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

Docket No: 70-143

Licensee No: SNM-124

Report No: 70-143/2004-204

Licensee: Nuclear Fuel Services, Inc.

Location: Erwin, TN

Inspection Dates: July 26 - 30, 2004

Inspectors: Larry Berg, Criticality Safety Inspector  
Dennis Morey, Senior Criticality Safety Inspector

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

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Enclosure

**EXECUTIVE SUMMARY****Nuclear Fuel Services, Inc.  
NRC Inspection Report No. 70-143/2004-204****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 July 26 through 30, 2004. The inspection included an on-site review of the license programs dealing with plant operations, the criticality alarm system, the NCS function, NCS training, NCS Audits, and NCS-related corrective actions. The license programs were acceptably directed toward the protection of public health and safety and in compliance with NRC requirements. The inspection focused on risk-significant [REDACTED] material processing activities including [REDACTED], the Blended Low Enriched Uranium (BLEU) preparation facility, the BLEU uranyl nitrate building (UNB), and the Waste Water Treatment Facility.

**Results**

- Plant operations involving [REDACTED] materials were conducted safely and in accordance with written procedures.
- The NCS function was adequate for maintaining acceptable levels of safety.
- The licensee performed an effective investigation of a reported criticality alarm audibility problem.
- The licensee's placement of criticality accident alarm system detectors provide acceptable coverage of risk-significant operations.



c. Conclusions

Plant operations involving [REDACTED] materials were conducted safely and in accordance with written procedures.

**2.0 NCS Function (88015)**

a. Scope of Inspection

The inspectors 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 inspectors reviewed selected aspects of the following documents:

- Memorandum 53T-03-0009, "[REDACTED]," dated July 15, 2003
- Memorandum CEA-97-012, "[REDACTED]," dated January 16, 1997
- Technical Article, "[REDACTED]" dated July 9, 1968 Nuclear Applications
- Section 3.1, "UN Receipt Process Description," ISA Summary Revision 3
- Section 3.2, "UN Storage Process Description," ISA Summary Revision 3
- 54X-03-0002, "Nuclear Criticality Safety Analysis for [REDACTED] the Production Fuel Facility," Revision 3, dated August 17, 2003
- 54X-04-0001, "Nuclear Criticality Safety Analysis for [REDACTED] the Production Fuel Facility," Revision 0, dated March 9, 2004
- 54X-04-0006, "Nuclear Criticality Safety Evaluation for [REDACTED] the Production Fuel Facility," Revision 0, dated May 13, 2004
- NFS-HS-A-63, "Verification and Validation of Nuclear Criticality Safety Codes," Revision 2, dated June 28, 2004
- 54T-04-0032, "Validation of the SCALE-PC (Version 4.3/27-Group) Computer Code Package for Uranium Systems Enriched in the U-235 Isotope," Revision 0, dated May 2004

b. Observations and Findings

The inspectors determined that analyses were performed by capable NCS engineers, that independent reviews were completed for the evaluations by other qualified NCS engineers, that subcriticality of the systems and operations was assured through appropriate limits on controlled parameters, and that double contingency was assured for each credible accident sequence leading to inadvertent criticality. The inspectors determined that NCS controls for equipment and processes assured the safety of the operations.

The inspectors learned that the licensee plans to eliminate controls on the introduction of [REDACTED] into UNB where uranyl nitrate solution (UNH) is stored [REDACTED]. Based on laboratory scale experiments performed in 1997 and 2004 and a technical article published in 1968, the licensee determined that the UNH tanks remain subcritical even when filled with the most reactive precipitate. Based on this conclusion, the licensee is revising the underlying nuclear criticality safety evaluation (NCSE) and plans to revise the ISA summary and work procedures to eliminate controls after the NCSE is approved. The controls in question concern introduction of materials such as cleaning agents into UNB where they may be introduced to the UNH [REDACTED] and reduce the pH resulting in precipitation of uranium. The licensee determined that precipitation results in a precipitate mixture rather than accumulation of uranium [REDACTED].

The inspectors were concerned that the licensee had not considered how the elimination of controls on precipitating agents would affect assumptions for other aspects of the UNB operation. The licensee showed that the current analysis was performed with no free acid in the UNH models which they consider to be an optimal assumption. The inspectors observed in a technical article that UNH without free acid has the worst characteristics relative to density increase resulting from freezing, specifically that during freezing, the UNH may exceed a critical density. The licensee had not implemented any changes at the time of the inspection. Revision of the UNB NCSE and the resulting impact on bounding assumptions will be tracked as **Inspection Follow-up Item (IFI) 70-143/2004-204-01**.

The inspectors reviewed the licensee's recently revised KENO Va validation report. The inspectors observed that the licensee's validation consisted of 290 benchmark experiments [REDACTED]. The inspectors observed that the licensee did not identify any correlation between the validation data and nuclear parameters (e.g., enrichment,  $H/^{235}U$ , etc.) and that the validation data appeared normally distributed. The inspectors reviewed the licensee's statistical treatment of the validation data which included the determination of 95% lower confidence limits, and the use of one-sided lower tolerance limits for establishing upper safety limits, including allowance for bias and uncertainty in the bias (i.e., 95% confidence that 99.9% of the calculated k-effective values will be subcritical). The inspectors determined that the licensee's statistical approach was consistent with industry practices.

The inspectors noted that the 290 benchmark experiments were divided into seven groups and that 95% lower confidence limits and upper safety limits were determined for both individual and combined groupings. [REDACTED]

[REDACTED]. The inspectors also noted that Section 4.2.3 of the license application specified a [REDACTED] to be used in the determination of the maximum allowed k-effective values. The inspectors observed that [REDACTED]

none of the 95% lower confidence limits dropped below 0.95 when the minimum subcritical margin was subtracted. Since both statistical treatments of the validation data did not result in k-effective values less than 0.95, the inspectors, therefore, determined that the licensee's revised validation report provides reasonable assurance of subcriticality.

c. Conclusions

The NCS function was adequate for maintaining acceptable levels of safety.

**3.0 NCS Inspections, Audits and Investigations (88015)**

a. Scope of Inspection

The inspectors reviewed the licensee response to a July 14, 2004, criticality alarm evacuation event.

b. Observations and Findings

The inspectors noted that a criticality alarm actuation and evacuation occurred at the facility on July 14, 2004, due to a lightning strike. During the evacuation, some participants stated that they had been unable to hear the alarm or that the alarm annunciation was not loud enough. The licensee determined that all employees evacuated as required. Licensee staff performed an audibility check immediately after the evacuation and determined that sound levels had declined in some areas of the plant; these areas were restricted pending investigation. Licensee technical staff traced the problem to a newly-installed amplifier with incorrectly set voltage. The licensee reset the voltage and performed decibel measurements throughout the plant. The inspectors determined that even with the amplifier turned down the alarm annunciation met license commitments.

The licensee identified an area where alarm audibility remains suspect due to the presence of an air conditioner. The licensee implemented interim compensatory measures to require that a door to the area remain open at all times to ensure audibility of the criticality alarm. The licensee is evaluating permanent corrective actions for this suspect area. Licensee staff was not able to establish quantitative sound measurements for the suspect area with both the alarm and air conditioner running simultaneously. The inspectors determined that interim corrective actions were adequate to ensure immediate and complete evacuation of the facility during a criticality alarm evacuation. Implementation of final corrective actions to assure criticality alarm audibility in the suspect area will be tracked as **IFI 70-143/2004-204-02**.

c. Conclusions

The licensee performed an effective investigation of a reported criticality alarm audibility

problem.

#### 4.0 Criticality Accident Alarm System (88015)

##### a. Scope of Inspection

The inspectors reviewed criticality accident alarm system (CAAS) detector placement analyses. The inspectors visually inspected detector placement configurations to verify that dual detector coverage of risk significant operations was being maintained. The inspectors reviewed selected aspects of the following documents:

- [REDACTED] CAAS Detector Drawing Numbers 333-E3091-D and 333-E3079-D
- [REDACTED] CAAS Detector Drawing Numbers 130-E0044-D and 013-E0400-D
- Contractor Technical Report, "Demonstration of Criticality Accident Alarm System (CAAS) Detector Coverage for the BLEU Processing Facility (BPF), [REDACTED]," Rev. 1

##### b. Observations and Findings

The inspectors observed that the licensee's detector placement methodology employed a conservative source term based only on the prompt gammas emitted by primary fission events. The inspectors observed that the dose contribution from prompt neutrons, neutron-induced photons, and delayed fission/activation product photons was excluded from the coverage analyses. In addition, the inspectors observed that prompt gammas from secondary fission events (due to neutron absorption in proximal non-critical uranium sources, e.g., adjacent areas) were omitted.

The inspectors reviewed the calculated results for the BPF facility and observed that the licensee's calculations did not show coverage based on specific detector pairs. Instead, coverage at specific locations is based on multiple overlapping detector coverage. The inspectors visually verified detector pair placement in [REDACTED] and confirmed that the detector pair location (i.e., X, Y and Z coordinates) used in the detector placement calculations was under configuration control.

##### c. Conclusions

No safety concerns were identified regarding CAAS coverage at the BPF. The licensee's placement of criticality accident alarm system detectors provides acceptable coverage of risk-significant operations.

## 5.0 Open Items

### VIO 70-143/2004-201-01

The violation concerned failure to control six greater-than- plastic bags in the . The inspectors reviewed licensee corrective actions related to the violation and determined that the licensee had briefed all staff on requirements for non-favorable geometry containers and in what areas those requirements were applicable. The licensee had also acquired several types of containers which could be used in restricted areas such as mesh bags and wire mesh shopping baskets which would not accumulate liquid. In addition to planned corrective actions, the inspectors determined during walkdowns that the licensee had taken steps to clarify the boundaries of restricted areas. This item is closed.

### IFI 70-143/2004-201-02

This item tracks resolution of CAAS equipment and installation problems. The inspectors reviewed the licensee's progress in upgrading the CAAS. The inspectors reviewed the licensee's CAAS performance records and interviewed staff regarding the progress of installing new RMS-3 detector units. The licensee expects to complete RMS-3 installation by early 2005. The inspector noted that trouble alarm events have decreased. When RMS-3 installation is complete, the inspectors will be able to establish the adequacy of the system. This item remains open.

## 6.0 Management Meetings

The inspectors presented the inspection scope and results to members of the licensee's management and staff during an exit meeting on February 27, 2004. The licensee acknowledged and understood the findings as presented.

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

**Opened**

- IFI 70-143/2004-204-01**      Tracks revision of the UNB NCSE and the resulting impact on bounding assumptions
- IFI 70-143/2004-204-02**      Tracks implementation of final corrective actions to assure criticality alarm audibility in a suspect area

**Closed**

- VIO 70-143/2004-201-01**      Failure to control six greater-than [REDACTED] plastic bags in the [REDACTED]

**Discussed**

- IFI 70-143/2004-201-02**      Tracks resolution of criticality accident alarm system equipment and installation problems

**Inspection Procedures Used**

- IP 88015**      Headquarters Nuclear Criticality Safety Program

**Partial List of Persons Contacted**

**Nuclear Fuel Services, Inc.**

- |                 |  |
|-----------------|--|
| *N. Brown       | Engineer, NCS                          |
| *D. Chaney      | Engineer, Quality                      |
| *N. Kenner      | Manager, Training Department           |
| *A. Maxin       | Director, Safety                       |
| *B. Moore       | Vice President, Safety and Regulatory  |
| *R. Shackelford | Manager, NCS                           |
| *M. Tester      | Manager, Radiological Control          |
| *S. Skiles      | Engineer, NCS                          |
| *A. Vaughan     | Director, Fuel Production              |
| *J. Kirk        | Licensing Specialist                   |
| *J. Nagy        | Licensing and Regulatory Compliance    |
| R. Ratnor       | Health Physicist, Nuclear Measurements |
| C. Miller       | Engineer, NCS                          |

**NRC**

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|------------|-------------------------------------|
| *D. Rich   | Senior Resident Inspector, NFS      |
| *M. Crespo | Fuel Cycle Inspector, NRC Region II |

\*Denotes attendance at the exit meeting on July 30, 2004.

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