

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

Docket Number: 70-7001

Certificate Number: GDP-01

Report Number: 70-7001/2005-201

Certificatee: United States Enrichment Corporation

Location: Paducah, Kentucky

Inspection Dates: April 18 - 21, 2005

Inspector: Lawrence 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
Office of Nuclear Material Safety
and Safeguards

ENCLOSURE 1

**United States Enrichment Corporation
Paducah Gaseous Diffusion Plant**

**NRC Inspection Report
70-7001/2005-201**

EXECUTIVE SUMMARY

Introduction

Staff of the U. S. Nuclear Regulatory Commission (NRC) performed a routine, scheduled, and announced criticality safety inspection of the Paducah Gaseous Diffusion Plant in Paducah, Kentucky, from April 18 - 21, 2005. The inspection included an on-site review of certificatee programs dealing with plant operations, the nuclear criticality safety (NCS) function, and NCS-related corrective actions. The certificatee programs were acceptably directed toward the protection of public health and safety and were in compliance with NRC regulatory requirements. The inspection focused on risk-significant fissile material processing activities including Buildings C-310, C-335, C-337, C-360, C-400, C-409, C-746, C-746Q, and C-754.

Results

- No safety concerns were noted during the inspection.
- Nuclear criticality safety analyses and supporting calculations demonstrated adequate identification and control of NCS hazards to assure operations within subcritical limits.
- The NCS function as observed was adequate for maintaining acceptable levels of safety.
- Certificatee NCS walkthroughs and assessments were adequate for maintaining acceptable levels of safety.
- Observed operations were conducted safely and in accordance with regulatory requirements.

REPORT DETAILS

1.0 NCS Function (88015)

a. Scope

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

- Nuclear Criticality Safety Evaluation (NCSE) 080, "Operation and Maintenance of the C-310 70ft and 200ft Exhaust Stacks," Revision 1, dated March 3, 2005
- DAC 832-ZA1280-0062, "Calculations for the C-310 Tops Purge Trapping System," Revision 0, dated January 14, 2005
- NCSE 3971-07, "Operation and Maintenance of the C310 Tops Purge Trapping System," Revision 6, dated January 20, 2005
- NCSE 100, "Use and Handling of NPO 1000 and 2000 CFM (cubic feet per minute) Negative Air Machines," Revision 1, dated October 21, 2004
- DAC 832-ZA1280-0052, "Calculations for Used Negative Air Machine Filter Storage," Revision 0, dated April 27, 2004
- NCSE 028, "C-360 Pits and Drains," Revision 2, dated March 10, 2005
- NCSE 063, "Liquid Uranium Salvage Operations," Revision 3, dated November 4, 2004
- NCSE 049, "Handling, Storage, and Valve Change Operations of Large Uranium Hexafluoride (UF₆) Cylinders," Revision 6, dated January 26, 2005
- NCSE 049, "Handling, Storage, and Valve Change Operations of Large UF₆ Cylinders," Revision 7, dated January 13, 2005
- NCSE 095, "Operation and Shutdown of the Diffusion Cascade," Revision 2, dated April 14, 2005
- CP4-EG-NS1101, "Evaluation of Requests for Criticality Safety Approval," Revision 9, dated April 18, 2005
- NCSE 085, "Operation of the C-400 Cylinder Washing, Hydrostatic Testing, and Drying Facility," Revision 3, dated January 20, 2005

b. Observations and Findings

Within the selected aspects reviewed, the inspectors determined that the 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 observed that NCSE 085 Scenario 7 discussed backflow of solution from the C-400 uranium recovery system to the cylinder wash system. The discussion of double contingency against the backflow scenario included an argument that double

contingency was based on backflowing solution never exceeding 100 grams uranium/liter. This assurance of a limiting concentration for solutions that might backflow to cylinder wash was provided by reference to a uranium recovery NCSE. The inspectors determined that, although double contingency for the backflow scenario was established, the basis was not clearly described in the cylinder wash NCSE. The certificatee committed to revise this section of the NCSE to clarify the solution concentration argument. Revision of NCSE 085 to clarify the double contingency argument for Scenario 7 will be tracked as **Inspection Follow-up Item (IFI) 70-7001/2005-201-01**.

c. Conclusions

Nuclear criticality safety analyses and supporting calculations demonstrated adequate identification and control of NCS hazards to assure operations within subcritical limits. The NCS function as observed was adequate for maintaining acceptable levels of safety.

2.0 NCS Inspections, Audits and Investigations (88015)

a. Scope

The inspectors reviewed records of previously completed walkthroughs of fissile operations in Buildings C-333, C-337A, C-335, C-337, C-709 and C-710. The inspectors also reviewed records of completed programmatic self-assessments. The inspectors reviewed selected aspects of the following documents:

- CP4-EG-NS-1107, "Nuclear Criticality Safety Oversight Program," Revision 3, dated March 31, 2005
- 05-WS-0001, "NCS Walking Spaces Summary for Building C-720," dated March 31, 2005
- 05-WS-0002, "NCS Walking Spaces Summary for Buildings C-333A and C-337," dated March 30, 2005
- C31-NCS-SA-04-03, "Implementation of Safety Related Items," dated December 22, 2004
- C31-SA-04-05, "Fume Hood Ventilation Systems in C-710," dated August 27, 2004

b. Observations and Findings

The inspectors determined that certificatee NCS engineers observed plant operations to determine adequacy of implementation of NCS requirements and ensured that implementation weaknesses were identified and entered into the corrective action system. The inspectors observed that the certificatee NCS walkthroughs and assessments were conducted in accordance with written procedures. The inspectors noted that the walkthroughs and assessments were performed by NCS engineers who: (1) reviewed open NCS issues from previous audits; (2) reviewed the adequacy of control implementation; (3) reviewed plant operations for compliance with certificate requirements, procedures, and postings; and (4) examined equipment and operations to

determine that past evaluations remained adequate. No safety concerns were noted regarding certificatee walkthroughs and assessments.

c. Conclusions

Certificatee NCS walkthroughs and assessments were adequate for maintaining acceptable levels of safety.

3.0 Plant Operations (88015)

a. Scope

The inspectors performed plant walkdowns to review activities in progress and to determine whether risk-significant fissile material operations were being conducted safely and in accordance with regulatory requirements. The inspectors verified the adequacy of management measures for assuring the continued availability, reliability and capability of safety-significant controls relied upon by the certificatee for controlling criticality risks to acceptable levels. The inspectors performed walkdowns of Buildings C-310, C-335, C-337, C-360, C-400, C-409, C-746, C-746Q, and C-754.

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

- NCSE 080, "Operation and Maintenance of the C-310 70ft and 200ft Exhaust Stacks," Revision 1, dated March 3, 2005
- NCSE 3971-07, "Operation and Maintenance of the C310 Tops Purge Trapping System," Revision 6, dated January 20, 2005
- NCSE 100, "Use and Handling of NPO 1000 and 2000 CFM Negative Air Machines," Revision 1, dated October 21, 2004
- NCSE 028, "C-360 Pits and Drains," Revision 2, dated March 10, 2005
- NCSE 085, "Operation of the C-400 Cylinder Washing, Hydrostatic Testing, and Drying Facility," Revision 3, dated January 20, 2005
- NCSE 051, "C-409 Uranium Precipitation System," Revision 7, dated November 4, 2004

b. Observations and Findings

The inspector verified that controls identified in the NCS analyses reviewed were installed or implemented and were adequate to assure safety. The cognizant NCS engineers were knowledgeable and able to explain the basis for changes in operations and controls.

c. Conclusions

Observed plant operations were conducted safely and in accordance with regulatory requirements.

4.0 Open Item Follow-up

IFI 70-7001/2004-201-02

Subsequent to an internal event in which poorly characterized waste drums were identified, the certificatee committed to develop corrective actions to assure adequate characterization of waste drums containing fissile material. The inspectors observed that the certificatee has developed effective corrective actions including revision of the controlling NCSE, improvement of the drum monitor calibration curves, recharacterization of suspect drums, and training of associated staff. Because a root cause of the event was over-reliance on an unlikely event argument, the certificatee is performing a review to identify other similar unlikely event arguments. The review of unlikely event arguments is ongoing although the certificatee indicated that review of systems considered risk-significant have been completed. This item is closed.

The inspectors noted that suspect drum recharacterization will begin in October of 2005 and will involve approximately 12,000 drums. Initiation of suspect waste drum recharacterization will be tracked as **IFI 70-7001/2005-201-02**.

IFI 70-7001/2004-203-01

The certificatee committed to revise the SCALE 4.4 validation report with additional technical justification for the use of mixed oxide (MOX) benchmarks in support of the area of applicability which included low-enriched uranium systems with uranium enrichment from 0.71 to 10.1 weight percent and H/X ratios (ratio of ²³⁵U atoms to hydrogen atoms) from 17 to 3134. The certificatee has completed reanalysis of the MOX benchmarks and revised the validation report, KY/S-221, "Validation of the SCALE 4.4 Nuclear Criticality Safety Code System and the ENDF/B-IV 27-Group Cross-Section Library at the Paducah Gaseous Diffusion Plant," Revision 6, dated January 2005 to remove the MOX benchmarks. The inspectors noted that the removal of the MOX benchmarks did not have a significant effect on the Upper Safety Limit. The inspectors also noted that the 44-group library was removed from the validation due to statistical adequacy issues that occurred with the library when the MOX benchmarks were removed. No additional concerns were noted. This item is closed.

VIO 70-7001/2004-203-02

This violation concerned the failure to establish or maintain double contingency for the accident scenario of recirculating cooling water in-leakage to the enrichment cascade through the purge and evacuation coolers. The inspectors determined that the certificatee had not completed all planned corrective actions for this violation including revision of the operating procedure. This item remains open.

IFI 70-7001/2005-001-05

This item tracks the certificatee's revision to Procedure CP4-EG-NS1101, "Evaluation of Requests for Criticality Safety Approval," and subsequent actions taken to ensure that NCSEs are maintained or developed in accordance with that procedure. During a previous Region II inspection (documented in inspection report 70-7001/2005-001), the inspectors questioned the completeness of NCSE documentation and the adequacy of existing NCS programmatic commitments (i.e., Procedure CP4-EG-NS1101) for ensuring that current and future NCSEs were documented with the level of detail necessary for maintaining criticality safety. The inspectors had noted that a similar weakness regarding inadequate level of detail and technical review of NCSEs had been previously documented in Inspection Report 70-7001/2004-201 and identified as an area needing improvement during the recent certificatee performance review.

During this inspection, the inspectors noted that the revisions to Procedure CP4-EG-NS1101 included requirements for summarizing the calculational analysis in the NCSE with sufficient detail to permit independent review of the basis for why the analysis was applicable and bounding for the analyzed conditions. The inspectors verified through discussions with NCS management that the revised procedure would be applied to all NCSEs currently being developed or revised as part of the ongoing NCSE corrective action program (CAP). At the time of the inspection, only one CAP NCSE had been completed to date using a previous version of CP4-EG-NS1101. Although the NCSE was issued prior to the effective date of the revised procedure, the inspectors observed that the NCSE had been substantially revised to address the concerns associated with IFI 70-7001/2005-001-05. The inspectors determined that the revised NCSE was documented with an acceptable level of detail. This item is closed.

IFI 70-7001/2005-001-06

This item tracks the certificatee's revision to Procedure CP4-EG-NS1107, "Nuclear Criticality Safety Oversight Program." During a previous Region II inspection (documented in inspection report 70-7001/2005-001), the inspectors had noted that the certificatee's walk-through/assessment process, as documented in certificatee Procedure CP4-EG-NS1107, "Nuclear Criticality Safety Oversight Program," Revision 2, was not always parallel with the certificatee's commitment to Section 4.1.6 of ANSI/ANS-8.1-1983 related to ascertaining that process conditions had not been altered so as to affect the nuclear criticality safety evaluation.

During this inspection, the inspectors reviewed the certificatee's revisions to CP4-EG-NS1107, and determined that adequate procedural requirements had been established to ensure that process conditions had not been altered so as to affect the NCSE. The inspectors noted that the procedural revisions included requirements for NCS engineers to read/understand the documented safety basis prior to completing the walkthrough. The inspectors also noted that the revisions included requirements to assess and document whether any identified changes or alterations to operation had invalidated assumptions and unlikely statements in the NCSE. The inspectors determined that the revisions made to Procedure CP4-EG-NS1107 assured that changes to plant configurations and processes conformed to the applicable NCSEs. This item is closed.

5.0 Exit Meetings

The inspectors communicated the inspection scope and results to members of Paducah Gaseous Diffusion Plant management and staff throughout the inspection and during an exit meeting on April 21, 2005. Paducah Gaseous Diffusion Plant management and staff acknowledged and understood the findings as presented.

Supplementary Information

1.0 List of Items Opened, Closed, and Discussed

Opened

| | |
|-------------------------|---|
| IFI 70-7001/2005-201-01 | Revision of NCSE 085 to clarify the double contingency argument for backflow Scenario 7 |
| IFI 70-7001/2005-201-02 | Tracks initiation of suspect waste drum recharacterization |

Discussed

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|-------------------------|---|
| VIO 70-7001/2004-203-02 | Failure to establish or maintain double contingency |
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Closed

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| IFI 70-7001/2004-201-02 | Development of corrective actions to assure adequate characterization of waste drums |
| IFI 70-7001/2004-203-01 | Revision of validation report to justify the use of MOX benchmarks |
| IFI 70-7001/2005-001-05 | Revision to Procedure CP4-EG-NS1101 and actions taken to ensure that NCSEs are maintained or developed in accordance with that procedure |
| IFI 70-7001/2005-001-06 | Certificatee review and update of Procedure CP4-EG-NS1107 |

2.0 Inspection Procedures Used

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| IP 88015 | Headquarters Nuclear Criticality Safety Program |
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3.0 Partial List of Persons Contacted

USEC

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|--------------|--------------------------------------|
| J. Martin | Manager, Nuclear Criticality Safety |
| S. Cowne | Manager, Nuclear Regulatory Affairs |
| D. Stadler | Engineer, Nuclear Regulatory Affairs |
| T. Hofer | Engineer, Nuclear Criticality Safety |
| T. Henson | Engineer, Nuclear Criticality Safety |
| C Hicks | Manager, Scheduling |
| J. Lewis | Engineer, Nuclear Criticality Safety |
| D. Baltimore | Engineer, Nuclear Criticality Safety |

Attachment

| | |
|------------|--------------------------------------|
| D. Harrell | Manager, Maintenance |
| R. Beck | Engineer, Nuclear Criticality Safety |
| B. Chenier | Nuclear Criticality Safety |
| M. Boren | Nuclear Regulatory Affairs |
| S. Penrod | General Manager |
| E. Paine | Manager, Chemical Operations |
| L. Jackson | Manager, Operations |
| S. Toelle | Director, Nuclear Regulatory Affairs |

NRC

D. Morey, Senior Criticality Safety Inspector, Headquarters
 L. Berg, Criticality Safety Inspector, Headquarters

All attended the exit meeting on February 4, 2005.

4.0 List of Acronyms and Abbreviations

| | |
|-----------------|---|
| ADAMS | agency-wide document access and management system |
| ANS | American Nuclear Society |
| ANSI | American National Standards Institute |
| CAP | corrective action plan |
| CFM | cubic feet per minute |
| DOE | U.S. Department of Energy |
| GDP | gaseous diffusion plant |
| H/X | ratio of ²³⁵ U atoms to hydrogen atoms |
| IFI | inspection follow-up item |
| IP | inspection procedure |
| MOX | mixed oxide |
| NCS | nuclear criticality safety |
| NCSE | nuclear criticality safety evaluation |
| NRC | U. S. Nuclear Regulatory Commission |
| UF ₆ | uranium hexafluoride |
| USEC | U.S. Enrichment Corporation |
| VIO | violation |