UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
SAM NUNN ATLANTA FEDERAL CENTER
61 FORSYTH STREET, SW, SUITE 23T85
ATLANTA, GEORGIA 30303-8931

June 9, 2006

CAL NO. 02-06-003
NRC Event Nos. 42393, 42411

Mr. Dwight B. Ferguson, Jr.
President, Chief Executive Officer
Nuclear Fuel Services, Inc.
P. O. Box 337, MS 123
Erwin, TN 37650

SUBJECT: NRC INSPECTION REPORT NO. 70-143/2006-006

Dear Mr. Ferguson:

This report refers to the special inspection team (SIT) inspection conducted from March 13-17, 2006, at the Nuclear Fuel Services, Inc. facility in Erwin, TN and the subsequent teleconference conducted on May 10, 2006. The purpose of the SIT was to review the causes and circumstances surrounding the inadvertent transfer on March 6, 2006, of high enriched uranyl nitrate solution into an enclosure that was not approved for operation. A copy of the SIT Charter is included as Enclosure 1. The inspection included a review of your safety operations, including criticality safety, chemical safety, plant operations, and management measures to determine that your facility was operated safely and in compliance with your license.

Areas examined during the inspection are identified in the report. Within these areas, the inspection consisted of a selective examination of procedures and representative records, interviews with personnel, and observation of activities in progress.

The SIT objectives were to: (1) determine the facts surrounding the specific event; (2) determine the safety implications and adequacy of licensee corrective actions; (3) assess the licensee's response to the event; (4) assess the licensee's activity during its event review and recovery; and (5) identify the root causes.

The SIT determined that the event's immediate safety consequences were very significant in that operators were unaware that their actions could result in transfer of high enriched uranium (HEU) to the filter enclosure. In addition, identification after the event of an unsafe accumulation point (elevator pit) in the BLEU Preparation Facility (BPF) floor raised significant safety concerns because solution leaks are a credible abnormal condition in the BPF, and the BPF floor is identified as an item relied on for safety to maintain solution leaks in a safe slab

[redacted]

configuration. There were no controls in place to prevent a solution leak from entering the elevator pit. The SIT specifically noted that the problem identification and resolution, configuration management, and change control programs failed to prevent the event. These issues are indicative of inadequate internal processes and ineffective management oversight.

The SIT concurred with your identification of causal factors and contributing factors surrounding the event as noted in your letter dated April 20, 2006. Corrective actions that have either been implemented or planned were determined to be adequate.

Based on the results of this inspection, the NRC has identified apparent violations of NRC requirements. The apparent violations involved the failures of the configuration control program, procedural controls, and problem identification and reporting. The apparent violations will be addressed in future correspondence, therefore, no response is required at this time.

This letter and the enclosed report contain sensitive unclassified information and will not be available for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system, agency-wide documents access and management system (ADAMS). Should you have any questions concerning this letter, please contact us.

Should you have any questions concerning this letter, please contact us.

Sincerely,
/RA/

Douglas M. Collins, Director
Division of Fuel Facility Inspection

Docket No. 70-143
License No. SNM-124

Enclosures: 1. SIT Charter w/attachment
2. NRC Inspection Report

cc w/encls:
B. Marie Moore
Vice President, Safety and Regulatory Management
Nuclear Fuel Services, Inc.
P. O. Box 337, MS 123
Erwin, TN 37650

L. Edward Nanney, Director
Division of Radiological Health
Tennessee Dept. of Environment & Conservation
L&C Annex, Third Floor
401 Church Street
Nashville, TN 37243-1532

[redacted]

[redacted]

D. B. Ferguson

[redacted]

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[redacted]

March 10, 2006

MEMORANDUM TO: William B. Gloersen, Leader
NFS Special Inspection Team

FROM: William D. Travers, Regional Administrator ***/RA/ D. Collins acting for***

SUBJECT: SPECIAL INSPECTION TEAM CHARTER FOR NUCLEAR FUEL SERVICES (NFS) - DOCKET NO. 70-143 (INSPECTION REPORT NUMBER 70-143/2006-006)

This memorandum confirms the establishment of a Special Inspection Team to inspect and assess the facts and circumstances of the inadvertent transfer of solution into an enclosure that was not approved for operation at the Nuclear Fuel Services, Inc. facility in Erwin, TN. The event occurred on March 6, 2006 (Event #42393) and was reported to the NRC Operations Center on March 7, 2006 (17:00 EST). You are the team leader and should report status directly to me. Your team members are: N. Jordan (NMSS), D. Morey (NMSS), S. Subosits (RII), and G. Wertz (RII),

The inspection and report will be performed in accordance with the guidance of Inspection Procedure (IP) 88003, 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 objective of the team is to gather information and make appropriate findings and conclusions in the areas listed in the Charter. These will then be used as a basis for any necessary followup. As indicated in the Charter, the foremost objective is to determine the safety implications and adequacy of licensee corrective actions for the sequence of events resulting in the transfer of high enriched uranyl nitrate solution to an enclosure that was not approved for operation.

If you have any questions, please contact me.

Enclosure: (See page 2)

[redacted]

Special Inspection Charter
Nuclear Fuels Services, Inc.
Unanalyzed Condition of Criticality Safety Controls
Event No. 42393

Basis

On March 6, 2006, approximately 37 liters of high enriched uranyl nitrate (HEUN) solution was inadvertently transferred to a filter enclosure not currently approved for operation in the blended low enriched uranium (BLEU) preparation facility (BPF). The filter enclosure was equipped with two independent safety related drains that diverted the solution to the building floor and maintained a safe slab configuration within the enclosure and on the building floor. Upon discovery of this condition, operations in the affected area were terminated and corrective actions were initiated.

The equipment, which was not approved for use, was connected to a solution transfer line in service. This allowed unintended transfer of solution to a process enclosure. This condition led to the determination that the existing safety analysis was not completed for the operation of this enclosure. The safety related enclosure drains were inspected by licensee safety personnel and verified to remain free of obstructions to ensure functionality.

Operations in Solvent Extraction Area and all solution transfers to Solvent Extraction were suspended. The unapproved enclosure was being physically disconnected from the Solvent Extraction process prior to releasing the affected Solvent Extraction Area for use.

Scope

In order to develop the safety significance of the event, the team should focus on the areas listed below. They are listed in order of importance.

1. Develop a complete sequence of events related to the event.

2. Identify and evaluate the effectiveness of the immediate corrective actions taken by the licensee in response to the event.

3. Evaluate the potential for the accumulation of U-235 material in excess of the as-found condition. This should consider the sequence of events leading to the transfer of solution and drainage of HEUN solution, the actual indicators and responses to problems occurring in the solution transfer process, determination of what barriers remained to a criticality (that is, what, and how many, and other things were needed to go wrong before a criticality could occur).

4. Determine whether any criticality controls (IROFS with appropriate management measures applied) were in place for the solution transfer process, and, if so, their adequacy, and the generic implications for the other processing lines with similar equipment and engineered safety controls. This should include a review of the adequacy of licensee actions to correct a potential for a non-functioning safety control on the other units similar to the one that occurred on the high enriched line.

5. Review and evaluate the licensee's root cause analysis for adequacy of scope, depth, and identification of causal factors.

6. Evaluate the adequacy of the licensee's response. Determine adequacy of internal and external licensee event reporting. This should include a review of the information available to the licensee to use as indicators of a problem, timeliness of reporting to the NRC, and the response to safety issues. Safety issues include criticality and radiological areas.

7. Determine the probable contributing and root causes for the loss or absence of safety controls. This should include a review of the extent of damage of the systems, structures and equipment on the high enriched line and licensee corrective actions.

8. Determine the adequacy of the licensee's actions to prevent recurrence.

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.:	70-143
License No.:	SNM-124
Report No.:	70-143/2006-006
Licensee:	Nuclear Fuel Services, Inc.
Facility:	Erwin Facility
Location:	Erwin, TN 37650
Dates:	March 13-17, 2006
Inspectors:	W. Gloersen, Team Leader (RII) G. Wertz, Senior Resident Inspector (BWXT) D. Morey, Senior Criticality Safety Inspector (NMSS) N. Jordan, Criticality Safety Inspector (NMSS) S. Subosits, Fuel Facilities Inspector (RII)
Approved by:	D. Ayres, Chief Fuel Facility Inspection Branch 1 Division of Fuel Facility Inspection

Enclosure 2

EXECUTIVE SUMMARY

Nuclear Fuel Services, Inc.
NRC Inspection Report 70-143/2006-006

The purpose of the Special Inspection Team (SIT) was to review the causes and circumstances surrounding the inadvertent transfer on March 6, 2006, of high enriched uranyl nitrate solution into an enclosure that was not approved for operation. The SIT objectives were to: (1) determine the facts surrounding the specific event; (2) determine the safety implications and adequacy of licensee corrective actions (3) assess the licensee's response to the event; (4) assess the licensee's activity during their event review and recovery; and (5) identify the root causes.

Event Description

On March 6, 2006, approximately 35 liters of high enriched uranyl nitrate (HEUN) solution was inadvertently transferred to a filter enclosure not currently approved for operation in the blended low enriched uranium (BLEU) preparation facility (BPF). The filter enclosure was equipped with two independent safety-related drains whose intended function was to maintain a safe slab configuration within the enclosure by diverting solution to the building floor. The equipment, which was not approved for use, was connected to an in-service solution transfer line. This allowed an unintended transfer of solution to a process enclosure. This condition led to the determination that the existing safety analysis was not completed for the operation of this enclosure. Upon discovery of this condition, operations in Solvent Extraction Area and all solution transfers to Solvent Extraction were suspended and corrective actions were initiated.

Event Response

NFS management failed to recognize the significance of the March 6 HEU spill event, specifically that the facility was operating in an unanalyzed condition without any approved controls to prevent a nuclear criticality accident. NRC notification was not made in accordance with the timeliness requirements of 10CFR70, Appendix A (APV 70-143/2006-006-01). The NRC Senior Resident Inspector's involvement was necessary to ensure event reporting and to protect the "as-found" condition of the enclosure and piping for further inspection and evaluation.

Effectiveness of Immediate Corrective Actions

Solvent extraction operators responded promptly to a spill of highly enriched uranyl nitrate solution on March 6. The spill was contained and cleaned by area workers who adhered to proper radiological protection requirements. On-site and off-site facility management was notified in order to assess the safety significance of the spill. Operations in solvent extraction

were halted pending identification of the source of the spill.

Criticality Safety

During the BPF HEU spill event, sufficient fissile solution was transferred that could have resulted in criticality in either of two available collection points, and no NCS controls were available to prevent accumulation of a critical system at either collection point. The following apparent violations were identified:

- Failure to verify proper installation of the tray dissolver filter enclosure drains prior to use of the system with fissile material (APV 70-143/2006-006-02).

- Failure to meet the performance requirements of 10CFR70.61(d) for accident sequences related to handling fissile material in the tray dissolver system
- (APV 70-143/2006-006-03).

- Failure to meet the performance requirements of 10CFR70.61(d) for accident sequences related to fissile solution accumulation on the solvent extraction room floor (APV 70-143/2006-006-04).

- Failure to assume in NCS analysis for the tray dissolver system that fissile solution could be misdirected from the solvent extraction feed transfer line (APV 70-143/2006-006-05).

Root Causes and Contributing Factors

The root causes of the March 6 spill of uranyl nitrate solution included inadequate configuration control, change analysis and design requirements. More specifically, the configuration control program lacked requirements to ensure that unapproved systems were isolated from operational systems, and that configuration changes, such as not implementing the operational requirements (e.g., procedures, IROFS) of a system, received a safety review (APV 70-143/2006-006-06). Design requirements also lacked criteria to prevent misdirected flow. The inspectors concluded that correction of any of these deficiencies would have prevented the March 6th misdirected flow event. Contributing causes included inadequate procedures for operation of the enclosure components (APV 70-143/2006-006-07) and failure to capture unusual conditions associated with yellow solution in the enclosure in the corrective action program (APV 70-143/2006-006-08).

Assessment of Licensee' s Investigation and Corrective Actions

Corrective actions for the March 6 spill event adequately addressed the root and contributing causes identified by the inspectors in Section 6 of this report with the exception of one of the contributing causes pertaining to the failure to use a valid procedure to conduct licensed activities. The licensee had performed or planned to perform corrective actions that would

ensure that: (1) configuration control requirements include isolation of SNM-bearing processes from unapproved systems; (2) configuration control changes are properly evaluated and corrected; (3) personnel are retrained to report unusual SNM holdup to NCS; and, (4) engineering design requirements include criteria for prevention of misdirected flow in SNM-bearing process lines.

No corrective actions were identified for the contributing cause pertaining to performing activities on unapproved equipment without procedures or with inadequate procedures.

Attachment:
Partial List of Persons Contacted
List of Inspection Procedures Used
List of Items Open/Closed
List of Acronyms Used

REPORT DETAILS

1. Event Description (NRC Event No. 42393)

The event description was independently developed and validated by the inspectors using a review of records, logs and interviews with personnel directly involved with activities prior to and during the spill event.

On March 6, 2006, at around 6:00 pm, approximately 35 liters of high enriched uranyl nitrate (HEUN) solution was inadvertently transferred to bag filter enclosure ENCLOS-2M05, an enclosure which was not approved for operation in the blended low enriched uranium (BLEU) preparation facility (BPF). The concentration of the solution was 266 gU/liter with a uranium enrichment of 63 wt.% ^{235}U. The filter enclosure was equipped with two independent safety-related drains whose intended function was to maintain a safe slab configuration within the enclosure by diverting solution to the building floor. The equipment, which was not approved for use, was connected to an in-service solution transfer line. This allowed the unintended transfer of solution to a process enclosure. This condition led to the determination that the existing safety analysis was not completed for the operation of this enclosure.

The event was discovered by the BPF solvent extraction (SX) second shift supervisor who noticed yellow solution running into the hallway from below the SX area door (see Figure 4). The shift supervisor notified the SX operator, who was on the other side of the room observing the transfer of solution to the SX feed columns. Nuclear Safety, Health Physics, BPF Management and the Plant Superintendent were notified. The plant superintendent then notified the Senior Resident Inspector. The solvent extraction system was shut down by BPF Management on the evening of March 6, 2006. On March 7, the licensee assembled a root cause and investigation team.

The licensee had performed a walk down of the out-of-service bag filter glove box ENCLOS-2M05 and related connecting lines and determined that the filter system had a direct piping connection to the SX system. The licensee also determined that there was no isolation valve on the ½ -inch stainless steel process tube between the bag filter glove box and the 1-inch stainless steel transfer line. Consequently, as the solution transfer was occurring between the 7-day columns and SX feed columns, part of the feed solution back-flowed from the 1-inch transfer line through the ½-inch transfer line, through the open bag filter housing, into the filter glove box, out of the glove box drains, and onto the floor.

In January 2006, the licensee decided to relocate filter enclosure ENCLOS-2M05 to another location. The licensee issued a maintenance work order to relocate the equipment. On February 28, 2006, preparations were being made to move the filter enclosure to another part of the BPF. Preparation for the move included opening the filter housing lids for inspection. Operators found solution in the filter housings and determined that the solution was water. On March 6, operators opened the bag filter

drain valves and bag filter housing tops to drain liquid in preparation to move the enclosure. It was likely that one or both of the filter housings and one or both of the filter housings isolation valves were left open or failed open which allowed misdirected flow of the solution into the filter enclosure. Previous to this event, misdirected flow was prevented by the filter seals being fully engaged and the isolation valve below each filter housing being in the closed position.

The inspectors noted that there were three previous occasions where either a small amount of yellow solution or evidence of yellow solution was found in the enclosure (see Figure 1). The operators involved reported their observations to their supervisor. The personnel involved thought the material was depleted uranium solution from start-up testing. None of the observed events were reported in the licensee's problem identification, resolution, and correction system (PIRCS).

The licensee's investigation determined that the BPF filter enclosure differed from a similar system in the uranium recovery area of the fuel facility. The filter enclosure in the uranium recovery area of the fuel facility was equipped with an isolation valve between the filters and the connection to the transfer line header. A review of the process and instrumentation drawings (P&IDs) for the BPF tray dissolver filter system showed earlier versions of the P&ID (2001 - 2003 versions) correctly showing valve 2M39 as a drain valve. In the 2004 version of the P&ID (currently under configuration control in the drawing data base), valve 2M39 was shown incorrectly as an in-line ball (isolation) valve. The P&ID had been changed in March 2004 during a Verification and Validation (V&V) review of the P&ID for the SX area feed columns. At that time, the V&V team incorrectly described drain valve 2M39 as an isolation/block valve and requested that P&ID be changed. A subsequent V&V review conducted in September 2005 did not identify the error in the P&ID. It should be noted that since the tray dissolver/bag filter system was not approved for use, the operation was not covered by procedure and did not go through the review and approval steps mandated by the licensee's internally-authorized change process.

On March 10, a licensee investigation team was chartered to begin a facility walk-down to validate P&IDs. On March 13, during inspections of the facility, NFS personnel identified an out-of-service equipment elevator and when the elevator door was opened, the licensee observed a pit area that was approximately 8-10 inches below the plane of the building floor. The licensee determined that it contained unsafe accumulation points and determined that this was a 1-hour reportable event (NRC Event No. 42411) because there was no item relied on for safety (IROFS) or formal controls in place to prevent a solution leak from entering this location. A solution leak to this area was considered a credible abnormal condition. No actual material accumulation occurred. The licensee implemented compensatory measures to prevent material accumulation in the area.

Missed Opportunity Event Timeline

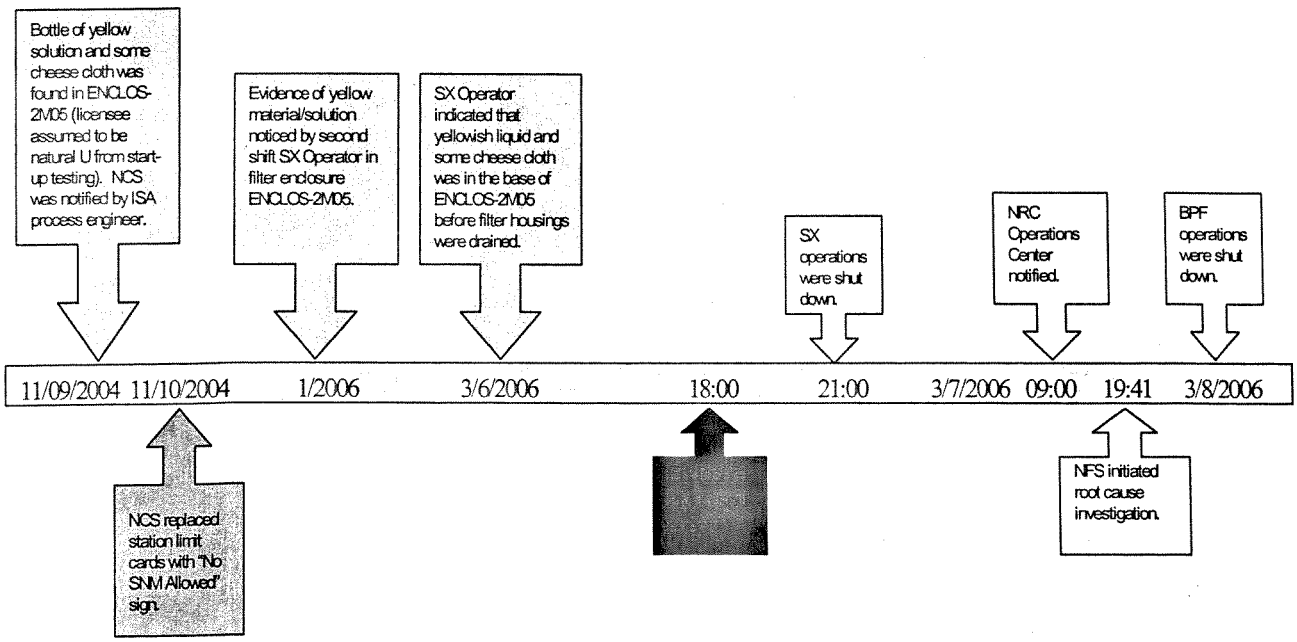

Figure 1: Event time line showing three previous occasions where either a small amount yellow solution or evidence of yellow solution was found in the bag filter enclosure (ENCLOS-2M05).

2. Event Response

Inspection Scope and Observations

The inspectors interviewed the Solvent Extraction (SX) operator, foreman, building manager, Integrated Safety Analysis (ISA) engineer and Vice President of Safety and Regulatory in order to evaluate NFS's assessment and reporting of the March 6 High Enriched Uranium (HEU) solution spill event. Immediate notification of the event through NFS management was prompt and effective. However, NFS management initially characterized the event as a routine spill. NFS management was aware that HEU solution entered enclosure 2MO5 and drained to a favorable geometry "safe slab" on the floor. However, the drains were not approved, tested, or maintained for use and could not be considered an approved safety control. In addition, the enclosure was not approved for special nuclear material (SNM) and had been posted to prohibit SNM since November 10, 2005. As such, administrative controls (station limit cards) were not being implemented to restrict items allowed in the enclosure in order to prevent any blockage of the drains. The SX operator who immediately responded to the spill identified two pieces of cheesecloth partially covering one of the drains. The inspectors concluded that it was fortuitous that the drains worked and allowed the HEU solution to drain to the floor.

On March 6, NFS management recognized that a spill of HEU solution had occurred into an unapproved and unfavorable geometry enclosure and that no safety controls or items relied on for safety (IROFS) were available to prevent a nuclear criticality accident. However, NFS management determined that NRC notification was not required by 10 CFR 70, Appendix A, (a)(4)(ii). The rationale for this decision was provided by the ISA engineer who indicated that 10 CFR 70, Appendix A(a)(4) applied only to IROFS identified in the ISA. Since the unapproved enclosure did not have any IROFS documented in the ISA, NFS management determined that the event was exempted from the 1-hour notification requirement. The inspectors disagreed with this assessment and concluded that the event constituted a condition wherein no IROFS were available to prevent a nuclear criticality accident, and should have been reported within one hour of discovery in accordance with 10 CFR 70, Appendix A, (a)(4)(ii). Failure to notify the NRC in accordance with 10 CFR 70, Appendix A, (a)(4)(ii) reporting requirements is identified as an apparent violation **(APV 70-143/2006-006-01)**.

In addition, NFS staff indicated that the NRC notification time did not start until the licensee had an opportunity to evaluate the event and determine if the requisite conditions for an event notification had occurred. NFS indicated that an event requiring a 1-hour NRC notification, for example, could take several hours to evaluate before deciding if the notification was required, and the 1-hour notification designation was the time necessary to assemble the notification paperwork and contact the NRC. The inspectors disagreed with this position. Specifically, in this case, NFS management was aware that the enclosure was not approved for SNM use, and no approved nuclear criticality safety (NCS) safety controls were in place on the evening of March 6. However, NFS management decided to stop their event review on the evening of March

6, and resume on the following day, March 7. The ISA engineer was asked to evaluate the depth of the NCS engineering review and approval of the drains, and to what extent ISA management measures had been implemented. This review consumed most of the day on March 7. Finally, NFS concluded that a 24-hour notification was required in the afternoon of March 7. NFS informed the NRC Senior Resident Inspector (SRI) that it planned to provide the notification the following day, Wednesday, March 8. The SRI advised NFS that the notification needed to be performed as soon as possible. The requisite personnel remained at the facility, and the notification was made at 7:41 p.m. on March 7.

Finally, the inspectors concluded that NFS management failed to recognize the significance of the March 6 HEU spill event which was that the facility was operating in an unanalyzed condition without any approved controls to prevent a nuclear criticality accident. Enclosure 2MO5 was scheduled to be relocated prior to the spill. On March 7, the day following the spill, the project manager notified management at the morning meeting, that he planned to immediately remove the enclosure. Only after the NRC resident inspector inquired if relocating the enclosure could alter physical evidence necessary for the root cause investigation, did management decide to leave the enclosure in place. This highlighted a less-than-adequate appreciation of the potential safety significance of the event. Subsequently, NRC management formally requested the enclosure remain "as-is" for inspection. Although SX processing was stopped on March 6 following the spill, the controlled safe shutdown of the BLEU facility was not initiated until March 8.

b. Conclusions

NFS management failed to recognize the significance of the March 6 HEU spill event which was that the facility was operating in an unanalyzed condition without any approved controls to prevent a nuclear criticality accident. NRC notification was not made in accordance with the timeliness requirements of 10 CFR 70, Appendix. The NRC Senior Resident Inspectors involvement was necessary to ensure event reporting and to protect the "as-found" condition of the enclosure and piping for further inspection and evaluation.

3. Effectiveness of Immediate Corrective Actions

a. Inspection Scope and Observations

The inspectors evaluated the licensee's immediate response and corrective actions to the March 6 uranyl nitrate (UN) spill. The event was identified when the area supervisor noticed yellow solution coming from beneath the access door to the solvent extraction (SX) area on March 6, at approximately 6:00 pm. The supervisor opened the door and noticed a larger floor area covered with what appeared to be UN solution. The foreman notified an operator who was in the SX area transferring UN solution. The operator immediately responded by looking for the source of the leak and identified UN solution leaking from one of two drains on enclosure 2MO5. The operator observed UN solution

in the enclosure up to the lip of the enclosure drain cap. The operator observed that all enclosure bag filter valves were closed and the leak had apparently stopped. The operator and foreman placed absorbent material around the spill to limit its spread.

The on-shift supervisor, building manager, Health Physics (HP) technician, foreman and operator coordinated cleanup activities while the Regulatory Affairs Vice-President and an Integrated Safety Analysis (ISA) specialist were notified to evaluate the event. Respiratory protection was provided prior to cleanup work. Activities in SX were terminated by the Regulatory Affairs Vice-President pending additional cause evaluation scheduled to begin the following day, March 7. The on-shift supervisor entered the event in the PIRCS as item 7459. The following day, the UN solution transfer feed line was removed, eliminating the possibility of additional misdirected flow of UN solution to the enclosure.

b. Conclusions

Solvent extraction operators responded promptly to a spill of high-enriched uranyl nitrate solution on March 6. The spill was contained and cleaned by area workers who adhered to proper radiological protection requirements. On-site and off-site facility management was notified in order to assess the safety significance of the spill. Operations in solvent extraction were halted pending identification of the source of the spill.

4. Criticality Safety

a. Inspection Scope and Observations

The inspectors reviewed criticality safety aspects of the BPF HEUN spill event reported by the licensee on March 6, 2006. The review included walk downs of the BPF tray dissolver equipment and procedures; interviews with engineers, operators, and root cause investigators; and reviews of technical analyses and other documentation.

System Description

The licensee used the BPF facility to dissolve uranium metals, oxides and alloys which it converted to HEUN solution. The uranyl nitrate solution was then downblended by mixing with natural uranyl nitrate solution and the resulting LEU solution was sent off site for oxide conversion. Following dissolution of feed material, fissile solute was filtered, converted to uranyl nitrate and sent to the solvent extraction room where the uranyl nitrate was purified and prepared for down blending.

The solvent extraction room was designed with a tray dissolver system which is shown in Figure 2. The tray dissolver system was intended to facilitate recovery of fissile solution from cleanup rags and mop heads and allow spilled solution to be fed directly to solvent extraction. The tray dissolver system had a filter enclosure with two bag filters and a cartridge filter, and the resulting filtrate was designed to be pumped to solvent extraction feed by a direct connection to the solvent extraction feed transfer line. Figure 3 shows the general equipment arrangement for the tray dissolver system and also shows the transfer line connections involved in the spill event. Figure 4 shows the spill, spill flow path, operator locations, and location of the elevator pit.

Enclosure Spill NCS Controls

The tray dissolver filter enclosure had two engineered NCS controls consisting of two drains which each had a diameter of two inches. There were no management measures in place to ensure that the drains could adequately perform their safety function. Items such as cheesecloth and poly-bottles which could block the drains were observed in the enclosure prior to the event (see Figure 1). The filter enclosure was considered out of service, and there were no approved procedures for enclosure operations including maintenance operations. No station limit card was in place, and operators were not trained on the unit. The licensee intended to use the enclosure drains as IROFS, and the drains would have been procedurally checked for obstructions prior to each use of the equipment. Other management measures on the drains would have included installation checks and preventive maintenance which were also not performed. The inspectors determined that the filter enclosure was uncontrolled for the accident sequence of a spill into the enclosure because these controls and measures were not implemented. In addition, a spill contained in the enclosure would not be easily noticed such that multiple spills to the enclosure could result in accumulation of fissile solution if the drains were blocked.

The licensee had performed an NCS analysis for the tray dissolver equipment and had prepared an operating procedure. The inspectors observed that the completed and approved NCS analysis for the tray dissolver process had reviewed the potential for accumulation of fissile solution in the enclosure and established appropriate NCS controls for that accident sequence which consisted of two 2-inch drains which were intended to be designated as IROFS. Because the system was considered out of service, the drains required by the analysis were not completely implemented, and double contingency was not established for the accident sequence of fissile solution spill into the tray dissolver filter enclosure. Specifically, verification of proper installation of the drains was not completed. License application Section 4.1.1.1.3 states, in part, that engineered controls must be verified as being properly installed prior to first use with fissile material. Failure to verify proper installation of the tray dissolver filter enclosure drains prior to use of the system with fissile material is identified as an apparent violation **(APV 70-143/2006-006-02)**.

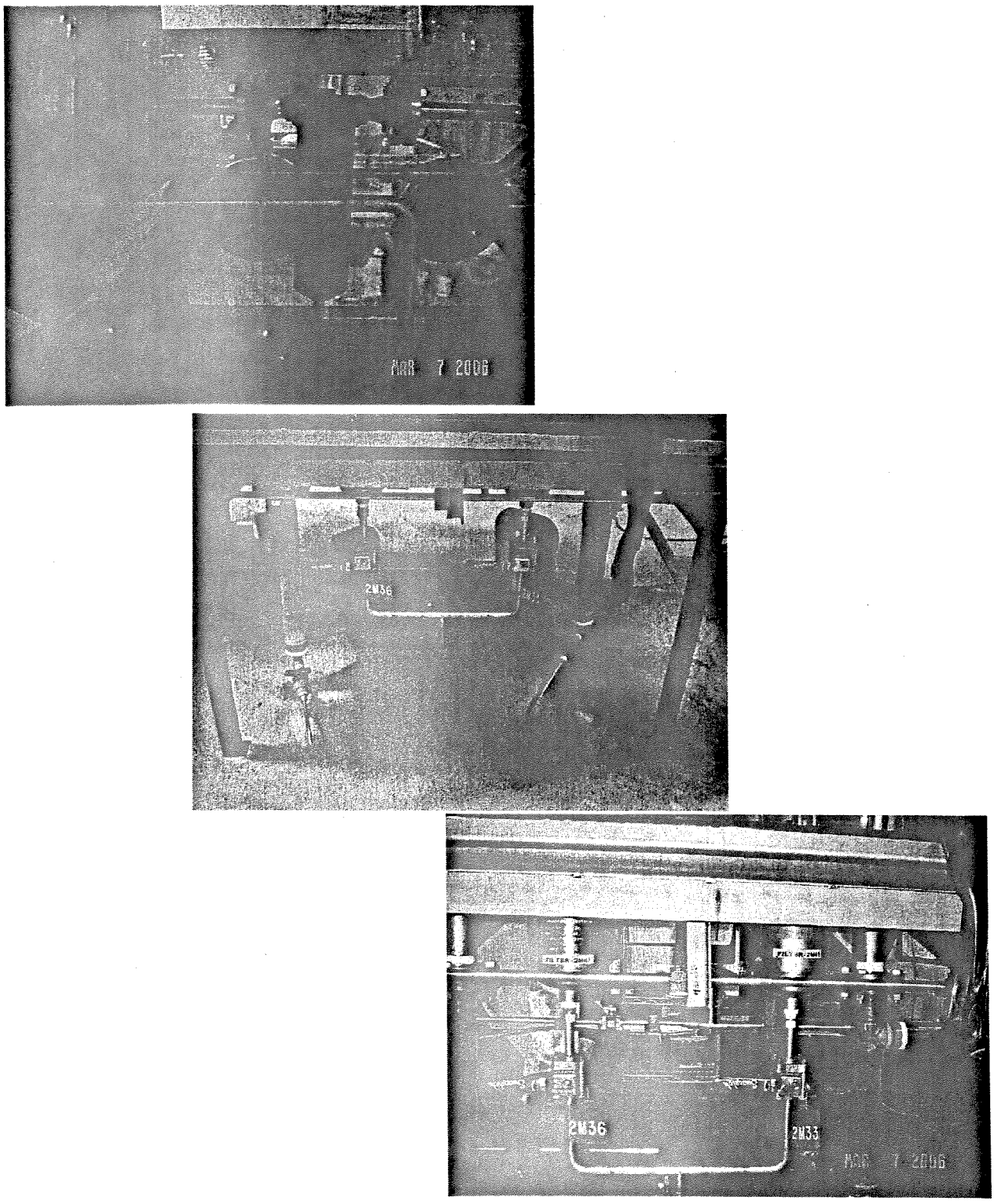

Figure 2: BPF Tray Dissolver 2M05 Enclosure, Piping and Drains

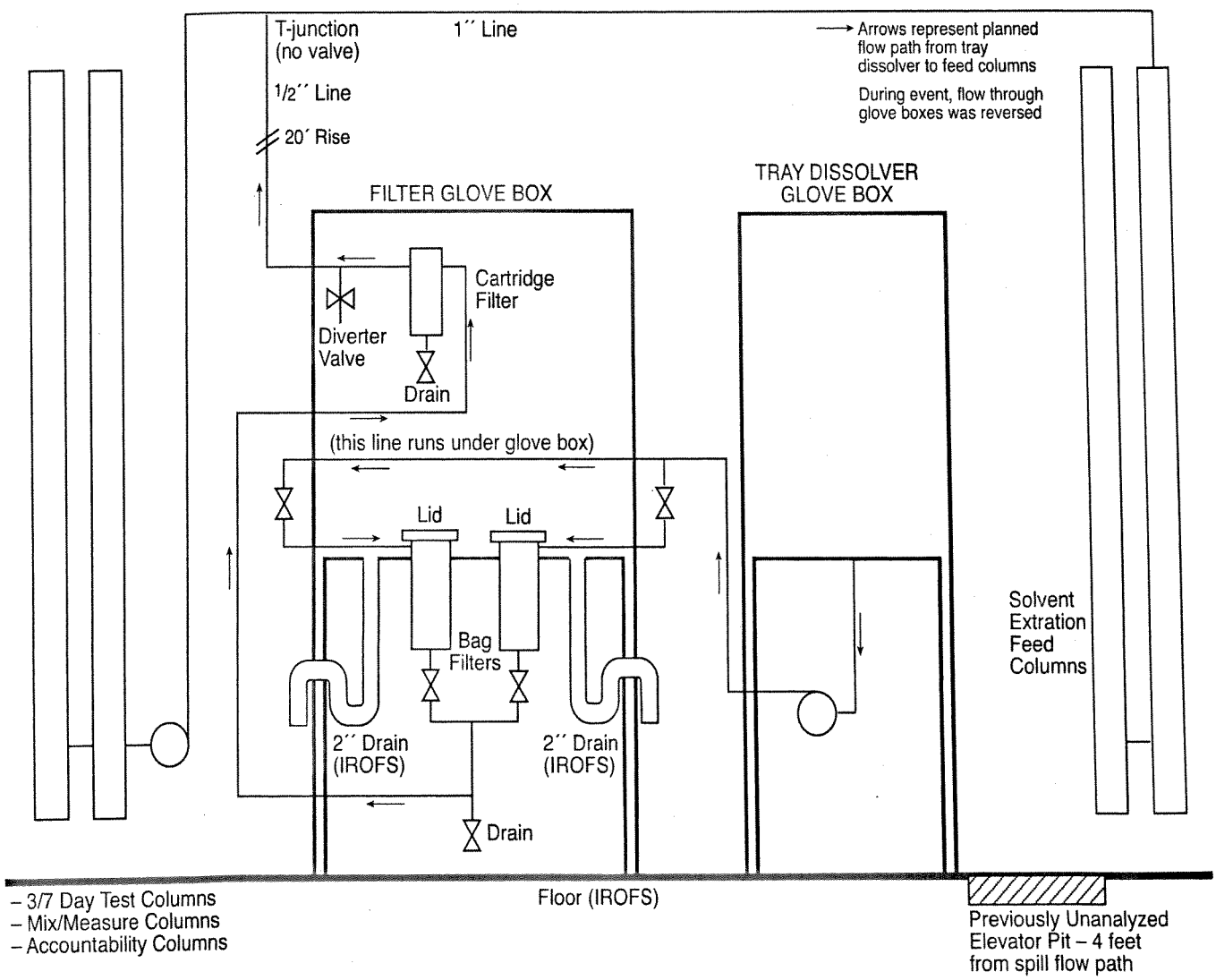

Figure 3: Tray Dissolver and Filter Enclosure Equipment Layout

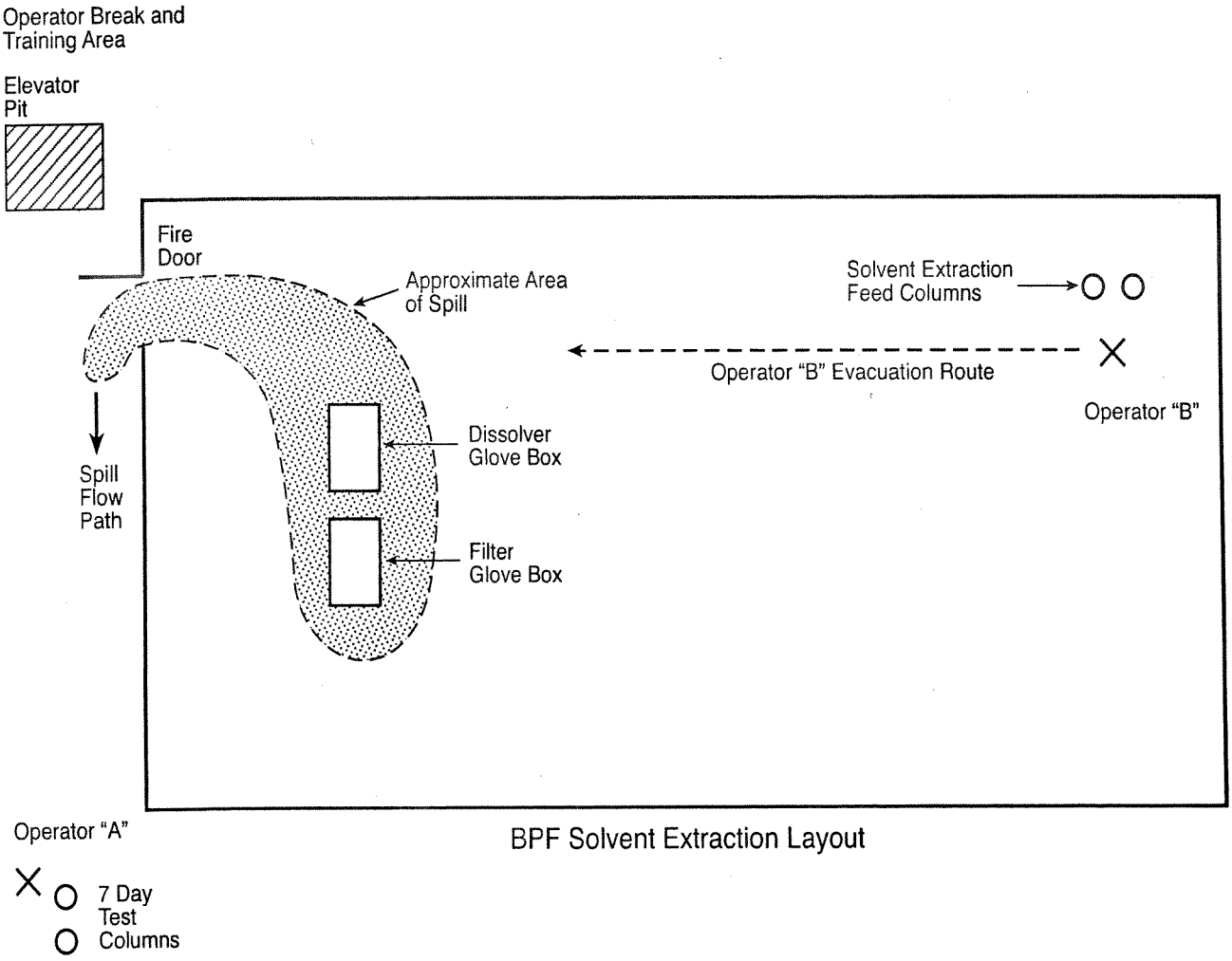

Figure 4: Solvent Extraction Room

The inspectors noted that the tray dissolver filter enclosure was installed without isolation valves and was connected to fissile process lines, utilities, and ventilation as if the tray dissolver system was in service and would therefore be required to meet the performance requirement of 10 CFR 70.61(d) for accident sequences leading to criticality due to handling fissile material with the tray dissolver equipment. The inspectors determined that because management measures were not implemented for the enclosure drain system, the enclosure did not meet performance requirements for criticality safety relative to accumulation of fissile material in the enclosure or on the floor of the solvent extraction room. Failure to meet the performance requirements of 10 CFR 70.61(d) for accident sequences related to handling fissile material in the tray dissolver system is identified as an apparent violation **(APV 70-143/2006-006-03)**. The inspectors reviewed similar filter enclosures in the plant and observed that they had isolation valves on both sides and an uninterrupted transfer line to the discharge point. No generic issue was identified relative to similar enclosures and equipment in the facility.

Floor Spill NCS Controls

The licensee had performed an analysis to establish the flatness of the floors throughout the facility and had analyzed the BPF solvent extraction room floor to establish that there were no collection points which would allow a solution depth greater than 1.25 inches. In order to meet the performance requirement of 10 CFR 70.61(d) for accident sequences leading to criticality involving solution spills to the operating facility floor, the licensee had designated the floor as an IROFS based on the area of the floor and the absence of collection points providing protection against a spill creating an unsafe slab on the floor. Immediately following the event, the licensee identified an unsafe collection point in the solvent extraction area floor, an elevator pit, which could accumulate more than 1.25 inches of solution. The inspectors determined that there were no controls available to protect the solvent extraction room floor from a spill of fissile solution accumulating into an unsafe geometry. The licensee's discovery of a previously-unanalyzed elevator pit dropping from the plane of the solvent extraction room floor results in the compromise of the IROFS for the accident sequence of fissile solution spill to the BPF solvent extraction room floor and failure to meet the performance requirement of 10 CFR 70.61(d). Failure to meet the performance requirements of 10 CFR 70.61(d) for accident sequences related to fissile solution accumulation on the solvent extraction room floor is identified as an apparent violation **(APV 70-143/2006-006-04)**.

The solvent extraction room floor and elevator pit were above the plane of the floor in the remainder of the facility so that other parts of the facility floor were not compromised by the presence of the pit. A spill to the solvent extraction floor was likely to be noticed by operators at the completion of a fissile solution transfer due to procedural requirements to have an operator in the solvent extraction room during the transfer. The inspectors determined that multiple spills to the floor prior to discovery would be unlikely.

NCS Analysis

The inspectors noted that the approved analysis for the BPF solvent extraction tray dissolver process considered fissile solution accumulation from the dissolution process so that the need for having enclosure drains was based on the maximum solution expected from the tray dissolver enclosure. The approved analysis did not consider accumulation of fissile solution in the enclosure due to misdirected flow of fissile solution from the solvent extraction feed transfer line. The inspectors determined that misdirected flow of fissile solution from the solvent extraction feed transfer line was a credible abnormal condition, and analysis of maximum possible flow rate and volume was essential to establishing the adequacy of the enclosure drains as NCS controls. The inspectors determined that misdirected flow of fissile solution from the solvent extraction feed transfer line was an unanalyzed condition. License application Section 4.1.1 states, in part, that all credible abnormal conditions are assumed to occur. Failure to assume that fissile solution could be misdirected from the solvent extraction feed transfer line in NCS analysis for the tray dissolver system is identified as an apparent violation **(APV 70-143/2006-006-05)**.

Risk Significance

The inspectors analyzed the BPF tray dissolver filter enclosure to determine how much solution would be required for a critical system. The inspectors performed the analysis using KENO IVa and used a model involving nominal reflection conditions in accordance with NCS requirements from the NFS license. The inspectors determined that a slab of the spilled solution in the shape of the tray dissolver filter enclosure with nominal reflection will become critical at 11 centimeters (4.3 inches) with 130 liters (34.3 gallons) of volume.

The licensee identified that the floor of the solvent extraction room was compromised by an elevator pit that was not considered in previous analysis of the facility floor. The inspectors analyzed the elevator pit to determine how much solution would be required for a critical system. The inspectors performed the analysis using KENO IVa and used a model involving a nominal reflection condition on top of the fissile slab. The inspectors determined that a slab of the spilled solution in the shape of the elevator pit with full reflection on the sides and bottom and nominal reflection on the top will become critical at 8 centimeters (3.15 inches) with a volume of 100 liters (26.4 gallons).

The actual transfer involved 200 liters of fissile solution and the maximum volume of fissile solution that could be transferred in a single batch to solvent extraction feed was 220 liters, limited by the volume of the solvent extraction feed columns. A critical condition could be reached in the enclosure by a single transfer if the transfer exceeded 130 liters and in the elevator pit if the transfer exceeded 100 liters and was directed entirely to the tray dissolver filter enclosure or the solvent extraction room floor. For the entire transfer to go to the enclosure, back pressure would be required to prevent flow

into the solvent extraction feed columns. The accountability period was seven days during which time many HEU solution transfers to solvent extraction feed could occur. The inspectors noted that, near the critical condition, the amount of solution in the tray dissolver filter enclosure would not be easily seen.

There were no controls preventing all solution in a single transfer from being spilled to the enclosure including no specific requirements for operator action if none of the transferred solution showed up in the solvent extraction feed columns during a transfer; although lack of flow into the feed columns would likely be noticed by operators due to procedural requirements to have an operator at the feed columns during the transfer. Further, there were no controls preventing multiple transfers from accumulating in the enclosure if the enclosure drains were blocked.

b. Conclusions

During the BPF HEU spill event, sufficient fissile solution was transferred for criticality in either of two available collection points, and no NCS controls were available to prevent accumulation of a critical system at either collection point. The following apparent violations were identified: (1) Failure to verify proper installation of the tray dissolver filter enclosure drains prior to use of the system with fissile material (APV 70-143/2006-006-02); (2) Failure to meet the performance requirements of 10CFR70.61(d) for accident sequences related to handling fissile material in the tray dissolver system (APV 70-143/2006-006-03); (3) Failure to meet the performance requirements of 10CFR70.61(d) for accident sequences related to fissile solution accumulation on the solvent extraction room floor (APV 70-143/2006-006-04); and (4) Failure to assume that fissile solution could back-flow from the solvent extraction feed transfer line in NCS analysis for the tray dissolver system (APV 70-143/2006-006-05).

5. Root Causes and Contributing Factors

a. Inspection Scope and Observations

The inspectors reviewed the event, developed a time line, and identified causal factors in accordance with the Management Oversight and Risk Tree (MORT®) tool in order to establish the root and contributing causes for the March 6, 2006, BPF Tray Dissolver 2M05 Enclosure spill. The root and contributing causes are presented below:

Root Cause 1 - Configuration Control Program Less Than Adequate

The licensee's program for configuration control, described in procedure NFS-GH-901, lacked any provision to ensure that process systems not approved for use were isolated from active SNM-bearing systems. In this case, the BPF Tray Dissolver system had not been approved for use and had not been isolated from active BPF solvent extraction processes. The inspectors determined that implementing such a configuration control program requirement could have prevented the event. The use of a less-than-adequate

configuration management system that failed to ensure that the safety impact of the partially installed and unisolated change was addressed per requirements of 10 CFR 70.72 is identified as an apparent violation **(APV 70-143/2006-006-06)**.

Root Cause 2 - Change Analysis Less Than Adequate

The licensee's program for configuration control lacked a provision to evaluate the change associated with not finalizing the installation and operational safety verification of a processing system. Sometime after the BPF Tray Dissolver system was constructed and placed into configuration control in March 2004, licensee management decided not to complete final installation and operational safety testing. Through discussions with the ISA specialist, the inspectors determined that no procedure existed to evaluate potential safety consequences of the unfinished system located in an SNM-bearing processing area. The ISA had been completed based on the assumption that the BPF Tray Dissolver system would be completed and operationally tested to ensure IROFS were maintained and available. Failure to re-evaluate the unfinished system meant the consequences of a misdirected flow event were not considered, and the BPF Tray Dissolver system was left vulnerable to the activities preceding the March 6 spill.

Root Cause 3 - Design Development Less Than Adequate

The licensee's design development guidance lacked any specific requirements to ensure that misdirected flow of SNM-bearing solution was prevented. The BPF Tray Dissolver system discharged in the solvent extraction system transfer header without any misdirected flow isolation or prevention device required nor installed. Implementation of a misdirected flow prevention design requirement could have prevented the event.

Contributing Cause 1 - Procedures Less Than Adequate/Not Used

The inspectors determined, that on at least two occasions, the 2M05 enclosure bag filter housing lid holddown bolts were removed by licensee personnel without a procedure. The project engineer, who examined the right-hand side filter housing around March 1, 2006, indicated he had removed the bolts to inspect the housing for the presence of any liquid. When questioned, he indicated no procedure was required. The ISA specialist indicated the a procedure was not available for use since the BPF Tray Dissolver system was not approved for operation. After the spill event, it was observed that two of the holddown bolts were not attached to the housing lid. In addition, the draining activity was performed by an operator using a generic draining procedure (Standard Operating Procedure (SOP) 409). This generic procedure did not identify specific drain valves, the required draining sequence, nor provide post-draining valve closure verification sequence. As such, the inspectors could not conclude that the drain valves were not inadvertently left open since SNM-bearing solution was observed flowing through the enclosure. Based on this information, the inspectors concluded a lack of adequate procedures contributed to the March 6 event. Failure to use a valid procedure to conduct licensed activities is identified as an apparent violation **(APV 70-143/2006-006-07)**.

Contributing Cause 2 - Problem Identification and Resolution Less Than Adequate

The inspectors identified three examples, prior to the event, where yellow solution was found in the 2M05 enclosure. Since the enclosure was not approved for use, the presence of yellow solution, possibly uranyl nitrate, was not authorized. In two cases, area supervision was notified, but the issue was not entered into the PIRCS system for formal safety review and was not reported to the Nuclear Criticality Safety function as required by NFS-HS-CL-26. As such, the inspectors concluded that the less-than-rigorous followup to the discovery of yellow solution in three different instances represented lost opportunities to possibly identify and correct the problem before the March 6 spill. The failure to report the events concerning the yellow solution in the 2M05 enclosure in accordance with the requirements of Section 5.1 of NFS-GH-65 is identified as an apparent violation **(APV 70-143/2006-006-08)**.

b. Conclusions

The inspectors identified inadequate configuration control, change analysis and design requirements as the root causes of a March 6 spill of uranyl nitrate solution. More specifically, the configuration control program lacked requirements to ensure that unapproved systems were isolated from operational systems, and that configuration changes, such as not implementing the operational requirements (e.g., procedures, IROFS) of a system, received a safety review. Design requirements also lacked misdirected flow prevention criteria. The inspectors concluded that correction of any of these deficiencies would have prevented the March 6 misdirected flow event. Contributing causes included inadequate procedures for operation of the enclosure components and failure to capture unusual conditions associated with yellow solution in the enclosure in the corrective action program.

6. Assessment of Licensee's Investigation and Corrective Actions

a. Inspection Scope and Observations

The inspectors reviewed the licensee's root cause investigation summary report, dated April 20, 2006, which contained the causal and contributing factors and corrective actions (CAs) for the March 6 event. The inspectors agreed with the licensee's root cause summary, but noted that nothing in the licensee's April 20 report addressed Contributing Cause 1, Procedures Less Than Adequate/Not Used (i.e., no corrective actions were identified for the contributing cause pertaining to performing activities on unapproved equipment without procedures or with inadequate procedures). Otherwise, the licensee's CAs were evaluated against the inspectors' identified root and contributing causes, as discussed below. The licensee indicated during a teleconference on May 10, 2006, that the corrective actions listed would be completed before BPF start-up. Additional corrective actions in response to this event have also been communicated to NRC and documented in separate correspondence.

Root Cause 1 - Configuration Control Program Less Than Adequate

CA 1 Engineering teams reviewed the BPF system configuration to identify unapproved operations or equipment connected to operational processes. During this review, another potentially unsafe condition was identified and reported in NRC event notification 42411. The fuel operations, OCB, and UNB areas were also reviewed.

CA 2 Revise NFS-GH-901, Configuration Management and NFS-GH-902, Operational Readiness Review procedures to require unapproved systems to by isolated from SNM-bearing systems and utilities.

CA 3 Revise NFS-HS-A-62, Implementation of NCSE, to require an inspection to verify no connections exist to any unapproved systems or equipment.

CA 4 Add a signature block to Attachment F of NFS-GH-44, "Approval For Startup," for engineers to document completion of the system inspection to ensure no connections to SNM-bearing equipment.

Root Cause 2 - Change Analysis Less Than Adequate

CA 5 Develop and implement a Verification and Validation (V&V) procedure for new systems with sufficient depth to identify configuration control issues (e.g., unapproved systems connected to the system being reviewed for startup, incorrect equipment symbols, etc.).

Root Cause 3 - Design Development Less Than Adequate

CA 6 Revise Engineering Design Guide to include the preferred practice of having SNM-bearing process lines enter a vented vessel separately so that misdirected flow paths are eliminated. If not feasible, consider other misdirected flow prevention methods.

CA 7 Inspect SNM-bearing process lines in the BPF and fuel operations areas to verify misdirected flow paths do not exist.

Contributing Cause 1 - Procedures Less Than Adequate/Not Used

No corrective actions were identified.

Contributing Cause 2 - Problem Identification and Resolution Less Than Adequate

CA 8 Retrain personnel to conservatively report to NCS any unusual holdup of SNM-bearing material as required by NFS-HS-CL-26 or CL-10.

b. Conclusions

Corrective actions for the March 6 spill event adequately addressed the root and contributing causes identified by the inspectors in Section 5 of this report with one exception. The licensee had performed or planned to perform corrective actions that would ensure: (1) configuration control requirements include isolation of SNM-bearing processes from unapproved systems; (2) configuration control changes are properly evaluated and corrected; and, (3) engineering design requirements include misdirected flow prevention as a preferred design practice for SNM-bearing process lines.

Corrective actions for Contributing Cause 2, Problem Identification and Resolution Less Than Adequate, included retraining personnel to report unusual SNM holdup to NCS. However, no corrective actions were identified for Contributing Cause 1 where activities were performed on unapproved equipment without procedures or with inadequate procedures for BPF Tray Dissolver System.

7. Exit Interview

The inspection scope and results were presented to members of the licensee management on March 17, 2006, as indicated in the Attachment. In addition, the inspectors re-exited with the licensee on May 10, 2006, to provide the SIT's assessment of the root causes and corrective actions pertaining to the event as well as the apparent violations. No dissenting comments were received from the licensee.

ATTACHMENT

1. PARTIAL LIST OF PERSONS CONTACTED

Nuclear Fuel Services, Inc.

[2]G. Athon, Jr., Principal Scientist
[1]S. Barron, Manager, Emergency Preparedness
[1,2]R. Bond, Senior Project Director, HEU Operations
[1,2]R. Booth, Vice President, Corporate Services
[2]N. Brown, Nuclear Safety Engineer
[1]B. Clouse, Health Physicist
[1]T. Coates, Engineering Section Manager
[1]D. Culberson, Licensing Manager
[1,2]R. Droke, Licensing and Compliance Director
[1,2]D. Ferguson, Chief Executive Officer
[1]K. Guinn, Advisor
[1]D. Hopson, BLEU Complex Safety and Regulatory Manager
[1]N. Kenner, Training Manager
[1,2]R. Maurer, Nuclear Criticality Safety Engineer
[1]A. Maxin, NFS Safety Consultant
[1,2]M. Moore, Vice President, Safety and Regulatory
[1,2]J. Nagy, Senior License and Regulatory Compliance Officer
[1]J. Parker, Industrial Safety Manager
[1]D. Rogers, BPF Facility Manager
[1]M. Rush, HEU Processing Manager (TapRoot® Leader)
[1]J. Schreiber, Transportation and Waste Manager
[1]K. Schutt, President and General Manager
[1,2]R. Shackelford, Nuclear Criticality Safety Manager
[1]T. Sheehan, Director, High Enriched Uranium (HEU) Operations
[1]M. Shope, Quality Assurance Manager
[2]S. Skiles, Criticality Safety Engineer
[1]M. Tester, Senior Manager, Radiological Control
[1]W. Tilson, Quality Engineering Supervisor
[1]A. Ward, General Counsel
[1]K. Weir, Security Operations Manager
[1]D. Wise, Vice President, Fuel Manufacturing
[1]J. Wheeler, ISA Manager

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

Knolls Atomic Power Laboratory

[1]T. Finan, Site Resident

Nuclear Regulatory Commission

[1]D. Collins, Region II
[1,2]D. Ayres, Region II
[1]D. Rich, Region II
[1]S. Burris, Region II

[1]Denotes those present at the exit meeting on March 17, 2006
[2]Denotes those present during the teleconference on May 10, 2006

2. LIST OF ITEMS OPENED AND CLOSED

Item Number	Status	Description
70-143/2006-06-01	Opened	APV - Failure to notify the NRC in accordance with 10 CFR 70, Appendix A, (a)(4)(ii) reporting requirements (Paragraph 2).
70-143/2006-06-02	Opened	APV - Failure to verify proper installation of the tray dissolver filter enclosure drains prior to use of the system with fissile material (Paragraph 4).
70-143/2006-06-03	Opened	APV - Failure to meet the performance requirements of 10 CFR 70.61(d) for accident sequences related to handling fissile material in the tray dissolver system (Paragraph 4).
70-143/2006-06-04	Opened	APV - Failure to meet the performance requirements of 10 CFR 70.61(d) for accident sequences related to fissile solution accumulation on the solvent extraction room floor (Paragraph 4).
70-143/2006-06-05	Opened	APV - Failure to assume that fissile solution could be misdirected from the solvent extraction feed transfer line in NCS analysis for the tray dissolver system (Paragraph 4).
70-143/2006-06-06	Opened	APV - Failure to ensure that process systems not approved for use were isolated from active SNM-bearing systems and failure to implement facility change process requirements of 10 CFR 70.72 (Paragraph 5).

70-143/2006-06-07	Opened	APV - Failure to use a valid procedure to conduct licensed activities (Paragraph 5).
70-143/2006-06-08	Opened	APV - Failure to report the events concerning the yellow solution in the 2M05 enclosure in accordance with the requirements of Section 5.1 of NFS-GH-65 (Paragraph 5).

3. INSPECTION PROCEDURES USED

IP 88003	Reactive Inspection for Events at Fuel Cycle Facilities
IP 88015	Headquarters Nuclear Criticality Safety Program
IP 93812	Special Inspection

4. LIST OF ACRONYMS USED

ADAMS	Agency Documents Access and Management System
APV	apparent violation
BLEU	Blended Low Enriched Uranium
BPF	BLEU Preparation Facility
CA	corrective action
CFR	Code of Federal Regulations
DFFI	Division of Fuel Facility Inspection
HEU	high enriched uranium
HEUN	high enriched uranyl nitrate
HP	health physicist
IP	inspection procedure
IR	inspection report
IROFS	item relied on for safety
ISA	integrated safety analysis
LEU	low enriched uranium
MORT®	Management Oversight and Risk Tree
NCS	nuclear criticality safety
NFS	Nuclear Fuel Services, Inc.
NRC	U.S. Nuclear Regulatory Commission
PARS	publicly available records
P&IDs	process and instrumentation drawings
PIRCS	Problem Identification and Correction System
RI	Resident Inspector
SIT	Special Inspection Team
SNM	special nuclear material
SOP	Standard Operating Procedure

SRI	Senior Resident Inspector
SX	solvent extraction
UN	uranyl nitrate
V&V	verification and validation