

[REDACTED]

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

Docket No: 70-143

Licensee No: SNM-124

Report No: 70-143/2004-207

Licensee: Nuclear Fuel Services, Inc.

Location: Erwin, TN

Inspection Dates: December 13 - 17, 2004

Inspectors: Larry Berg, Criticality Safety Inspector

Approved by: Melanie A. Galloway, Chief
Technical Support Group
Division of Fuel Cycle Safety
and Safeguards, NMSS

[REDACTED]

[REDACTED]

Enclosure

EXECUTIVE SUMMARY**Nuclear Fuel Services, Inc.
NRC Inspection Report No. 70-143/2004-207****Introduction**

Staff of the U.S. Nuclear Regulatory Commission (NRC) performed a routine and announced nuclear criticality safety (NCS) inspection of the Nuclear Fuel Services, Inc. (NFS), Erwin, Tennessee, facility from December 13 through 17, 2004. The inspection included an on-site review of the licensee programs dealing with plant operations, the NCS function, and NCS-related corrective actions. The licensee programs were acceptably directed toward the protection of public health and safety and in compliance with NRC regulatory requirements. The inspection focused on risk-significant [REDACTED] material processing activities including the Blended Low Enriched Uranium (BLEU) preparation facility, the Oxide Conversion Building, and the Uranyl Nitrate Building. In addition, the inspection included selected risk-significant activities [REDACTED]

Results

- One violation was identified related to implementation of the licensee's nuclear criticality safety program.
 - A non-cited violation was identified concerning storage of [REDACTED] containers on the [REDACTED].
 - In the area of NCS reported events, a violation was identified regarding the failure to ensure that k-effective values for credible abnormal conditions did not exceed the 0.95 limit.
 - One violation was identified related to the October 25, 2004, attempt to transfer liquid waste effluent from the Caustic Discard hold columns without the demonstration that the U²³⁵ concentration was less than [REDACTED]
- [REDACTED]

REPORT DETAILS**1.0 Plant Operations (88015)****a. Scope**

The inspector performed plant walkdowns to review activities in progress and to determine whether risk-significant [REDACTED] material operations were being conducted safely and in accordance with regulatory requirements. The inspector verified the adequacy of management measures for assuring the continued availability, reliability and capability of safety-significant controls relied upon by the licensee for controlling criticality risks to acceptable levels. The inspector performed walkdowns of risk-significant [REDACTED] material processing activities including the Blended Low Enriched Uranium (BLEU) preparation facility, the Oxide Conversion Building, the Uranyl Nitrate Building, and [REDACTED]. The inspectors interviewed operators and NCS engineers both before and during walkdowns.

The inspector reviewed selected aspects of the following documents prior to performing the walkdowns:

- 54T-04-0092, "Nuclear Criticality Safety Evaluation for OCB Natural Uranium and Scrap Uranium Dissolution Systems," Revision 2, dated August 27, 2004
- 54T-04-0044, "Nuclear Criticality Safety Evaluation for the BLEU Complex Uranyl Nitrate Building," Revision 4, dated June 4, 2004
- 54T-04-0125, "Nuclear Criticality Safety Evaluation for BLEU Preparation Facility Downblending," Revision 4, dated November 4, 2004
- NFS-HS-CL-27, "Nuclear Criticality Safety [REDACTED] OCB/EPB," Revision 3, dated December 14, 2004

b. Observations and Findings

The inspector verified that the controls identified in the NCS analyses were installed or implemented and were adequate to assure safety. The cognizant NCS engineers were knowledgeable and had good interfaces with operators on the process floors.

During a tour of the Oxide Conversion Building (OCB) Conversion Area, the inspector identified an open, unfavorable geometry bag [REDACTED] which was not kept flat, closed (by hand), sealed, or had the bottoms cut out leaving two openings in the bag of at least [REDACTED] in length as required by Section 4.10.3 of licensee procedure NFS-HS-CL-27. The inspector observed that the bag had not been closed, modified, or removed from the area upon completion of the activity which required the use of the bag.

Safety Condition No. S-1 of Special Nuclear Material License No. 124 requires that material be used in accordance with the statements, representations, and conditions in the license application dated July 24, 1996, and supplements thereto. Section 2.7 of the license application requires operations and safety function activities to be conducted in accordance with written procedures. Step 4.10.3 of licensee procedure NFS-HS-CL-27 requires bags be opened for the minimum time necessary to perform the task. Otherwise, unfavorable geometry bags shall be kept flat, closed (by hand), sealed, or have the bottoms cut out leaving two openings in the bag of [REDACTED] in length. Contrary to the above, on and before December 14, 2004, the licensee failed to comply with the unfavorable geometry bag handling requirements of NFS-HS-CL-27. Specifically, the licensee did not close, modify, or remove the unfavorable geometry bag from the area upon completion of the activity which required the use of the bag. The licensee's failure to comply with the unfavorable geometry bag handling requirements of NFS-HS-CL-27 is a low risk-significance violation of Section 2.7 of the license application (VIO 70-143/2004-207-01).

c. Conclusions

One violation was identified related to implementation of the licensee's nuclear criticality safety program.

2.0 NCS Function (88015)

a. Scope of Inspection

The inspector reviewed NCS evaluations to determine that criticality safety of risk-significant operations was assured through engineered features and human performance (controls) with adequate safety margin/certainty, preparation and review by capable staff. The inspector reviewed selected aspects of the following documents:

- 54T-04-0129, "Report On the Waste Water Treatment Facility Uranium Concentration Studies," Revision 0, dated December 9, 2004
- 54X-04-0046, "Nuclear Criticality Safety Evaluation [REDACTED]" Revision 1, dated December 13, 2004
- 54T-04-0125, "Nuclear Criticality Safety Evaluation for the BLEU Preparation Facility Downblending," Revision 4, dated November 4, 2004
- 54T-04-0092, "Nuclear Criticality Safety Evaluation for OCB Natural Uranium and Scrap Uranium Dissolution Systems," Revision 2, dated August 27, 2004

b. Observations and Findings

The inspector determined that analyses were performed by capable NCS engineers, that independent reviews were completed for the evaluations by other qualified NCS engineers, and that subcriticality of the systems and operations was assured through appropriate limits on controlled parameters. The inspector determined that NCS controls for equipment and processes assured the safety of the operations.

The inspector observed that the nuclear criticality safety evaluation (NCSE) for the [REDACTED] had been recently revised to account for the storage of [REDACTED] containers. The inspector noted that the previous station limit card for the storage [REDACTED] had authorized a maximum of [REDACTED] shipping cans which have approximately [REDACTED] [REDACTED] containers. The inspector noted that the licensee's investigation into the issue determined that the storage of [REDACTED] containers on [REDACTED] had begun without the prior NCS approval required by Section 4.1.6 of the license application. The inspector reviewed the licensee's revised NCSE, including Monte Carlo calculations, and verified that the storage of the [REDACTED] containers was of low risk-significance since system reactivity with the [REDACTED] containers did not exceed the 0.95 upset limit. This non-repetitive licensee-identified and corrected violation is being treated as an NCV consistent with Section VI.A.8 of the NRC Enforcement Policy. **NCV 70-143/2004-207-02.**

The inspector observed that the NCSE for the Downblending operation had been recently revised to replace an active engineered NCS item relied on for safety (IROFS) with an administrative control. The inspector noted that IROFS [REDACTED], the Rosemount density transmitter on the staging columns, had previously been relied upon to isolate the favorable geometry staging columns from the unfavorable geometry blending tank when the concentration of highly enriched uranyl nitrate was less than [REDACTED]. Given recently observed human performance issues in the BLEU Preparation Facility (e.g., October 25, 2004, reportable event associated with failure to sample uranium [REDACTED] solution prior to transfer from favorable to unfavorable geometry tanks), the inspector questioned the licensee's justification for replacing the engineered Rosemount control with an administrative sampling control when the root cause investigation team for the reportable event recommended replacing another administrative sampling control with an active engineered control. During the inspection, the licensee committed to ensure that the NCSE for Downblending adequately justified the acceptability of replacing an engineered control with an administrative control in a human performance-challenged operating environment. The licensee's actions to adequately justify the acceptability of replacing an engineered control with an administrative control will be tracked as **Inspector Followup Item (IFI) 70-143/2004-207-03.**

The inspector noted that double contingency [REDACTED] of the NCSE for the Oxide Conversion Building Scrap Dissolver was not adequately established. The

inspector observed that [REDACTED] required supervisory permission to unlock a transfer valve in the line between a favorable geometry mop sink and the unfavorable geometry natural uranium dissolver. The inspector observed that double contingency protection was provided by two administrative controls: (1) the prohibition on transfer of containers from the enriched uranium process areas to the natural uranium process area; and (2) the requirement for a supervisor to unlock the transfer valve isolating the mop sink from the natural uranium dissolver. According to the NCSE, the supervisor was expected to unlock the transfer valve when he/she determined that the solution to be transferred contained only natural uranium. The inspector questioned the adequacy of this control since the supervisor would not normally be present when the mop sink was filled, and would have no means for positively verifying solution enrichment (e.g., no requirement to perform dual, independent sampling prior to transfer). The inspector determined that double contingency [REDACTED] had, therefore, not been established. Because the Scrap Dissolver part of the Oxide Conversion Building had not been granted readiness to operate by the NRC, and the mop sink was not authorized for use, the inspector determined that the licensee's failure to establish double contingency for [REDACTED] was a violation of minor safety significance, and not subject to further enforcement action.

During the inspection, the licensee committed to revise the NCSE for the Scrap Dissolver operation to adequately demonstrate double contingency protection. The licensee's actions to revise the NCSE for the Scrap Dissolver operation will be tracked as **IFI 70-143/2004-207-04**.

c. Conclusions

A non-cited violation was identified concerning storage of [REDACTED] containers on the [REDACTED]. The NCS function was otherwise adequate for maintaining acceptable levels of safety.

3.0 NCS Event Review

a. Inspection Scope

The inspectors reviewed the licensee response to a recent NCS reportable event. The inspectors reviewed the progress of investigations and interviewed licensee staff regarding immediate and long-term corrective actions. The inspectors reviewed selected aspects of the following document:

- 54X-04-0001, "Nuclear Criticality Safety Analysis [REDACTED] Facility," Revision 0, dated March 9, 2004

b. Observations and Findings

On December 17, 2004, the licensee transferred materials to a storage area without being transferred thru a particular device as required by the Standard Operating Procedure (SOP). This device was designed to prevent a more reactive/incorrect material type from being transferred to the storage area. In the unlikely event that a more reactive/incorrect material type was added to the process, the particular device prevented this material from being transferred to the storage area. A root cause investigation was initiated as a result of the event. Transfers via [REDACTED] equipment were suspended until compensatory measures could be put in place. A Letter of Authorization (LOA) was put in place which highlighted the use of the transfer device and which required additional labeling of the components in the system. In addition, the NCSE was reviewed to determine whether the device should have been credited as an administrative control or eliminated altogether.

The inspector reviewed [REDACTED] NCSE, and noted that the accident analysis focused on the potential for criticality in the storage area. The inspector observed that controls for preventing the introduction of more reactive materials and the installation of the passive engineered device were selected by the licensee to demonstrate that the likelihood for transfer of the more reactive materials to the storage area was highly unlikely. The inspector noted that the licensee performed calculations on the storage area to further demonstrate safety margin by assuming the more reactive materials had been transferred to the storage area. The inspector questioned, however, the credibility of the accident analysis since a credible mechanism for transferring the more reactive materials could not be postulated. The inspector also questioned whether the licensee's consideration of the more reactive material being in the storage area adequately demonstrated that the 0.95 k-effective limit was not exceeded for credible abnormal conditions.

The inspector reviewed the input file referenced by the NCSE for the [REDACTED] system which included the more reactive material in the storage area and independently verified the k-effective reported in the [REDACTED] NCSE. The inspector modified the input file to relocate the more reactive materials to the head end of the process and observed that the calculated k-effective exceeded 0.95. The inspector determined that placing the more reactive materials in the head end of the process, [REDACTED], produced a more reactive configuration than the base case considered in the NCSE. The inspector discussed this issue with the licensee's NCS engineer and determined that the calculation referenced in [REDACTED] did not support the licensee's position that introduction of a single batch of more reactive material into the head end of [REDACTED] would be less than 0.95. The licensee's NCS engineer performed additional calculations with more realistic modeling assumptions (e.g., offset reflection) and was able to demonstrate the resulting k-effective would be less than 0.95. Although [REDACTED] did not credit the reflection controls credited [REDACTED] in the NCSE, the reflection controls were adequate to keep the system k-effective less than 0.95.

Safety Condition No. S-1 of Special Nuclear Material License No. 124 requires that material be used in accordance with the statements, representations, and conditions in the license application dated July 24, 1996, and supplements thereto. Section 4.2.3 of the license application requires that the k-effective for a failure or a single contingency not exceed 0.95, including bias and uncertainty. [REDACTED] of 54X-04-0001, "Nuclear Criticality Safety Analysis [REDACTED] Facility," Revision 0, dated March 9, 2004, identifies the introduction of more reactive materials in [REDACTED] as a failure or single contingency. Contrary to the above, on March 9, 2004, [REDACTED] NCSE failed to ensure that the introduction of the more reactive materials in [REDACTED] process would not result in a k-effective exceeding 0.95. Specifically, [REDACTED] analysis did not consider optimal placement of the more reactive material. Because reflection controls were maintained, the licensee's failure to ensure that k-effective values for credible abnormal conditions did not exceed the 0.95 limit is a low risk-significance violation of Section 4.2.3 of the license application (**VIO 70-143/2004-207-05**).

c. Conclusions

In the area of NCS reported events, a violation was identified regarding the failure to ensure that k-effective values for credible abnormal conditions did not exceed the 0.95 limit.

4.0 Open Items

IFI 70-143/2004-204-01

This item tracked the licensee's revision of the UNB NCSE and the resulting impact on bounding assumptions. The inspector reviewed the revised NCSE and determined that the licensee's bounding assumptions regarding freezing of the uranyl nitrate solution were adequately justified and documented. The inspector noted that the licensee had not eliminated risk-significant controls associated with accident scenarios, and that bounding assumptions related to chemical characteristics of uranyl nitrate were not relied upon as a basis for criticality safety. This item is closed.

IFI 70-143/2004-206-02

This item tracked the licensee's development of additional guidance to ensure accurate and complete technical reviews. During inspection 70-143/2004-206, the inspector had noted that a key technical reference associated with the revision to the Waste Water Treatment Facility NCSE had not been completed prior to implementation. The inspector reviewed the completed technical reference and verified that the technical basis for the new Waste Water Treatment Facility limits were adequately justified and documented. The additional guidance to ensure accurate and complete technical reviews was not reviewed during this inspection. This item remains open.

Unresolved Item (URI) 70-143/2004-206-04

This item tracked the licensee's investigation of the aborted Caustic Discard transfer and identification of long-term corrective actions to prevent recurrence. The inspector noted that the findings from the licensee's root cause investigation included: (1) few opportunities to operate the caustic discard process; (2) lack of formality in communication (e.g., turnovers) between the facility manager, supervisors and operators; and (3) procedure weaknesses which increased opportunities for confusion. The inspector noted that the licensee's immediate corrective actions in response to the process upset included: (1) isolation [REDACTED]; (2) sampling and laboratory analysis of the solution held up in the discharge line; and (3) non-destructive assay monitoring of the discharge receiving tank and transfer lines for hold up. Followup licensee investigation verified that less than a safe mass of enriched uranium was involved in the transfer. The inspector also noted that the licensee's lessons learned from this event included: (1) engineered controls are preferable to administrative controls that rely on human performance; (2) during startup of new operations, there should be an increased level of field support (e.g., NCS, process engineers); and (3) confusion on approved operational steps should be cause for immediate stand-down until clarification is obtained. The inspector observed that the licensee had entered the lessons learned into its corrective action system for further evaluation and potential implementation.

Safety Condition No. S-1 of Special Nuclear Material License No. 124 requires that material be used in accordance with the statements, representations, and conditions in the license application dated July 24, 1996, and supplements thereto. Section 4.1.1 of the license application requires that all process equipment and systems be designed to incorporate sufficient factors of safety to require at least two unlikely, independent, and concurrent changes in process conditions before a criticality is possible [REDACTED] of NCSE 54T-04-0014, Revision 2, dated April 2, 2004, identifies the requirement to demonstrate by way of dual samples and analyses that the U^{235} is less than [REDACTED] before liquid waste effluent is released from favorable geometry [REDACTED] to unfavorable geometry tanks. Contrary to the above, on October 25, 2004, the licensee released liquid waste effluent from the Caustic Discard [REDACTED] without the demonstration that the U^{235} concentration was less than [REDACTED]. Because less than a safe mass of enriched uranium was involved in the transfer, the licensee's failure to demonstrate that the concentration was less than [REDACTED] is a low risk-significance violation of Section 4.1.1 of the license application (VIO 70-143/2004-207-06).

5.0 Exit Meetings

The inspectors presented the inspection scope and results to members of the licensee's management and staff during an exit meeting on December 17, 2004, and a telephone re-exit was held on January 13, 2005, with the licensee's Vice President, Safety and Regulatory, to communicate an apparent violation associated with the [REDACTED] reportable event. Upon further review, the apparent violation was dispositioned as a Severity Level IV violation (Section 3 of this report). The licensee acknowledged and understood the findings as presented.

SUPPLEMENTAL INFORMATION

1.0 List of Items Opened, Closed, and Discussed

Opened

- VIO 70-143/2004-207-01** The licensee's failure to comply with the unfavorable geometry bag handling requirements of NFS-HS-CL-27
- IFI 70-143/2004-207-02** Failure to get NCS approval prior to storing [REDACTED] containers
- IFI 70-143/2004-207-03** Tracks the licensee's actions to adequately justify the acceptability of replacing an engineered control with an administrative control
- IFI 70-143/2004-207-04** Tracks the licensee's actions to revise the NCSE for the Scrap Dissolver operation
- VIO 70-143/2004-207-05** The licensee's failure to ensure that k-effective values for credible abnormal conditions did not exceed the 0.95 limit
- VIO 70-143/2004-207-06** The licensee's failure to demonstrate that the concentration was less than [REDACTED]

Closed

- URI 70-143/2004-206-04** Tracked the licensee's investigation of the aborted Caustic Discard transfer and identification of long-term corrective actions to prevent recurrence
- IFI 70-143/2004-204-01** Tracked the licensee's revision of the UNB NCSE and the resulting impact on bounding assumptions
- IFI 70-143/2004-207-02** Failure to get NCS approval prior to storing [REDACTED] containers

Discussed

- IFI 70-143/2004-206-02** Tracked the licensee's development of additional guidance to ensure accurate and complete technical reviews

2.0 Inspection Procedures Used

- IP 88015** Headquarters Nuclear Criticality Safety Program
- [REDACTED]

3.0 Partial List of Persons Contacted

Nuclear Fuel Services, Inc.

| | |
|------------------|---------------------------------------|
| *R. Mauer | Engineer, NCS |
| *A. Maxin | Director, Safety |
| **B. Moore | Vice President, Safety and Regulatory |
| **R. Shackelford | Manager, NCS |
| M. Tester | Manager, Radiological Control |
| *A. Vaughan | Director, Fuel Production |
| *J. Kirk | Licensing Specialist |
| *J. Nagy | Licensing and Regulatory Compliance |
| *N. Brown | Engineer, NCS |

NRC

| | |
|-----------|----------------------------------|
| *D. Rich | Senior Resident Inspector, NFS |
| **L. Berg | Criticality Safety Inspector, HQ |

* Denotes attendance at the exit meeting on December 17, 2004.
**Denotes attendance at the re-exit meeting on January 13, 2005.