010.

Section 11.5, Procedures, of the License Application dated April 2, 2007, states that licensed material processing or activities will be conducted in accordance with properly issued and approved management control procedures.

Operating Procedure 2301.00, FMO HVAC Maintenance Operation, Revision 9, Section F, Operation Sequence – Primary Filter Units, states that after removal of prefilter or high efficiency particulate air filter from the housing, vacuum out the filter housing, if necessary.

Contrary to the above, on February 1 and 5, 2011, the licensee failed to vacuum out the sinter test grinder high efficiency particulate air filter housing, when it was necessary. Specifically, the licensee replaced the prefilter and high efficiency particulate air filter and did not clean out approximately 15.3 kilograms of uranium dioxide powder that had accumulated in the filter housing transition piece.

This is a Severity Level IV violation (Section 6.2)

B. Safety Condition S-4 of Special Nuclear Material License 1097 states that GNF-A may continue to conduct license activities and maintain records in accordance with the approved SNM 1097, Revision 1 of Chapter 3, Integrated Safety Analysis, and Revision 1 of Chapter 11, Management Measures, subject to GNF-A's commitments in GNF-A's reply to Notice Of Violation (EA-090268) dated July 23, 2010, including but not limited to: (1) its commitment regarding criticality control-related event reporting; and (2) until completion of the actions set forth in its Integrated Safety Analysis Action Plan and Schedule maintained in Attachment 2 to the July 23, 2010, Reply to Notice of Violation.

Reply to a Notice of Violation (EA-09-268), dated July 23, 2010, states, in part, that "GNF-A added a commitment to its internal procedure for event reporting that if a condition is identified in which criticality controls necessary to meet double contingency are not maintained or available, it will be reported to NRC within 24 hours."

Operating Procedure 40-32, Safety Event Communication & Notification, Revision 14, Appendix B, Supplemental Reporting Criteria: Commitment 1 of GNF-A ISA Action Plan Letter (1/11/2010), Step 2a, states, in part that when multiple parameters were initially controlled, loss of one or more criticality safety controls such that only one parameter remains under control, a notification to NRC using telecon and/or event worksheet within 24 hours is required.

Section III.B, Criticality Safety Controls for Dry Uranium Dioxide Processes Moderator Controlled Area, of Criticality Safety Analysis - No. 2310.00, Primary High Efficiency Particulate Air Filter Systems, Revision 2 states, in part, that mass and moderation controls are necessary controls to meet this analysis. In order to achieve mass control the uranium dioxide holdup is limited to less than 25 kilograms by controlling differential pressure across the housing to 4-inches of water or less.

Contrary to the above, on February 5, 2011, the licensee failed to notify the NRC within 24 hours for the loss of mass control when the sinter test grinder high efficiency particulate air filter exceeded the mass control limit of 25 kilograms of uranium dioxide. Specifically, the sinter test grinder high efficiency particulate air filter contained 26.9 kilograms of uranium dioxide.

This is a Severity Level IV violation (Section 6.2)

Pursuant to the provisions of 10 CFR 2.201, Global Nuclear Fuels-Americas is hereby required to submit a written statement or explanation 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). This reply should be clearly marked as a "Reply to a Notice of Violation" and should include for each violation: (1) the reason for the violation, or, if contested, the basis for disputing the violation or severity level, (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 previous docketed correspondence, if the correspondence adequately addresses the required response. If an adequate reply is not received within the time specified in this Notice, an order or a Demand for Information may be issued as to why the license should not be modified, suspended, or revoked, or why such other action as may be proper should not be taken. Where good cause is shown, consideration will be given to extending the response time. If you contest this enforcement action, you should also provide a copy of your response, with the basis for your denial, to the Director, Office of Enforcement, United States Nuclear Regulatory Commission, Washington, DC 20555-0001.

If you choose to respond, your response will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's document 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 of receipt.

Dated this 29th day of June 2011

March 11, 2011

MEMORANDUM TO: Omar R. López, Team Leader
Global Nuclear Fuel – America, L.L.C., Special Inspection

FROM: Victor M. McCree, Regional Administrator /RA/ by L. Wert for

SUBJECT: SPECIAL INSPECTION TEAM CHARTER FOR GLOBAL NUCLEAR FUEL-AMERICA, L.L.C., DOCKET NO. 70-11113 (INSPECTION REPORT NO. 70-1113/2011-006)

This memorandum confirms the establishment of a Special Inspection Team (SIT) at Global Nuclear Fuel – America, L.L.C. (GNF-A) to inspect and assess the facts and circumstances surrounding the failure to maintain mass control within the UO2 Sinter Test Grinding Station HEPA filter enclosure. The issue was reported to the NRC Operations Center on March 2, 2011, (Event # 46650). You are the inspection leader and should report your status directly to me. Nicole Coovert and Christian M. Fisher are assigned as members of the team to assist in completing the objectives of the Charter. The onsite inspection should begin on March 14, 2011.

Management Directive 8.3, "NRC Incident Investigation Program," was used to evaluate the level of NRC response for this operational event. Based on the deterministic criteria the staff concluded that this issue led to the loss of a significant safety function; involved possible adverse generic implications; involved significant design defects involving safety-related equipment; involved repetitive events involving safety-related equipment; and involved questions pertaining to licensee operational performance. NRC determined that the appropriate level or response was to conduct a Special Inspection.

The inspection will be performed in accordance with the guidance of Inspection Procedure (IP) 88003, IP 88020, and the applicable provisions of IP 93812; and will be consistent with Management Directive 8.3 and Manual Chapter 2600. The report will be issued within 30 days of the completion of the inspection.

A copy of the Charter is enclosed for your use. The objectives of the inspection are to gather information and make appropriate findings and conclusions in the areas listed in the Charter. These results will be used as a basis for any necessary follow-up. As indicated in the Charter, the foremost objective is to determine the safety implications and adequacy of the licensee's corrective actions for the issues which resulted in the event.

Enclosure: As stated

CONTACTS: Marvin D. Sykes, RII/DFFI
404-997-4629

Anthony T. Gody, RII/DFFI
404-997-4701

Special Inspection Team Charter
Global Nuclear Fuel - Americas
Failure to Maintain Mass Control in HEPA Filter Housing

Event

On February 1, 2011 at Global Nuclear Fuel−Americas (GNF-A), the licensee noticed a high differential pressure (Δp) of approximately 4 inches of H2O across the filtration unit in the UO2 Sinter Test Grinding Station. The licensee, using an approved procedure, replaced the pre-filter on February 1. Approximately 4 kilograms of UO2 powder was removed from the pre-filter. The system was returned to service; however, the licensee did not see a reduction in the Δp readings.

On February 5, the licensee again removed the system from service and replaced the HEPA filter. During this activity, approximately 26.9 kilograms of UO2 powder was removed from the HEPA. The combination of material removed from the pre-filter and HEPA totaled 30.9 kilograms of UO2 powder, slightly less than the safe mass limit of 31 kilograms for dry UO2 powder. The licensee stated that a Δp of 4 inches H2O would normally be reached before 25 kilograms of UO2 accumulated on the HEPA filter. This particular HEPA filter is believed to have been in service for approximately two years. The licensee entered this occurrence into their near miss tracking database and continued to operate the UO2 Sinter Test Grinding Station.

On March 1, while performing routine non-destructive analysis (NDA) of the ventilation duct around the UO2 Sinter Test Grinding Station HEPA enclosure, the licensee identified material in the transition section of the HEPA filter enclosure. The licensee re-entered the system and removed approximately 15.3 kilograms of UO2 powder. This additional UO2 powder was determined to have been present in the HEPA enclosure since at least February 1. Therefore, approximately 46 kilograms of UO2 powder was present and uncontrolled in HEPA filter enclosure.

Upon discovery of the additional material in the transition section of the enclosure, the licensee shutdown the UO2 Sinter Test Grinding Station and the other grinders in the facility to assess the extent of condition. GNF identified similar grinders and reviewed historical Δp data for all of the HEPA enclosures. No other examples of excessive material accumulation were identified. The licensee determined that all other grinder HEPA enclosures had a different design, no common issues were noted. The UO2 Sinter Test Grinding Station remained shutdown but all other grinders were returned to service while the licensee conducts a root cause investigation.

GNF relied on mass and moderation control to ensure double contingency and this condition represented a loss of mass control. Although the licensee has reported that moderation control was not impacted, double contingency was no longer satisfied. GNF reported this event on March 2, 2011 (EN 46650) but did not specify the reporting criteria. A preliminary review of the issue by the staff indicates that the issue may have been reported in accordance with 10 CFR 70 Appendix A (b)(1), “Any event or condition that results in the facility being in a state that was not analyzed, was improperly analyzed, or is different from that analyzed in the Integrated Safety Analysis, and which results in failure to meet the performance requirements of 10 CFR 70.61.”

Objectives

The objectives of the inspection are to: 1) review the facts surrounding the failure to maintain mass control within the of UO2 Sinter Test Grinding Station HEPA filter enclosure; 2) assess the licensee's response to the higher than anticipated UO2 mass in the HEPA enclosure; and 3) evaluate the licensee's immediate and long term corrective actions to prevent recurrence. To accomplish these objectives, the following tasks will be completed:

1. Develop a timeline of the licensee's actions leading up to and following this process upset condition.

2. Determine the actual and potential safety significance to the workers, public, and the environment.

3. Evaluate the adequacy of the licensee's response to this process upset condition including operator response and maintenance effectiveness.

4. Evaluate the adequacy of licensee's event reporting.

5. Evaluate the adequacy of the licensee's causal analysis and extent of condition review.

6. Evaluate the adequacy of the licensee's immediate and long term corrective actions; and actions to prevent recurrence.

7. Evaluate the adequacy of the licensee's integrated safety analysis to ensure that performance requirements are met for this and related accident scenarios.

Documentation

Document the inspection findings and conclusions in an inspection report within 30 days of the completion of the inspection.

U.S. NUCLEAR REGULATORY COMMISSION

REGION II

SPECIAL INSPECTION TEAM

| | |
|---|---|
| Docket No.: | 70-1113 |
| License No.: | SNM-1097 |
| Report No.: | 70-1113/2011-006 |
| Licensee: | Global Nuclear Fuel-Americas (GNF-A) |
| Location: | Wilmington, NC 28402 |
| Dates: | March 14 through April 8, 2011 |
| Inspectors: | O. López, Team Leader<br>C. Fisher, Criticality Safety Inspector<br>N. Coovert, Fuel Facility Inspector (in-training)<br>M. Toth, Fuel Facility Inspector (in-training) |
| Approved by: | Marvin D. Sykes, Chief<br>Fuel Facility Inspection Branch 3<br>Division of Fuel Facility Inspection |

# EXECUTIVE SUMMARY

## Global Nuclear Fuel-Americas (GNF-A)
## NRC Inspection Report No. 70-1113/2011-006

The purpose of the special inspection was to inspect and assess the facts surrounding the failure to maintain mass control within the uranium dioxide ($UO_2$) sinter test grinding station high efficiency particulate air (HEPA) filter enclosure. The objectives of the inspection were to: 1) review the facts surrounding the failure to maintain mass control within the $UO_2$ sinter test grinding station HEPA filter enclosure; 2) assess Global Nuclear Fuel – Americas (GNF-A)'s response to the higher than anticipated $UO_2$ mass in the HEPA enclosure; and 3) evaluate GNF-A's immediate and long term corrective actions to prevent recurrence.

## Event Description

On February 1, 2011, GNF-A identified a high differential pressure (Δp) of approximately 4-inches of water ($H_2O$) across the ventilation housing of the $UO_2$ sinter test grinding station. The licensee's criticality safety analysis (CSA) stated that limiting the Δp to less than 4-inches $H_2O$ would limit mass accumulation to less than or equal to 25 kilograms (kgs) of $UO_2$ mass. On February 1, the licensee initiated maintenance to replace the prefilter to reduce the Δp. The prefilter contained approximately 4 kgs of $UO_2$ powder. The system was returned to service; however, the anticipated reduction in Δp readings was not achieved. The licensee scheduled a HEPA filter replacement for February 5, 2011.

On February 5, the licensee replaced both the HEPA filter and prefilter and removed approximately 26.9 kgs of $UO_2$ powder from the HEPA filter. The combined mass removed on February 1 and February 5 totaled 30.9 kgs of $UO_2$ powder, which exceeded the credited limit of 25 kgs $UO_2$ mass per CSA - No. 2310.00, Primary HEPA Filter Systems, Revision 2, and was slightly less than the safe mass limit of 31 kgs for dry $UO_2$ powder per CSA – Safe Mass Limits for Uranium Systems, Revision 1. The licensee determined that the February 5 mass accumulation was not reportable but entered this occurrence into their near miss tracking database and continued to operate the $UO_2$ sinter test grinding station.

On February 18, 2011, an unscheduled radiation protection survey of the sinter test grinder HEPA housing transition area resulted in a reading of 1.5 milliRoentgen/hour (mR/hr) above background, which was greater than the 0.5 mR/hr above background action limit as specified in Nuclear Safety Instruction (NSI) O-15.0, Revision 33, HVAC Systems Audits & Inspections. A work order for clean out was ordered and scheduled for March 1, 2011. In the interim, the grinder remained in operation.

On March 1, 2011, the licensee cleaned out the transition section and removed a total of 15.3 kgs of $UO_2$. This powder was in the HEPA filter housing enclosure at the same time as the powder identified in the prefilter and HEPA described above. In total, the licensee determined that there was potentially a maximum of 46 kgs of $UO_2$ powder in the HEPA enclosure before February 1, 2011, which exceeded the safe mass limit for dry $UO_2$ powder. The $UO_2$ powder was transferred into favorable geometry 3-gallon cans in accordance with approved procedures. On March 2, 2011, the licensee made a 24-hour notification (EN 46650) to the NRC for the failure to meet double contingency, in accordance with Safety Condition S-4 of Special Nuclear Material License 1097. The licensee completed a root cause evaluation on March 17, 2011, and began implementing additional corrective actions. The $UO_2$ sinter test grinding station remained shut down while the licensee conducted an investigation.

**Actual and Potential Safety Significance to the Workers, Public, and the Environment**

The team determined that there was no actual safety significance to the workers, public, or environment. The team determined that the risk of a criticality accident went from highly unlikely to unlikely, since the licensee was able to maintain control on moderation. The potential safety significance to the workers was high, since a criticality is a credible accident scenario. Although the likelihood of a criticality incident was increased, moderation control was not compromised therefore the potential safety significance to the public or the environment was low.

The team identified that the HEPA filter housing enclosure did not incorporate sufficient margins of safety to require at least two unlikely, independent, and concurrent changes in process conditions before a criticality accident was possible. Specifically, the licensee did not ensure that the $UO_2$ holdup in the HEPA filter enclosure for the sinter test grinder was limited to less than their credited limit of 25 kgs for HEPA enclosure. In addition, the licensee did not apply sufficient controls to the extent needed to reduce the likelihood of occurrence of a criticality in the sinter test grinder HEPA filter enclosure so that, upon implementation of such controls, the event was highly unlikely.

**Evaluation of Licensee's Response to the Process Upset Condition and Event Reporting**

The team determined that the licensee did not implement and apply their existing configuration change process by not verifying the controls selected and installed were appropriate to limit the $UO_2$ accumulation to less than 25 kgs. In addition, the licensee did not conduct a CSA on the sinter test grinder prior to initial operation as required by Chapter 5 of the license application. Instead, the licensee completed a criticality safety summary (CSS) that did not include model description, calculational results sections, and parts of the criticality safety controls/bounding assumptions.

The team identified that weaknesses existed in the interdepartmental roles and responsibilities related to procedures, processes, and communications between Nuclear Safety, Operations, maintenance personnel, and radiation protection personnel. Radiation Protection Survey procedure, NSI O-15.0, HVAC Systems Audits & Inspections, Revision 33, only required a resurvey if clean out was performed due to a high survey reading. If the action limit of 0.5 mR/hr was reached, the procedure stated to notify specific personnel and request a clean out, but this was not consistently performed. The inspectors noted multiple occasions where notifications were not made and clean outs were not performed. Specifically, the team identified that on August 1, 2010, and January 23, 2011, the licensee did not notify specified personnel and request a clean out for the sinter test grinder HEPA filter housing transition when the survey results for the transition exceeded the action limit of 0.5 mr/hr above background.

A violation was identified for the failure to vacuum out the sinter test grinder HEPA filter housing when it was necessary. Specifically, the licensee changed out the prefilter and HEPA filter on February 1 and 5, 2011 and did not clean out approximately 15.3 kgs of $UO_2$ powder that had accumulated in the filter housing transition piece. (VIO 70-1113/2011-006) (Section 3)

The team also identified multiple examples where the licensee exhibited non-conservative decision making. On February 5, the sinter test grinder was authorized for restart even though there was only 0.1 kgs of margin to the dry powder safe mass limit of 31 kgs. In addition, operation resumed the next day without the licensee understanding the cause, considering extent of condition, performing a radiation protection survey to verify no additional material remained, or taking any additional immediate actions other than filter replacement.

Another example of non-conservative decision making occurred on February 5, 2011, when the licensee failed to notify the NRC within 24 hours when the credited mass control limit of 25 kgs $UO_2$ was exceeded. The licensee determined that the mass accumulation event was not reportable because 30.9 kgs $U_2O$ was less than the safe mass limit of 31 kgs, stated in CSA, Safe Mass Limits for Uranium Systems, Revision 1 for generic criticality safety application. The licensee did not utilize the 25 kgs mass control limit as stated in CSA No. 2310.00, Primary HEPA Filter Systems, Revision 2. The licensee also did not perform a confirmatory post-maintenance radiation protection survey to validate that no accumulated mass remained in the ventilation housing or ductwork. A violation was identified for the failure to notify the NRC within 24 hours for the loss of mass control when the sinter test grinder HEPA filter exceeded the mass control limit of 25 kgs $UO_2$ on February 5. The $UO_2$ weight of the sinter test grinder HEPA filter during the February 5 HEPA filter replacement was 26.9 kgs $UO_2$. (VIO 70-1113/2011-007) (Section 4)

The team identified missed opportunities for problem identification and resolution. The team noted elevated readings and trends for radiation protection surveys and $\Delta p$ readings that started as early as August 2010 but this was not documented in the corrective action program. In addition, the responsible departments did not interact with each other to address the available trends and resolve the issues in a timely manner.

<u>**Evaluation of Licensee's Causal Analysis and Associated Corrective Actions**</u>

The team determined that the root cause analysis adequately identified the casual factors associated for this specific event but did not explore the underlying latent organizational issues that allowed this event to occur. Specifically, the licensee's root cause did not address the organizational mindset and lack of rigor that allowed the licensee to not implement the configuration change process as written; and the organizational behaviors that did not exhibit importance, ownership, or accountability for criticality safety control surveillances, maintenance, and corrective actions. The licensee's root cause also did not evaluate the non-conservative decision making and less than adequate management oversight attributes that contributed to the event.

The licensee performed an extent of condition review in a timely manner, but strictly focused on replacing filters and determining if additional mass accumulation was present in other housing units. The extent of condition results were not incorporated into the analysis such that generic causes could be understood and corrected.

The team determined that the immediate corrective actions taken by the licensee were sufficient to restore safety and compliance with license requirements. However, the corrective actions as written would not prevent reoccurrence of similar generic root causes. The team also identified that not all of the corrective actions in the root cause analysis directly correlate to a root cause and if the action was taken as written, some of the actions would not directly correct or prevent the root cause from reoccurring. For example, one of the root causes was that no preventative maintenance existed. The corrective action to address this root cause was to replace the sinter test grinder HEPA filter with a favorable geometry design.

**Independent Determination of Root Causes and Contributing Factors**

The team performed an independent root cause analysis for the 46 kgs of $UO_2$ powder accumulation in the sinter test grinder filter housing unit, as reported to the NRC on March 2, 2011. The team identified two root causes and two contributing causes for the event. The root and contributing causes involved less than adequate technical rigor and implementation of the existing configuration change process; and the lack of enforcement related to the requirements for safe mass limit controls as it applies to surveys, monitoring, and taking required action when established limits were exceeded.

Attachments:
Partial List of Persons Contacted
List of Items Open/Closed
List of Inspection Procedures Used
Documents Reviewed
List of Acronyms Used

## REPORT DETAILS

### Event Description (NRC Event No. 46650)

This event description was independently developed and validated by the team using a review of records, logs, and interviews of personnel directly involved with activities prior to and during the failure to maintain mass control within the uranium dioxide ($UO_2$) sinter test grinding station high efficiency particulate air (HEPA) filter enclosure. Refer to Figure 1 for additional information.

On February 1, 2011, at GNF-A, the licensee identified a high differential pressure ($\Delta p$) of approximately 4-inches of $H_2O$ across the ventilation housing of the $UO_2$ sinter test grinding station. The licensee stated that limiting a $\Delta p$ of less than 4-inches $H_2O$ would limit mass accumulation to less than or equal to 25 kilograms (kgs) of $UO_2$ mass. The licensee, using an approved procedure, replaced the prefilter on February 1, which contained approximately 4 kgs of $UO_2$ powder. The system was returned to service; however, the anticipated reduction in $\Delta p$ readings was not achieved. The licensee scheduled a HEPA filter replacement for February 5, 2011. The post prefilter replacement $\Delta p$ reading was 3.2-inches $H_2O$.

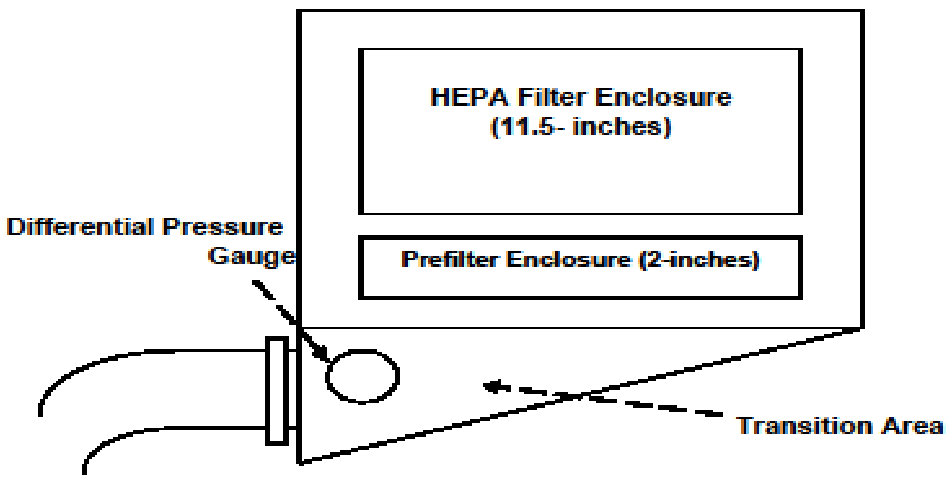


Figure 1: Example of Sinter Test Grinder Filter Housing

On February 5, the licensee again removed the system from service and replaced both the HEPA filter and prefilter. During this activity, approximately 26.9 kgs of $UO_2$ powder was removed from the HEPA filter. The combination of the prefilter, from the February 1, 2011 replacement, and the HEPA on February 5, totaled 30.9 kgs of $UO_2$ powder, which was slightly less than the safe mass limit of 31 kgs for dry $UO_2$ powder per CSA – Safe Mass Limits for Uranium Systems, Revision 1. This particular HEPA filter had been in service for approximately two years. The licensee entered this occurrence into their near miss tracking database and continued to operate the $UO_2$ sinter test grinding station.

On February 18, 2011, an unscheduled radiation protection (RP) housing survey was performed for the sinter test grinder HEPA housing transition area. The survey results were 1.5 milliRoentgen/hour (mR/hr) above background, which was greater than the 0.5 mR/hr above background action limit in the approved RP survey procedure. A work order for clean out was ordered and scheduled for March 1, 2011. The grinder remained in operation.

On March 1, 2011, the licensee cleaned out the transition section and removed a total of 15.3 kgs of $UO_2$. This powder was in the HEPA filter housing enclosure at the same time as the powder identified in the prefilter and HEPA discussed above. In total, there was approximately 46 kgs of $UO_2$ powder in the HEPA enclosure, which exceeded the safe mass limit for dry $UO_2$ powder. This additional $UO_2$ powder was determined to have been present in the HEPA enclosure since at least February 1. The $UO_2$ in the HEPA filter housing was transferred into favorable geometry 3-gallon cans per approved procedures.

Upon discovery of the additional material in the transition section of the enclosure, the licensee shutdown the $UO_2$ sinter test grinding station and the other grinders in the facility to assess the extent of condition. GNF-A cleaned out the HEPA filters attached to the other grinders as a part of extent of condition activities. The licensee did not observe any additional instances with accumulated mass greater than safety limits for HEPA enclosures that utilized mass control as a criticality safety control. The other grinders also had a different design that included specific equipment to catch the grinding dust. The licensee subsequently resumed operations of the others grinders however the $UO_2$ sinter test grinding station remained shut down. The licensee completed a root cause evaluation on March 17, 2011, and began implementing corrective actions.

GNF-A reported this event to the NRC on March 2, 2011 (EN 46650) due to the failure to meet double contingency. GNF-A relied on mass and moderation control to ensure double contingency and during this event, they lost the control on mass. As part of their corrective actions, the licensee replaced the unfavorable geometry HEPA enclosure with a favorable geometry enclosure which changed the controls to geometry and moderation.

GNF-A made the reportability determination based on a generic dry powder spill safe mass limit of 31 kgs. The inspection team noted that the CSA for the HEPA filters credited a safe mass limit of 25 kgs and did not mention the safe mass limit of 31 kgs. In addition, the design of the system was to prevent an accumulation of less than 25 kgs (4-inches $\Delta p$ = 25 kgs) and two previous nuclear criticality safety (NCS) managers who were part of the original design review team, stated that the mass control limit was 25 kgs.

**Inspection Scope:**

The objectives of the Special Inspection were to: 1) review the facts surrounding the failure to maintain mass control within the $UO_2$ sinter test grinding station HEPA filter enclosure; 2) assess GNF-A's response to the higher than anticipated $UO_2$ mass in the HEPA enclosure; and 3) evaluate GNF-A's immediate and long term corrective actions to prevent recurrence.

The inspection included a review of procedures, procedural implementation, and operational decision making to determine if the facility operated safely and in compliance with its license. Areas examined during the inspection were identified in each of the charter items. Within these areas, the inspection consisted of a selective examination of procedures and records, interviews with personnel, and observation of activities performed by GNF-A staff following the event.

**Charter Items:**

## 1. Develop a timeline of the licensee's actions leading up to and following this process upset condition

Through interviews of licensee personnel and review of licensee records, the team developed a timeline associated with the event surrounding the loss of mass control in the sinter test grinder HEPA enclosure. The timeline is shown in Figure 2-a and 2-b.

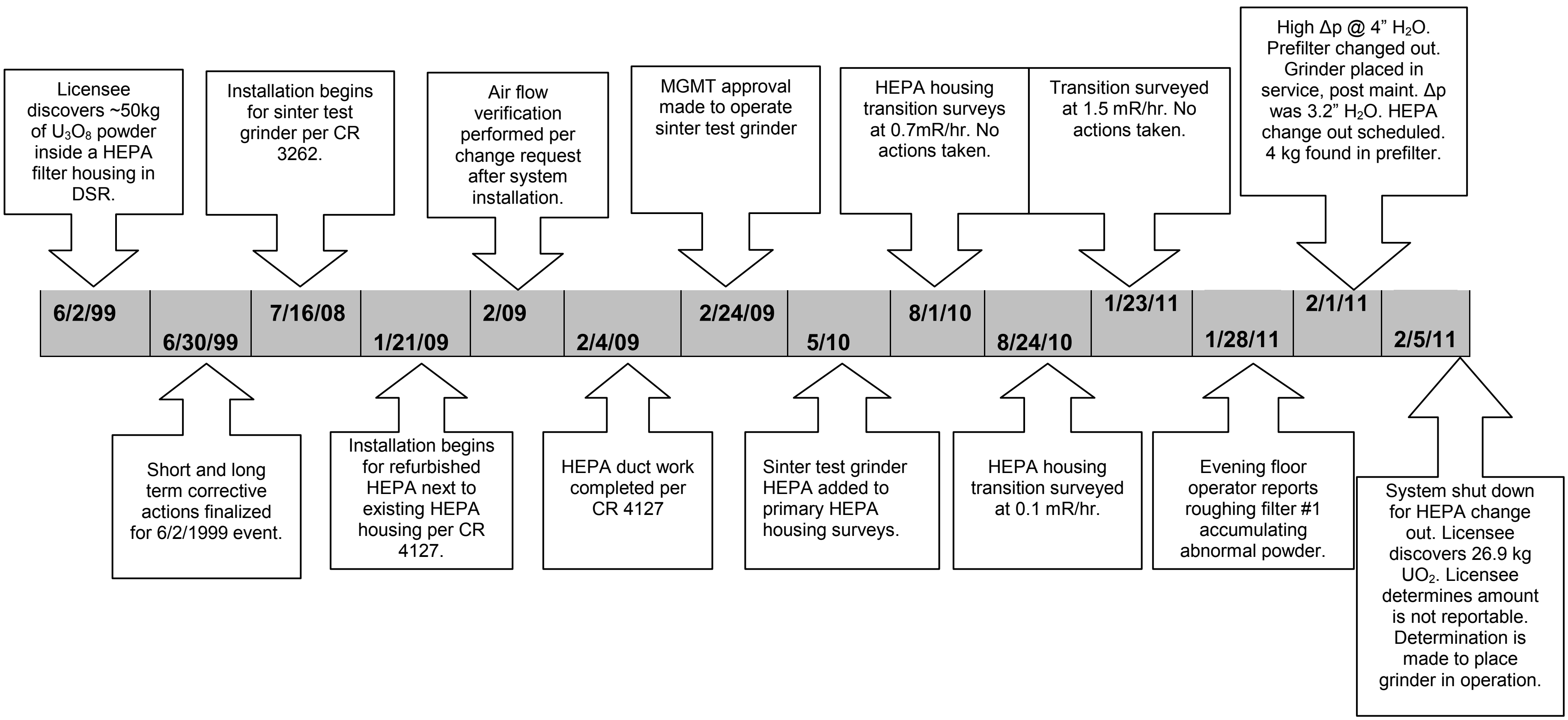


**Figure 2-a: Timeline of events leading up to the loss of mass control in the sinter test grinder and subsequent responses**

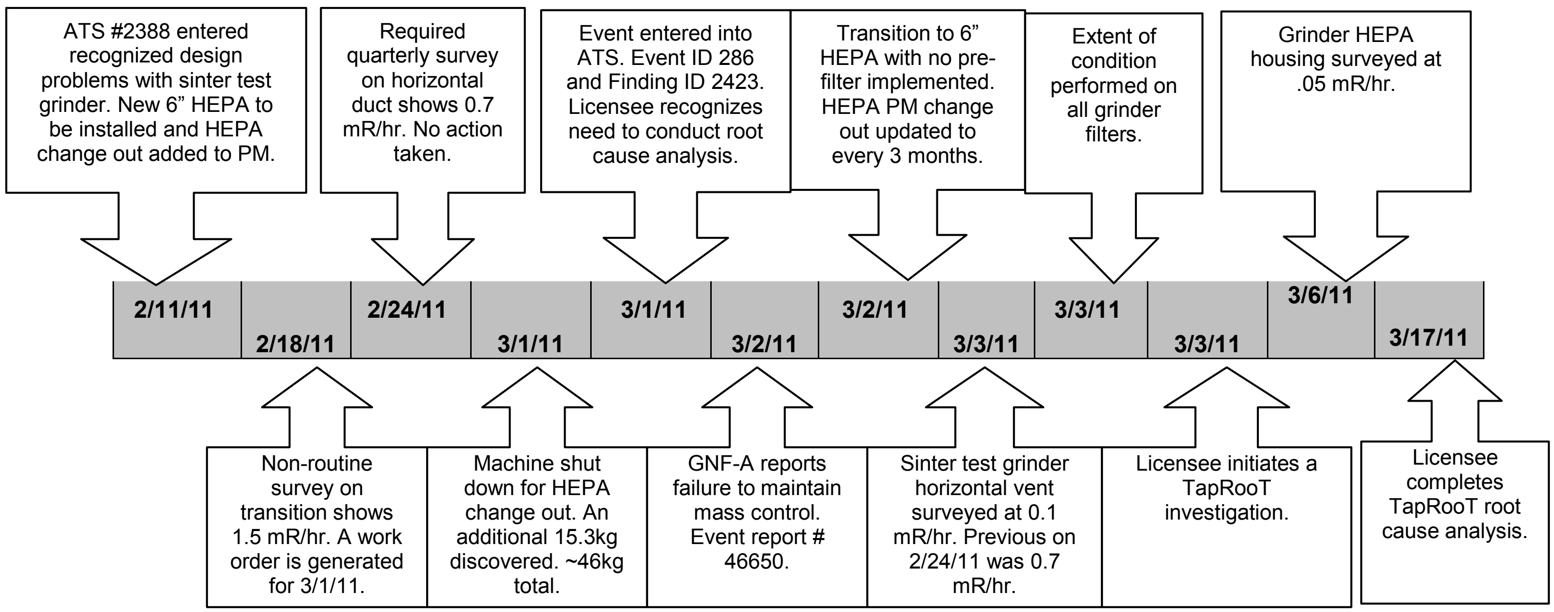


**Figure 2-b: Timeline of events leading up to the loss of mass control in the sinter test grinder and subsequent responses**

**2. Determine the actual and potential safety significance to the workers, public and the environment**

The team determined that there was no actual safety significance to the workers, public, or environment. The team determined that the risk of a criticality accident went from highly unlikely to unlikely, since the licensee was able to maintain control on moderation. The potential safety significance to the workers was high, since a criticality is a credible accident scenario. Although the likelihood of a criticality incident was increased, moderation control was not compromised therefore the potential safety significance to the public or the environment was low.

To determine this conclusion, the inspectors looked at the CSA for primary HEPA filter system and the CSS for the sinter test grinder. The CSA No. 2310.00, "Primary HEPA Filter Systems," Revision 2, (where the powder accumulation occurred) was a general CSA and covered many different areas of the facility. The analysis divided the primary HEPA system into moderator restricted areas (MRAs), moderator controlled areas (MCAs), and by types of uranium in the HEPAs; dry $UO_2$, dry $U_3O_8$, or a combination of wet $UO_2$ and $U_3O_8$. The HEPA filter where the accumulation occurred was connected to the sinter test grinder, and therefore was covered by the dry $UO_2$ section analysis.

The CSA for the primary HEPA filter system listed mass and moderation as the criticality controls for dry $UO_2$ systems in the MCA. The analysis had a mass control of 25 kgs and a moderation control of dry $UO_2$ with no more than 50,000 parts per million (ppm) water equivalent. The mass control was implemented by controlling $\Delta p$ across the housing to 4-inches $H_2O$ or less, and the ductwork and HEPA housing transitions were periodically monitored for buildup of uranium using RP surveys of the ductwork. The moderation control was implemented by ensuring that the exhaust air passing through the HEPA housing must originate from process equipment in the MCA or meet the moderation content requirements. Also, the primary HEPA housing and ductwork was completely sealed to prevent external moderation from entering the housing.

On February 5, 2011, the licensee identified that there was approximately 30.9 kgs of dry $UO_2$ in the sinter test grinder HEPA enclosure. The inspectors determined that mass control in the primary HEPA enclosure was lost when the 25 kgs limit as listed in the applicable HEPA CSA was exceeded. Section 5.1.1 of the license application (Application) stated that double contingency principle is the fundamental technical basis for design and operation of processes within the GNF-A fuel manufacturing operations using fissile materials. As such, "process designs shall incorporate sufficient margins of safety to require at least two unlikely, independent, and concurrent changes in process conditions before a criticality accident was possible." For each significant portion of the process, a defense of one or more system parameters was documented in the CSA, which was reviewed. The failure of the mass control resulted in a failure to maintain double contingency control for the primary HEPA filter housing attached to the sinter test grinder and was identified as unresolved item (URI) 70-1113/2011-006-01. This item will require additional NRC review and evaluation in a subsequent inspection.

During the inspection, the team looked at the analysis for the sinter test grinder, which was where the $UO_2$ going into this HEPA filter originated from. The team found that it did not have a formal CSA, but that it had a CSS. A CSA was required by Section 5.3.1 of the Application, and the team determined that the CSS did not satisfy the requirements of a CSA. Specifically that the CSS did not contain a model description, calculation results, or an accurate statement of interface conditions. Failure to conduct a CSA was identified as URI 70-1113/2011-006-04. This item will require additional NRC review and evaluation in a subsequent inspection.

**Conclusions**

The team determined that the actual safety significance went from highly unlikely to unlikely, since the licensee was able to maintain control on moderation. The potential safety significance was high, since a criticality was a credible accident scenario. The team determined that the licensee lost one of two NCS controls identified in the primary HEPA filter systems CSA. An unresolved item, URI 70-1113/2011-006-01, was identified for the failure to maintain double contingency control for the primary HEPA filter attached to the sinter test grinder. The team also determined that the CSS performed for the sinter test grinder did not satisfy the Application requirement of conducting a CSA. Failure to conduct a CSA was identified as URI 70-1113/2011-006-04.

3. **Evaluate the adequacy of the licensee's response to this process upset condition including operator response and maintenance effectiveness.**

The NRC determined the adequacy of the licensee's response to the process upset condition, as reported (EN 46650) on March 2, 2011, was less than adequate. Specifically, radiation protection (RP), heating, ventilation, and air conditioning (HVAC) maintenance, and applicable management/supervision utilized less than adequate technical rigor for the sinter test grinder HEPA filter and associated ventilation configuration changes, surveillances, maintenance, and proceduralized corrective actions. Contributing to the inadequate licensee event response, organizational integration issues existed including communications and procedural interface breakdowns. The organizations involved in this event utilized non-conservative decision making by not taking actions when trends occurred or when readings were at or above the mass safety limits.

The team determined that licensee's response applied to the configuration change for the sinter test grinder and associated ventilation was less than adequate. The precursors to the mass accumulation event, reported on March 2, 2011, started during the modification and installation process in late 2008 and early 2009. The change requests (CRs) submitted, CRs 3262 and 4127, proposed changes to an existing grinder and HEPA ventilation housing, respectively. The purpose of the sinter test grinder and associated ventilation was to operate as a quality control process, in which small amounts of pellets were tested prior to producing large amounts of powder for pellet production. For each of the two CRs, the change request package evaluated the specific changes of the component but did not review the balance of plant impacts or consider how the two modifications affected each other. In addition, CR 4127 for the HEPA housing ductwork was treated as a point A to point B pipe run from the ventilation housing to the sinter test grinder without engineering flow design consideration. The technical reviews and approvals for the modifications included a Project Manager, Nuclear Safety Engineer/ Manager, Area Manager, Area Engineer, and the Maintenance (HVAC) Manager.

The team noted that for CR 3262 the following documents established the performed safety reviews and proposed criticality safety controls: Criticality Safety Summary (CSS), dated February 18, 2009, Nuclear Safety Release/Requirements (NSR/R) # 03.03.21, and a What-If analysis (Node 146). CR 4127 stated that the "Integrated Safety Analysis (ISA) Team Review and Process Hazard Analysis (PHA) Update requirement was removed from this [4127] CR and replaced by the requirement in CR 3262." The team noted that CR 3262 only considered the grinder and did not address the HEPA housing and ductwork. The safety analysis that applied to CR 4127 was CSA for $UO_2$ Processes (MCA), No. 2310.00, Primary HEPA Filter Systems, Revision 2, which stated, in part, that the $UO_2$ holdup was limited to less than 25 kgs by controlling Δp across the housing to 4-inches $H_2O$ or less.

The team determined that the licensee failed to verify as part of the change process that the controls selected and installed for CR 4127 would limit the $UO_2$ holdup to less than 25 kgs by controlling a Δp across the ventilation housing to 4-inches $H_2O$ or less. Section 5.4.1.1, Verification Program, of the License Application dated February 24, 2009, stated that the purpose of the verification program was to assure that the controls selected and installed fulfill the requirements identified in the criticality safety analyses. The failure to assure that the mass control selected and installed fulfilled the requirements identified in CSA – No. 2310.00, Primary HEPA Filter Systems was identified as URI 70-1113/2011-006-03. This item will require additional NRC review and evaluation in a subsequent inspection.

In addition, throughout CR 4127, CR 3262, and the CSS for CR 3262, statements existed such as "small-scale pellet grinder;" "similar in form and function to a production grinder except that it processes considerably smaller amounts of uranium pellets during operation;" and "due to the small amounts of uranium processed on this station, a 7-inch pre-filter will be used to collect the small, particulate swarf discharged through the ventilation system instead of Apitron filter cartridge." The sinter test grinder and associated ventilation modification was not considered a new system or new process to GNF-A, which was confirmed through interviews with management and technicians involved in the modification. This specific equipment was also considered to be less of a risk because of the low amount of $UO_2$ processed through the system and as a result, the CRs did not consider using safe geometry HEPA filters like used in other grinder ventilation housings.

The team noted that the personnel involved with the modification process failed to recognize and/or implement the following activities prior to placing the components into service: RP surveys to monitor mass accumulation; identification and execution of post installation testing for the swarf collection beaker; and creation of preventative maintenance requirements for filter changes at a designated frequency.

The team determined that the licensee's response to surveillance performed for the sinter test grinder associated ventilation was inadequate. RP performed ventilation ductwork and housing surveys and HVAC maintenance technicians monitored the HEPA housing Δp readings from the magnehelic Δp gauge physically located on the housing. Both of these surveillance activities were intended to proactively identify mass accumulation and take corrective actions before accumulations approached safety limits.

Radiation protection surveys consisted of monthly and quarterly readings of the ventilation ductwork and housing per NSI O-15.0, Revision 33 “HVAC Systems Audits & Inspections.” Per section 5.2.3.1 for horizontal ducts and section 5.2.3.3, for primary HEPA filter housing transitions, if the survey results were greater than 0.5 mR/hr above background, the RP technician was to notify the HVAC and area manager and request a clean out of the affected duct or transition. In addition, the procedure instructed that any material removed during the clean out should be weighed and that the area be resurveyed. Last, the RP technician would distribute all documents to the Nuclear Safety Manager, HVAC maintenance, area manager(s) and other appropriate team leaders, per step 5.2.3.5.

The team noted that for the sinter test grinder, RP survey requirements were only added to NSI O-15.0 in March 2010, a year after the modification was approved and the system was placed online.

From June 2010 to March 2011, the team noted one quarterly survey (February 2011), and three monthly surveys (August 2010, January 2011, and February 2011) for the sinter test grinder ductwork that exceeded the action limit of 0.5 mR/hr above background. In addition, the sinter test grinder ventilation RP survey was not performed (blank on the survey form) for the monthly survey on November 16, 2010, and there were three months (July 2010, September 2010, and February 2011) when the entire ventilation RP survey was not completed, but instead performed twice in the following month. The team determined that the licensee’s performance in response to RP survey action limits was not in accordance with plant procedures.

Section 5.2.3.3, Primary HEPA Filter Housing Transition, of NSI O-15.0, Revision 33, stated, in part, that if the survey results of a transition exceed the action limit of 0.5 mr/hr above background notify HVAC and the area manager and request a clean out of the affected transition. On August 1, 2010, and January 23, 2011, the survey results for the sinter test grinder primary HEPA filter housing transition exceeded the action limit of 0.5 mR/hr above background and the licensee failed to notify HVAC and the area manager and request a clean out of the affected transition, as required by procedure NSI O-15.0. The failure to notify HVAC and the area manager and request a clean out when action limits were exceeded was identified as URI 70-1113/2011-006-05. This item will require additional NRC review and evaluation in a subsequent inspection.

For the two RP surveys (August 2010 and January 2011) that were greater than the procedural action limit, neither of these two survey readings resulted in a clean out being performed. Through the interviews performed, the team identified that when RP surveys limits were exceeded for any of the survey results in NSI O-15.0, in some cases, notifications were made but to the wrong people; notifications were made to the correct people but no actions were taken, or actions were taken to clean out the mass accumulation but the work coordination was not clear and follow-up communications were dropped among departments. The organizational roles and responsibilities with respect to the sinter test grinder ventilation system surveys were not clear or direct, such that the procedures did not integrate departmental actions nor direct a formal communication method when action limits were exceeded. In addition, the RP surveys required two signatures, the performer and an independent reviewer. Per step 3.2 of NSI O-15.0 Revision 33, if an action limit had been exceeded the reviewer must verify that the appropriate notifications were made. Of the fifteen RP surveys reviewed, the RP Manager signed as the independent reviewer for thirteen of the surveys and signed as performer for the fourteenth survey. These additional barriers failed to prevent missed surveillances, did not drive corrective actions to be taken when action limits were exceeded, and did not display accountability for monitoring criticality safety controls through surveillance surveys.

The team determined that the licensee's response to the maintenance performed for the sinter test grinder associated ventilation was inadequate. Criticality Safety Analysis No. 2310.00, Primary HEPA Filter Systems, Revision 2 and in CR 3262 What-If analysis (Node #146) established mass control for the sinter test grinder operations by maintaining the ventilation housing at less than 4-inches $H_2O$ Δp. The HVAC technicians used procedure OP 2301.00, Revision 9, "FMO HVAC Maintenance Operation," to monitor the Δp five times a week and recorded the Δp every two weeks into an electronic HVAC database. Since May 2010, the sinter test grinder ventilation housing Δp had been recorded as 3.0-inches $H_2O$ Δp. From September 2010 until January 18, 2011, the Δp was 3.5-inches, and neither the prefilter nor the HEPA filter was replaced. Procedure OP# 2301.00 stated to change the HEPA filter and/or prefilter when Δp across the filters reaches 4-inches and the required airflow could no longer be maintained. The NSR/R 03.03.20 also stated that if the Δp reaches 4-inches, corrective actions must be taken to reduce the Δp to less than 4-inches before operations could continue. On February 1, 2011, the HEPA housing reached 4.0-inches $H_2O$ Δp and the prefilter was replaced. This was the first time a filter change was completed for the sinter test grinder since the grinder was put online in March 2009. The HEPA filter was replaced for the first time on February 5, 2011.

The sinter test grinder Δp was near the 4-inches $H_2O$ Δp limit for four months, which correlates with the RP survey results when they started to go over the 0.5 mR/hr action limit in August 2010. In addition, none of the high Δp readings or the RP survey results greater than action limits were documented in the GNF-A corrective action programs, Audit Tracking System (ATS) and Gensuite. The separate data inputs and lack of trending analysis was another example of an organization integration weakness and thus the licensee missed an opportunity for earlier problem identification and resolution.

During the week of January 24, 2011, a floor operator identified that the sinter test grinder roughing filter #1, located in the grinder hood, was accumulating powder faster than anticipated. The operator notified the area engineer, who performed troubleshooting by cracking open the damper, which caused the Δp to increase above 4-inches Δp $H_2O$. The area engineer then requested the HVAC technicians to check the filters. The operator exhibited a good questioning attitude by identifying and reporting an unexpected condition.

On February 1, 2011, when the Δp was approximately 4-inches $H_2O$, HVAC technicians performed a prefilter replacement. At that time, the $UO_2$ mass removed from the prefilter was 4 kgs $UO_2$. After the prefilter was changed, the Δp was 3.2-inches $H_2O$. The HVAC technician stated that the Δp did not lower as he had anticipated and subsequently recommended a HEPA filter change out, which was scheduled for Saturday, February 5, 2011. On February 5, the HVAC technician removed the HEPA filter by tapping the HEPA filter onto the prefilter and then removing the prefilter for weighing. This was done four times. This technique was not described in procedure OP 2301.00 but the technician stated this was done for airborne or loose particulate concerns. The total weight removed from the February 5, 2011 filter replacement was 26.9 kgs of $UO_2$ from the HEPA filter. After the HEPA and prefilter were changed, the technician stated that the Δp was 0.6-inches $H_2O$.

During the evolution, the HVAC technician was in a full-face respiratory mask. As part of the filter replacement, a filter housing vacuuming was performed "if necessary" in accordance with OP# 2301.00, Revision 9, but the procedure did not provide specific requirements when to perform a clean out. In addition, there was no procedure guidance to direct the technician where and how to perform the visual inspection of the filter housing and transition area. However, through interviews, it was determined that the skill of the craft knowledge was for the technician to look through the top of the HEPA filter housing opening when the filter was removed and then look down into the housing toward the transition area to visually inspect for accumulation. The technician however, stated he looked through the prefilter opening (2-inch opening), which was a smaller opening than the HEPA filter opening (11.5-inch opening). The technician was aware of the technique to view the transition area through the HEPA filter opening but stated it was difficult to see through the HEPA filter opening with a facemask. The technician stated that he did see fines in the ductwork but did not identify additional holdup during his visual inspection and as a result, determined no vacuuming was necessary. Operation Sequence – Primary Filter Units, of OP 2301.00, Revision 9, Section F, stated that after removal of prefilter or HEPA filter from the housing "vacuum out the filter housing, if necessary." On February 1 and 5, 2011, the licensee failed to vacuum out the sinter test grinder HEPA filter housing when it was necessary. Specifically, the licensee changed out the prefilter and HEPA filter and did not clean out approximately 15.3 kg of $UO_2$ powder that had accumulated in the filter housing transition piece. The failure to clean out the filter housing transition after a filter change out was considered a violation of NRC requirements. (VIO 70-1113/2011-006-06)

The HVAC maintenance procedure OP# 2301.00 also did not require a post-maintenance RP survey to be performed. Because the filter replacement was initiated due to high Δp under OP# 2301.00 and not because of greater than RP survey action limits, per NSI O-15.0, Revision 33, a RP resurvey of the ductwork and transition area was not required to be performed immediately following the filter replacement on February $5^{th}$ to verify additional mass accumulation was not present. This was another example of organization integration weaknesses and a missed opportunity for effective corrective actions.

On February 5, the GNF-A management team reviewed the filter weight data to determine if the event was reportable per GNF-A procedure 40-32, "Safety Event Communication and Notification." The licensee discussed the event through e-mail and telephone communications between the NCS Manager, the acting Maintenance Manager, acting Operations Director, licensing personnel, the area manager, and other personnel. The management involved combined the mass from the February 1 prefilter replacement (4.0 kgs $U_2O$) with the mass from the February 5 HEPA and prefilter replacement (26.9 kgs $U_2O$) and determined that the mass accumulation event was not reportable because 30.9 kgs $U_2O$ was less than the safe mass limit of 31 kgs, stated in CSA – Safe Mass Limits for Uranium Systems, Revision 1 for generic criticality safety application. The licensee did not utilize the 25 kgs mass limit as stated in CSA - No. 2310.00, Primary HEPA Filter Systems, Revision 2 for HEPA filter mass control limits.

As part of the reportability determination, licensee discussions were made to determine if other material might exist in the ductwork or the swarf collection beaker. The management team did not validate if the HVAC technician had performed an adequate visual inspection during filter replacement or request an alternate means to validate there was no additional mass in the ventilation housing or ductwork, such as an independent post-maintenance RP survey.

The licensee concluded that because the amount of material processed through the sinter test grinder was low and there was a planned shutdown in April when the sinter test grinder HEPA filter could be changed to a favorable geometry design, the 30.9 kgs $U_2O$ was not reportable and the system was safe to restart and operate until April. Although the accumulated mass was only 0.1 kgs away from safe operating limits, management felt confident to authorize the sinter test grinder back to operation. The restart of the sinter test grinder occurred on February 6 with the first transaction recorded at 5:46 am.

The licensee utilized less than adequate technical rigor by not evaluating and verifying that additional mass accumulation did not exist in the ductwork. The group assumed that no additional material existed and did not validate that the visual HVAC inspection performed was adequate, such that operating decisions could be made from. In addition, the licensee exhibited non-conservative decision making by authorizing restart of the system on the same day as the discovery of 30.9 kgs $U_2O$ total accumulated mass without understanding the cause of the event or extent of condition. There were no additional immediate corrective actions taken prior to start up other than filter replacement.

On February 11, Operations, RP, and NCS groups met to discuss the February 5 mass accumulation event. The team concluded that the higher than expected mass accumulation in the sinter test grinder HEPA filter was a result of four issues: (1) the ventilation was not appropriately designed; (2) the swarf collection beaker installed in the vent line was not highly effective; (3) the swarf generation rates were initially underestimated and not appropriately considered; and (4) the swarf particle size was very small, similar to the $U_3O_8$, which changed the effect holdup has on the $\Delta p$ across the filter. These conclusions were documented in ATS Finding ID 2388. In addition, the team recommended to replace the mass control (4-inch $\Delta p$) with a geometry control by specifically changing the HEPA filter to a 6-inch safe geometry housing design with no prefilter. Additional actions included: (1) investigate a different type of trap to improve swarf collection; (2) make modifications to the ventilation design to reduce the amount of particulate pulled into the HEPA; and (3) to implement a 6-month preventative maintenance (PM) activity to replace the HEPA filters.

On February 18, the RP manager and area engineer performed an area walkdown during which the RP manager performed an unscheduled survey of the sinter test grinder ventilation transition area and identified a 1.5 mR/hr above background reading. The RP manager requested a follow-up confirmatory survey from a RP technician. A second reading of 1.5 mR/hr above background was recorded on February 18, 2011, on Exhibit #7 of NSI O-15.0, Revision 33. The RP manager and area engineer submitted an emergency work order, WO #356668, to perform a clean out of the transition area, which was scheduled for March 1, 2011, approximately a week and a half later. On February 24, a RP technician performed a scheduled quarterly survey, Exhibit #3 of NSI

O-15.0, for the horizontal duct section and identified a 0.7 mR/hr above background reading for the sinter test grinder ductwork. No additional action was taken on February 24 because it was known that a clean out was already scheduled.

On March 1, the HEPA and prefilter was replaced again, which was weighed and totaled 3.8 kgs. The transition and ductwork were vacuumed out, which contained a total of 15.3 kgs. The licensee concluded that the 15.3 kgs must have been present at the time of the February 1 and 5 filter replacements because of the relatively low amount of pellets processed through that grinder in a one month period. As a result, the licensee determined that the total amount of $UO_2$ mass on February 5 was approximately 46 kgs and that the mass accumulation event was now reportable. The GNF-A performed a 24-hour notification to the NRC on March 2, 2011. GNF-A also initiated a root cause analysis (RCA) under ATS Event ID 286.

**Conclusions**

During the course of the event for the loss of mass control, there were multiple examples when the license's response to the process upset condition, as reported (EN 46650) on March 2, 2011, was less than adequate. GNF-A organization failed to apply adequate levels of technical rigor, including the over-reliance on assumptions without validation during the configuration change process (4-inch $H_2O$ $\Delta p = 25$ kg), and tolerated RP and HVAC surveillance readings and trends relating to critical safety mass limit control that were at or above action levels stated in approved procedures.

An URI was identified for the failure to assure that controls selected and installed fulfilled the requirements identified in CSA – No. 2310.00, Primary HEPA Filter Systems. Specifically, the licensee failed to assure that the $UO_2$ holdup would be limited to less than 25 kgs by controlling $\Delta p$ across the housing to 4-inches of $H_2O$ or less. (URI 70-1113/2011-06-03)

Additional areas that lacked technical rigor were maintenance of the sinter test grinder HEPA system and proceduralized corrective action execution. The sequence of events identified that latent weaknesses existed in the interdepartmental roles and responsibilities, specifically with procedures, processes, and communications between Nuclear Safety, Operations, HVAC personnel, and RP. The precursors and trends for this event had started as early as August 2010. The departments were independently observing the individual issues instead of globally recognizing and acting on the trends. When the procedures required notification to other departments because action limits were exceeded, notifications were not always made, made to the wrong people, or made and no actions were taken by the notified groups.

An URI was identified for the failure to notify HVAC and the area manager and request a clean out on August 1, 2010, and January 23, 2011 for the affected sinter test grinder primary HEPA filter housing transition when the survey results for the transition exceeded the action limit of 0.5 mr/hr above background. (URI 70-113/2011-06-05)

A violation was identified for the failure to vacuum out the sinter test grinder HEPA filter housing when it was necessary. Specifically, on February 1 and 5, 2011, the licensee changed out the prefilter and HEPA filter and did not clean out approximately 15.3 kg of $UO_2$ powder that was accumulated in the filter housing transition piece. (VIO 70-1113/2011-006)

There were also examples of non-conservative decision making exhibited by the licensee throughout the event, for example, when the restart was authorized after identifying 30.9 kgs mass compared with a generic safety limit of 31 kgs, and the cause or extent of condition of the issue was not known or understood.

**4. Evaluate the adequacy of licensee's event reporting**

On March 1, 2011, GNF-A replaced the HEPA filter and prefilter and cleaned out the sinter test grinder ventilation housing and associated ductwork. The $UO_2$ weight in the filters measured 3.8 kgs and there was 15.3 kgs $UO_2$ identified in the transition area. The licensee concluded that the 15.3 kgs must have had been present at the time of the February 1 and 5 filter replacements because of the relatively low amount of pellets processed through that grinder in a one month period. As a result, the licensee determined that the total cumulative amount of $UO_2$ was approximately 46 kgs:

- 4 kgs from February 1 in the prefilter
- 26.9 kgs from February 5 in the HEPA filter
- 15.3 kgs from March 1 in the transition area

The licensee determined that the 46 kgs $UO_2$ was greater than the 31 kgs $UO_2$ safe mass limit for a homogeneous $UO_2$ sphere, as documented in CSA – Safe Mass Limits for Uranium Systems, Revision 1. As a result, on March 2, 2011, GNF-A reported EN # 46650, a 24-hour notification to the NRC per GNF-A procedure 40-32. The reportability criterion was "2a. When multiple parameters were initially controlled, loss of one or more criticality safety controls such that only one parameter remains under control." Previously, on February 5, 2011, the licensee had determined that the mass accumulation event was not reportable because the 30.9 kgs total $UO_2$ weight, identified at that time, was less than the safe mass limit of 31 kgs, stated in CSA – Safe Mass Limits for Uranium Systems, Revision 1.

The licensee did not utilize the 25 kgs mass limit as stated in CSA - No. 2310.00, Primary HEPA Filter Systems, Revision 2 for HEPA filter mass control limits. CSA - No. 2310.00 stated that in order to achieve mass control, the $UO_2$ holdup is limited to less than 25 kgs by controlling $\Delta p$ across the housing to 4-inches of $H_2O$ or less. This mass control was also documented in the 2009 configuration change request for the sinter test grinder modification, CR 3262 and What-If document for Node #146. Through interviews performed and documentation review, the team could not identify any documentation or guidance references that allowed the licensee to utilize the safe mass limit of 31 kgs instead of the cited 25 kgs mass limit from the HEPA filter CSA. In addition, two previous NCS managers interviewed, who were part of the original design review team, stated that the mass control limit was 25 kgs.

Step 2a. of Appendix B, "Supplemental Reporting Criteria: Commitment 1 of GNF-A ISA Action Plan Letter (1/11/2010)," of procedure 40-32, "Safety Event Communication & Notification," Revision 14, stated, in part that when multiple parameters were initially controlled, loss of one or more criticality safety controls such that only one parameter remains under control, a notification to NRC using telecon and/or event worksheet within 24 hours was required. The failure to notify the NRC within 24 hours for the loss of mass control on February 5, 2011, when the sinter test grinder HEPA filter exceeded the mass control limit of 25 kgs was considered a violation of NRC requirements. The $UO_2$ weight of the sinter test grinder HEPA filter during the February 5 HEPA replacement was 26.9 kgs $UO_2$. (VIO 70-1113/2011-06-07)

**Conclusions**

The team determined that the licensee failed to notify the NRC within 24 hours when the safe mass control limit of 25 kgs $UO_2$ was exceeded on February 5, 2011, for the sinter test grinder HEPA filter. The $UO_2$ weight of the sinter test grinder HEPA filter during the February 5 HEPA replacement was 26.9 kgs $UO_2$. (VIO 70-1113/2011-006-07)

5. **Evaluate the adequacy of the licensee's causal analysis and extent of condition review**

On March 17, 2011, the licensee completed a RCA (ATS Event # 286) for the 46 kgs of $UO_2$ powder accumulation in the sinter test grinder filter housing unit that was identified on March 1, 2011. The licensee implemented TapRoot® methodology to evaluate the event. The root cause was facilitated by a qualified and experienced TapRoot® licensee employee who was also independent from the work group and associated processes.

Based on the independent NRC review, interviews with licensee personnel, and comparison with TapRoot® guidance documents, the team determined that GNF-A performed an unusual event investigation for the loss of mass control event, as required by Section 11.7 "Incident Investigations" of the license application and GNF-A procedure 40-12, "Incident Classification and Investigation." The investigation identified root or most probable root cause(s) and required corrective actions. The licensee identified a total of six causal factors and twelve root causes, which included, in part:

The first causal factor stated that the $\Delta p$ monitoring was not effective due to small particle size and process characteristics. There were four root causes associated with this causal factor, which were (1) appropriate independent review was not included in the design review; (2) design specifications used for the application of the differential pressure monitoring relied on $UO_2$ data from production grinders; (3) no preventative maintenance existed; and (4) equipment difficulty, such that the March 1, 2011 mass accumulation was similar to a 1999 event when a HEPA filter in the Dry Scrap Recycle process exceeded a safe mass limit of 25 kgs. The material in that event was $U_3O_8$.

The second causal factor was the swarf collection system design was inadequate. The two root causes for this factor were design specifications needed improvement because the swarf particles entrained in the airflow did not fall out into the collection canister as designed. Second, the independent review needed improvement because there was an inadequate review performed of the particle behavior in the ventilation and collection system.

The third causal factor was that the RP survey notifications were not made or acted upon by the required parties. The root causes for this factor were: (1) procedure NSI O-15.0, "HVAC Systems Audits & Inspections" was not followed; (2) the required communications made did not draw attention to the failed survey results; and (3) RP technicians' adherence to NSI O-15.0 needed enforcement.

The fourth GNF-A causal factor was that a RP follow-up survey was not performed or required after the filter replacement. The root cause was the RP procedure did not address this survey follow-up requirement when a filter was changed due to high $\Delta p$.

The fifth causal factor was the HVAC technician looked through the prefilter door to inspect for accumulation verses the HEPA filter door. The report stated that filter housing, low light, and working conditions affected the technician's ability to perform a proper inspection. The root cause in this case was the procedure details needed improvement.

The last causal factor was HVAC procedure, OP 2301.00 "FMO HVAC Maintenance Operation," stated that after a filter replacement, a clean out of the ductwork was performed only if necessary. The root cause was the procedure details needed improvement.

Based on the causal factors and root causes identified in the licensee investigation ATS # 286, the team determined that the licensee met the license requirement for conducting an event investigation. However, the licensee did not address any latent organizational weaknesses and underlying causes of this event.

The licensee adequately identified causal factors of the event, but narrowly identified root causes. The twelve root causes focused on this specific event instead of comprehensively understanding why the problem or causal factors existed that allowed this event to occur. For example, the root causes identified, in part, were a design specification needed improvement, an inadequate independent review was performed, and a preventative maintenance activity did not exist. From the identified causal factors, the licensee had the opportunity to develop inclusive root causes that identified programmatic and organizational weaknesses in the implementation of their existing configuration change process, which had adequate guidance available at the time of the 2009 sinter test grinder modification. Instead, the licensee identified single failures or weaknesses to correct as they applied to this event.

In addition, the licensee did not evaluate the generic implications, including extent of condition and extent of cause, of the event. The event investigation did document corrective actions and the licensee performed a timely extent of condition review for mass accumulation in HEPA filters, prefilters, and associated ductwork. The extent of condition review did not identify any other instance where the mass limits were exceeded for filters and associated ductwork that used mass control as a criticality safety control.

However, the extent of condition did identify two grinders, #5 and the scrap hood, that were close to the 25 kgs total mass (23.47 kgs and 23.68 kgs respectively). For grinder #5, the HVAC Δp readings had been at or near the 4-inch $H_2O$ Δp limit from August 2009 to early March 2011. The bi-monthly HVAC readings ranged from 3-inches to 4-inches Δp, with the majority of the readings at 3.8-inches and higher. During that time period, only the prefilter was replaced, and starting in January 2011, it was replaced every two weeks. The HEPA filter was not replaced until March 4, 2011 as part of the extent of condition review. Although grinder #5 utilized a different ventilation design, it still had the same 4-inches $H_2O$ Δp limit and RP survey requirements as the sinter test grinder ventilation system. The operational acceptance of running at or near safety limits for grinder #5 and less than adequate system monitoring were also common to the sinter test grinder operations, starting in August 2010. However, the licensee did not document an extent of condition evaluation, which considered why the problem or causal factors existed such that they also allowed similar conditions to exist in other areas and how those findings applied to the overall root cause of this event.

The licensee also did not evaluate extent of cause for the event. TapRoot® guidance refers to extent of cause as a subset to determining the generic root causes or the systematic cause that allows a root cause to exist, and directs the user to perform this analysis as part of the investigation. For ATS #286, extent of cause was not evaluated and as a result, the root cause analysis did not assess if any other equipment, change requests, or processes potentially were impacted by the same root causes identified from this event.

Evaluating for generic causes was specifically relevant to this event because of a similar event that occurred in 1999. On June 2, 1999, GNF-A made a 24-hour event notification (EN 35788) to the NRC due to a primary HEPA filter that exceeded the mass control limits of 25 kgs. The licensee had identified a total of 50.5 kgs $U_3O_8$ material in the Dry Scrap Recycle (DSR) filter housing enclosure, which included 30 kgs found in the HEPA filter itself. The event investigation performed in 1999, was documented in GNF-A's Unusual Incident Report (UIR) system, as UIR No. ChPL-9914. The investigation stated the mass control for the HEPA filter was based upon historical data that the HEPA filter would not accumulate greater than 25 kgs of $UO_2$ with a Δp less than or equal to 4-inches $H_2O$. The Δp at the time of the 1999 event was 3-inches $H_2O$.

The investigation stated that the filter housing was a standard design made by Flanders and utilized an 11-inch HEPA filter, which was not designed to be geometrically safe. The system utilized a powder collection bottle, located in the piping, and was emptied out approximately twice a month. The criticality controls for the DSR process were based upon moderation control and mass control, specifically, that the mass would be administratively controlled by monitoring Δp across the prefilter and HEPA filter and by changing the filters when the Δp across the filters was equal to or exceeded 4-inches of $H_2O$. All of these configuration characteristics were the same for the DSR and the sinter test grinder processes. In addition, moderation control for the DSR process and the sinter test grinder included both being located in a MCA. The primary differences between the DSR process and the sinter test grinder process was that the DSR system processed $U_3O_8$ versus $UO_2$ and the DSR design included "knockers" that were used to detach material from the inner walls of the tube. The system configuration in the 1999 event was the same or similar to the configuration in the 2011 event investigation and for the purpose of this root cause and generic cause analysis, the 1999 event was relative to the analysis of the 2011 licensee event investigation.

The licensee's 1999 investigation identified three causal factors: (1) the ISA did not address overweight HEPA filters or accumulations in the housing; (2) mass control was based upon historical data of Δp versus uranium accumulation; and (3) the DSR HEPA housing was not included on the RP gamma scan survey. For the three factors, the investigation cited that lack of understanding of the characteristic of $U_3O_8$ in the ventilation system prevented the licensee from recognizing the potential problem.

The corrective actions for the 1999 event were to change the HEPA filter housing with safe geometry controls, perform an extent of condition for $U_3O_8$ processes including replace filters and weigh $U_3O_8$ mass as necessary, and increase monitoring of the $U_3O_8$ HEPA filter housing. Additional long-term actions included a review of previous HEPA filter changes with respect to Δp, net weight, and material type; development of criteria for using Δp as a control for HEPA filters; and development of a procedure to address the handling of overweight filters. The corrective actions in the 1999 event investigation were the same or similar to the corrective actions listed in the 2011 event investigation, both in the actions required and the focus on addressing a single fault rather than addressing a global process failure.

In February 2000, the NRC issued Information Notice (IN) 2000-03, alerting licensees to a potentially significant nuclear criticality risk for HEPA filters, which could, in some cases, accumulate special nuclear material beyond a safe mass. The notice described the GNF-A 1999 event and emphasized the need for licensee to understand the basis for established safety limits when reviewing new installations or configuration changes, specifically those new or changed configurations may undermine the basis for proposed limits, which were valid in other applications. The expectation was for all NRC licensed fuel-cycle conversion, enrichment, and fabrication facilities to evaluate the information in the notice for applicability.

The 1999 event investigation was narrowly focused on the characteristics of $U_3O_8$ particles instead of identifying why the technical reviews and approval processes at the time allowed less than adequate technical rigor to permeate through the configuration change process. The investigation also did not delve into the configuration change process or the review of safety limit impacts during new installations or process changes, as stated in the IN. If the licensee would have performed a more thorough investigation in 1999 to identify and correct the generic causes, specifically the latent organizational weaknesses and process failure(s) that allowed an established control specification (4-inches $\Delta p$ $H_2O$ = 25 kgs) to be inaccurately applied to a new installation or configuration change and less than adequate system monitoring with respect to RP survey readings, the 2011 mass accumulation event in the sinter test grinder may have been prevented. Instead, the licensee narrowly focused on that specific event as it applied to the material type.

**<u>Conclusions</u>**

The licensee event investigation for the March 1, 2011 sinter test grinder HEPA filter housing mass accumulation was written to address the specific errors of this event. The licensee's root cause analysis did not identify or address any latent organizational weaknesses or generic causes that led to the March 1, 2011 event. Although the licensee did identify appropriate causal factors, they failed to identify and subsequently create actions to correct key aspects of the event that allowed inaccurate control specifications to permeate through the licensee's change process, and less than adequate system monitoring that tolerated readings above action limits when required procedularized corrective actions existed and were not taken. Similar generic root causes with respect to incorrect control specifications and less than adequate system monitoring were repeat to the 1999 $U_3O_8$ mass accumulation event.

## 6. <u>Evaluate the adequacy of the licensee's immediate and long term corrective actions; and actions to prevent recurrence</u>

The team reviewed the immediate and long-term corrective actions, including the documentation for those items listed as complete.

The team determined that the immediate corrective actions taken by the licensee were sufficient to restore safety and compliance with license requirements. The immediate actions taken included replacement of the HEPA and prefilter, clean out of the filter housing enclosure, addition of the HEPA filter replacement to a preventative maintenance frequency, HEPA filter configuration change to a safe geometry HEPA with no prefilter, extent of condition performed for other HEPA filters, and completed a stand-down to discuss procedure compliance.

The inspector determined that the actions created from the investigation were sufficient to prevent reoccurrence of this specific event however, as stated in the previous section, the actions were narrowly focused at addressing only this specific event. Because the investigation was not comprehensive and did not evaluate generic causes, the corrective actions as written would not prevent reoccurrence of similar root causes.

For example, the corrective actions did not address the reason why the change process failed to identify equipment problems (ineffective swarf collection beaker) and invalid safety assumptions related to mass control (4-inches $H_2O$ $\Delta p$ = 25 kgs). Furthermore, the licensee decided to institute geometry control through the change in filter type instead of understanding why mass control failed.

In the root cause analysis report, the licensee identified a total of 24 corrective actions that were binned to the associated causal factor and root cause. There were also three actions that were categorized as Additional Actions. A review of these items indicated that not all of the corrective actions directly correlated to a root cause nor if the action was taken as written, some of the actions would not directly correct or prevent the root cause from reoccurring. For example, one of the root causes was that no preventative maintenance existed. The corrective action to address this root cause was to replace the sinter test grinder HEPA filter with a favorable geometry design. Although the corrective action was appropriate and would address the loss of mass control event, it did not align with the preventative maintenance root cause or the associated causal factor of $\Delta p$ monitoring was ineffective due to small particle size. In this case, the causal factor was appropriate; however, the licensee missed the opportunity to understand why the $\Delta p$ monitoring failure occurred, why preventative maintenance activities were not considered as part of the change request process, or how the associated generic cause(s) could be corrected. As a result, the corrective action listed did not directly correlate to a root cause or to the causal factor.

An example of a corrective action that, if performed as written, would not directly correct or prevent the root cause from reoccurring was for a second root cause listed under the causal factor $\Delta p$ monitoring was ineffective due to small particle size. The root cause was design review and specifically, that the initial design failed to include independent reviewers to identify potential issues with relying on differential pressure to monitor filter hold up. The associated corrective action was to integrate into the configuration management procedure, the requirement that a Failure Mode and Effects Analysis (FMEA) or similar technical review be completed for significant facility changes.

The CR process utilized procedure 10-10, “Configuration Management Program -Fuel Manufacturing”, Revision 13, as the guidance document and was in place during CRs 3262 and 4127. This procedure stated change requests have the following reviews; the originator, ISA reviewer, Area Engineer, Area Manager, Nuclear Safety Manager, Environmental, Health, and Safety (EHS), the Configuration Management Program Leader, the Facilities Document Center, Quality Engineer, Design Engineer, and Quality Control Engineer. In addition, for changes that affect Fuel Manufacturing Operation

(FMO), which applied to CRs 3262 and 4127, additional reviews may be required, which included airflow verification, operating procedure updates, structural review, and Wilmington Safety Review Council (WSRC). In addition, Procedure 10-20-A, "Integrated Safety Analysis," discussed the use of FMEA as one of the hazards and risk evaluation method to be used during the ISA review. For CRs 3262 and 4127, the licensee utilized the What-If methodology which was a similar type of hazard analysis and was documented in the associated PHA, listed as numbers 146 and 119 respectively. The reviews performed in 2008 and 2009 for these two CRs included the Area Manager, Nuclear Safety Engineer and Manager, ISA Reviewer, EHS, Radiation Protection, Licensing, and air flow verification.

These multiple reviewers had the opportunity, through existing procedures and PHAs, to identify potential issues with differential pressure used for monitoring filter hold up, including the validation of assumptions relate to the historical Δp data trends. As a result, the corrective action to integrate the requirement that a FMEA or similar technical review into the configuration management procedure, would not directly correct or prevent the root cause from reoccurring because this type of review already existed in the change request process at the time of the sinter test grinder modification.

**Conclusions**

The team determined that the immediate corrective actions taken by the licensee were sufficient to restore safety and compliance with license requirements. However, the actions were narrowly focused at addressing this specific event. Because the investigation was not comprehensive and did not evaluate generic causes, the corrective actions as written would not prevent reoccurrence of similar root causes. In addition, not all of the corrective actions directly correlate to a root cause nor if the action was taken as written, some of the actions would not directly correct or prevent the root cause from reoccurring.

7. **Evaluate the adequacy of the licensee's integrated safety analysis to ensure that performance requirements are met for this and related accident scenarios**

This event was an example of one of the accident sequences that was improperly analyzed as a low consequence and therefore no items relied on for safety (IROFS) were designated. Since there were no IROFS for this accident sequence, the licensee was not meeting the performance requirements. The team looked at the controls that the licensee had in place on the HEPA filter attached to the sinter test grinder and determined that the loss in mass control resulted in the likelihood of a criticality accident to be unlikely as described previously in Section 2. Therefore, the likelihood of the high consequence event was no longer highly unlikely and did not meet the performance requirements as stated in 10 CFR 70.61 and was identified as URI 70-1113/2011-006-02. This item will require additional NRC review and evaluation in a subsequent inspection.

However, as a result of violations that arose from inspection 70-1113/2010-003, the NRC accepted the licensee's corrective action to update the ISA. The difference between this specific accident sequence and the other previously identified in inspection report 70-1113/2010-003, was that, in this case, one of the controls to prevent criticality failed.

All related criticality accident sequences that were previously classified as low consequence had been analyzed to determine if they were meeting double contingency. Double contingency does not necessarily equate to highly unlikely accident sequences. While it did in this example, the team had no reason to believe that the other accident sequences were not being kept at highly unlikely.

**Conclusions**

The team determined that the licensee's ISA was not adequate for this accident sequence and an URI was identified for failure to meet the performance requirements, 10 CFR 70.61. (URI 70-1113/2011-006-05)

## 8. Independent Root Cause Analysis

The team performed an independent root cause analysis (RCA) for the 46 kgs of $UO_2$ powder accumulation in the sinter test grinder filter housing unit, as reported to the NRC on March 2, 2011 (EN #46650). The team utilized the Management Oversight and Risk Tree (MORT) methodology to evaluate the event and identified two root causes and two contributing causes. A root cause is defined as a cause that if corrected, would prevent the recurrence of this event and similar possible events through generic implications. A contributing cause is a cause that contributed to an event but, by itself, would not have caused the event.

Root Cause 1:

The licensee applied less than adequate technical rigor and implementation of the existing configuration change process.

The licensee did not apply the adequate level of technical rigor and questioning attitude during the configuration change process. As a result, the sinter test grinder CRs did not include key discipline reviews, safety control evaluations and validations, and appropriate pre-operational testing. Specifically, there was no pre-operational swarf collection beaker testing or acceptance criteria; the technical basis for the 4-inch $H_2O$ $\Delta p$ equals 25 kgs $UO_2$ mass was not validated and subsequently identified during the 2011 event to be incorrect for this process; and the configuration change did not include safe geometry filters, Apitrons, and "knockers" as used on pre-existing grinder configurations. Other deficiencies identified were: (1) flow dynamics were not considered as part of the ventilation modification, primarily because the HVAC discipline review and input was not involved in the initial design phase; (2) the project manager for the configuration change did not enforce the adherence to procedure, "Configuration Management Program – Fuel Manufacturing," 10-10; and (3) the 1999 $U_3O_8$ mass accumulation event was not appropriately considered for generic implications and lessons learned and applied to the sinter test grinder CRs. The configuration change documentation was less than adequate such that a CSS was performed instead of a CSA, and the system drawings were not signed by an engineer or part of the electronic configuration change package when the CRs were approved. In addition, the CRs were handled separately so each modification narrowly focused on the grinder or the ventilation and did not consider the system interaction with each other or other balance of plant implications. The configuration changes were fast track modifications that were treated as a field change for ductwork on existing components and were not considered a new process that needed formal engineering direction.

Root Cause 2:

The licensee did not adhere to and enforce the requirements for safe mass limit controls as it applied to surveys, monitoring, and taking required action when established limits were exceeded. These failures were potentially indicative of an organization that did not value the importance or significance of these activities.

Specifically, procedure NSI O-15.0 “HVAC Systems Audits & Inspections” was cited in CSA No. 2310.00 – Primary HEPA Filter Systems, Revision 2, and stated, “Horizontal spans of ductwork are monitored per NSI O-15.0 for accumulations of uranium, typically by NDA (non-destructive analysis) measurement such as the Scout gamma monitor. In addition to vent line surveys HEPA transitions are also surveyed for buildup of uranium along the transition walls.“

The procedure for vent line and transition surveys, locations where monitoring must be performed, and action limits for clean outs were provided in NSI O-15. Per the procedure, if survey readings reached 0.5 mR/hr or greater above background, specific actions were required to be taken to address potential material buildup. However, on multiple occasions, RP did not consistently perform the monthly surveys or make required notifications when action limits were exceeded. In addition, when notifications were made, follow-up actions to clean out the associated ductwork were not consistently performed.

The RP supervision did not enforce procedure adherence and the action limit requirements for NSI O-15.0, such that RP supervision was involved and had signed 14 of the 15 RP survey sheets reviewed for the event investigation. In addition, the Criticality Safety group had a responsibility to ensure the criticality safety controls that were put in place were adhered to and unexpected results were addressed. Interviews performed during the event investigation identified that the Criticality Safety group was both unaware that some RP surveys were not performed per the established frequency or that there were instances when RP action limits were exceeded and required actions were not taken. The licensee failed to emphasize and enforce the importance of adhering to the requirements when action limits were exceeded and notifications went out to the applicable departments. Overall, the licensee did not adhere to and enforce the requirements for safe mass limit controls as it applied to surveys, monitoring, and taking required action when established limits were exceeded.

Contributing Cause 1:

The licensee applied less than adequate technical rigor that resulted in non-conservative operational decision making.

Throughout the sequence of events, from the 1999 $U_3O_8$ mass accumulation event, to the sinter test grinder CRs initiated beginning in late 2008, to the event response of the 46.2 kg total $UO_2$ mass accumulation in 2011, the licensee did not apply an adequate level of technical rigor, which was primarily due to a perceived mindset that the sinter test grinder and associated ventilation was not a new or different process or design (i.e. similarity biases).

Examples included performing a narrowly focused event investigation that did not consider generic root causes for the 1999 $U_3O_8$ mass accumulation event. The lack of understanding of the true root cause in this event and failure to consider this lesson learned as part of the sinter test grinder modification, contributed to the same control specification failing to perform the intended criticality mass limit control in 2011. In addition there were multiple examples of less than adequate technical rigor applied to the configuration change process. Other examples included less than adequate questioning attitude when RP and HVAC surveillance readings, trends, and actual mass weights were above established limits and no actions were taken to understand the cause.

On February 5, 2011, management accepted a 30.9 kg mass accumulation, only 0.1 kg mass before reaching the limit, as being below reportability limits without applying more rigorous and available methods of validating that no additional mass accumulation existed (i.e. trust but verify). The 0.1 kg equates to a 0.3% available margin, and does not consider allowable scale tolerances. The licensee was also willing to resume sinter test grinder operation the next day without considering extent of condition, performing a RP re-survey to verify no additional material remained, and without taking any additional immediate actions other than filter replacement.

These three different time intervals, the 1999 event, the change control process executed in late 2008 and early 2009, and the sinter test grinder mass accumulation event in 2011, all involved less than adequate technical rigor and directly resulted in non-conservative operational decision making by the licensee.

Contributing Cause 2:

The licensee did not provide adequate levels of oversight, enforcement, and accountability to the organization directly involved with configuration change, operations, maintenance, and monitoring of the sinter test grinder and ventilation.

The licensee did not enforce procedure compliance, tolerated operations at or above safety limits, and did not promote the importance of problem identification and resolution, specifically when trends, established action limits, and procedure actions were available.

The licensee had multiple opportunities, through the available processes and procedures, to have self-identified and corrected these trends before an event occurred. The licensee tolerated organizational behaviors that inevitably waited for the event to occur. Management oversight failed to prevent missed surveillances, did not drive corrective actions to be taken when action limits were exceeded, and did not display accountability for monitoring criticality safety controls through surveillance surveys.

**Conclusions**

The team performed an independent root cause analysis for the 46 kgs of $UO_2$ powder accumulation in the sinter test grinder filter housing unit, as reported to the NRC on March 2, 2011. The team identified two root causes and two contributing causes for the event. The root and contributing causes involved less than adequate technical rigor and implementation of the existing configuration change process; and the lack of enforcement related to the requirements for safe mass limit controls as it applies to surveys, monitoring, and taking required action when established limits were exceeded.

**Exit Meetings**

The inspection scope and results were summarized with licensee management in meetings on April 27, 2011 and June 3, 2011.  Although proprietary information and processes were reviewed during this inspection, proprietary information was not included in this report.

# ATTACHMENT

## 1. PARTIAL LIST OF PERSONS CONTACTED

### Licensee

N. Holmes, Chief Operating Officer, Facility Manager
K. Walsh, GNF-A CEO
E. Anderson, GNF-A Industrial Safety
M. Short, PP&SS Manager
F. Beaty, DCP Area Manager
M. Campbell, Manager, Industrial Safety
C. Davidson, Environmental Specialist
J. DeGolyer, Criticality Safety Program Manager
J. Hawkins, MC&A Program Manager
A. Hilton, FAB, Manager
B. Howell, DCP Conversion Engineer
M. Huntly, Nuclear Measurements
B. Keenan, Radiation Protection
A. Kennedy, Program Manager, ISA
D. Livengood, Gad Ceramics Process Engineer
R. Martyn, Manager, Material Control & Accounting
A. Mulligan, Manager, GNF-A Quality
S. Murray, Manager, Licensing & Liabilities
D. Nay, Maintenance
P. Ollis, Licensing Engineering, Licensing & Liabilities
L. Paulson, GEH Manager, Nuclear Safety Programs
T. Priest, Radiation Protection, Fuels Growth Projects
J. Reeves, Manager, Integrated Safety Analysis
J. Reynolds, Manager, Fuels EHS
J. Rohner, Criticality Safety Engineer
C. Savage, FMO Maintenance
M. Shipman, MC&A Specialist
M. Venters, Manager, Emergency Preparedness and Site Security
A. Vexler, FMO Operations Leader

Other licensee employees contacted included engineers, operators, supervisors, technicians, and maintenance craft personnel.

## 2. LIST OF ITEMS OPENED, CLOSED, AND DISCUSSED

| Item Number | Status | Description |
|---|---|---|
| URI 70-1113/2011-006-01 | Open | Failure to maintain double contingency. (Section 2) |

| | | |
|---|---|---|
| URI 70-1113/2011-006-02 | Open | Failure to meet the performance. requirements of 10 CFR 70.61 (Section 7) |
| URI 70-1113/2011-006-03 | Open | Failure to validate assumptions related to mass control .(Section 3) |
| URI 70-1113/2011-006-04 | Open | Failure to conduct a CSA as required by the license application. (Section 2) |
| URI 70-1113/2011-006-05 | Open | Failure to follow procedure for exceeding radiation protection action limits. (Section 3) |
| VIO 70-1113/2011-006-06 | Open | Failure to follow procedure for vacuuming out the transition piece as required. (Section 3) |
| VIO 70-1113/2011-006-07 | Open | Failure to report to the NRC, when the one leg of double contingency was lost. (Section 4) |

## 3. INSPECTION PROCEDURES (IPs) USED

IP 88003 Reactive Inspection for Events at Fuel Cycle Facilities
IP 93812 Special Inspection
IP 88020 Operational Safety

## 4. DOCUMENTS REVIEWED

Criticality Safety Analysis, "Safe Mass Limits for Uranium Systems," Revision 1, September 2007

Criticality Safety Analysis, "Primary HEPA Filter Systems," Revision 2, CR 05.0122, August 21, 2006

Criticality Safety Analysis, "Line 5 Grinder," CSA No. 1040.11, Revision 1, CR 05.0311, September 1, 2005

Criticality Safety Summary, "Sinter Test Grinder," CR 3262, February 18, 2009

Nuclear Safety Release/Requirements # 03.03.21, CR 3262, Revision 0

"Sinter Test Grinder HEPA Powder Accumulation," TapRoot® Investigation Report and completed corrective actions, March 17, 2011, ATS #286

Unusual Incident Report No. ChPL-9914, "Mass Control within a absolute (HEPA) filter was exceeded. Maintenance found 47 kgs of $U_3O_8$ in a filter when exceeded limit of 25 kgs," June 2, 1999

NRC IN 2000-03, "High Efficiency Particulate Air Filter Exceeds Mass Limit Before Reaching Expected Differential Pressure," February 22, 2000

Audit Tracking System # 2388, Initial Discovery of Sinter Test Grinder ‘Heavy’ Hepa Issue, February 11, 2011

GNF-A ISA Reference Report, No. 119, “HVAC Primary HEPA for MCA Dry $UO_2$ Applications,” Revision 13.16, December 13, 2010

GNF-A ISA Reference Report, No. 146, “Sinter Test Pellet Grinding Station,” Revision 13.16, December 13, 2010

NSI E-2.0, “Internal Nuclear Safety Audits,” Revision 47

NSI E-3.0, “NUCLEAR SAFETY REVIEWS,” Revision 36

NSI O-15.0, “HVAC Systems Audits & Inspections” Revision 33 and 34

OP# 2301.00, “FMO HVAC Maintenance Operation,” Revision 9

OP# 1020.21, “Sinter Test Process,” Revision 19

Section Administrative Routine (SAR) 350-09, “Hepa Filter Change and Certification,” Revision 6

CP-16-01, “Corrective Action Process,” Revision 10

P/P 10-20-A, “Integrated Safety Analysis,” Revision 4

P/P 40-32, “Safety Event Communication & Notification,” Revision 14

TOP 7371, “Processing of Sinter Tests with a NY Material Type,” Revision 0

“GEH, GNF, AND GLE GLOSSARY AND ACRONYM LIST FOR USE IN POLICIES, PLANS, PROCEDURES, AND WORK INSTRUCTIONS,” Revision 3

“Configuration Management Program – Fuel Manufacturing,” No. 10-10, Revision 13

QRA 126.2, “$UO_2$ Scrap Press Station,” Revision 2, January 29, 2010

QRA 47.2, “Gad Rotary Press Station,” Revision 3, December 13, 2010

QRA 92.3, “Loss of Mass Control/Loss of Geometry in SPF Scrap Hood,” Revision 1, December 29, 2009

Emergency Work Order # 356668, “Clean out pan under HEPA. Break horizontal line behind grinder base for clean out,” February 18, 2011

CR 7572, Replace Existing Sinter Test Grinder HEPA Housing With 6” Type, March 1, 2011

CR 4295, Sinter Test Grinder, March 24, 2009

CR 4127, Sinter Test Press HEPA and Ductwork Change, January 21, 2009

CR 3262, Sinter Test Grinder, July 16, 2008

CR 4215, Sinter Test Grinder Start Up, February 11, 2009

Flanders Filter Manufacturer's Guide, "Nuclear Grade Hepa Filters," PB-2016-0305

## 5. LIST OF ACRONYMS USED

| | |
|---|---|
| ATS | Audit Tracking System |
| CFR | Code of Federal Regulations |
| CR | Change Request |
| CSA | Criticality Safety Analysis |
| CSS | Criticality Safety Summary |
| DSR | Dry Scrap Recycle |
| EN | Event Notification |
| FMEA | Failure Mode and Effects Analysis |
| FMO | Fuel Manufacturing Operation |
| GNF-A | Global Nuclear Fuel – Americas |
| $H_2O$ | Water |
| HEPA | High Efficiency Particulate Air |
| HVAC | Heating, Ventilating and Conditioning |
| IN | Information Notice |
| IP | Inspection Procedure |
| IROFS | Items Relied On For Safety |
| ISA | Integrated Safety Analysis |
| MCA | Moderator Controlled Area |
| MORT | Management Oversight and Risk Tree |
| mr/hr | milliRoentgen /hour |
| MRA | Moderator Restricted Area |
| NCS | Nuclear Criticality Safety |
| NRC | Nuclear Regulatory Commission |
| NSR/R | Nuclear Safety Release/Requirements |
| PHA | Process Hazard Analysis |
| PM | Preventative Maintenance |
| PPM | Parts Per Million |
| QRA | Qualitative Risk Assessment |
| RCA | Root Cause Analysis |
| RP | Radiation Protection |
| SIT | Special Inspection Team |
| SNM | Special Nuclear Material |
| UIR | Unusual Incident Report |
| URI | Unresolved Item |
| $U_3O_8$ | uranium trioxide |
| $UO_2$ | uranium dioxide |
| VIO | Violation |
| WSRC | Wilmington Safety Review Council |
| $\Delta p$ | Differential Pressure |