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UNITED STATES ENRICHMENT CORPORATION
PORTSMOUTH GASEOUS DIFFUSION PLANT

Pre-Decisional Enforcement Conference
Apparent Violation 2008-004-01

February 5, 2009

Agenda

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Introduction

- On September 8, 2008, USEC discovered that a partially cooled cylinder had been moved the previous day prior to completing its full cool down period.

- USEC notified the NRC Region II by phone and forwarded such detail as was currently available.

- On January 5, 2009, the NRC identified an apparent violation related to this event:

  "TSR 2.1.3.14 required that cylinders containing liquid UF6 be moved by overhead cranes or scale carts. Movement of a cylinder containing liquid UF_6 by a means other than an approved overhead crane or scale cart as required by TSR 2.1.3.14 is an apparent violation."

Introduction (cont.)

- USEC understands the seriousness of this event and has taken positive actions to enhance our existing process, provide additional controls, and reinforce site expectations.

- We have approached this event from a programmatic perspective and have reviewed implementation practices for similar Technical Safety Requirements.

- During our presentation, we will discuss the chronology of activities leading up to the event and the results of our investigation.

- Most importantly, we will also discuss our comprehensive corrective actions.

Chronology

- 10-ton normal assay cylinder PP5256 placed in X-344 Autoclave (A/C) #4 for sampling on September 4, 2008 at 2215 hours.
- Sampling completed on September 5 at 2115 hours.
- Cylinder was disconnected and Cylinder Solidification Verification Form (A-3845) was initiated at 2140 hours.
- The approximate cylinder tare weight of 4400 pounds was inadvertently entered on Form A-3845 as the liquid UF_6 net weight (actual net weight was approximately 20,650 pounds).

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Chronology (cont.)

- Based on the incorrect 4400 pound liquid UF_6 net weight and proceduralized cylinder cooling times, a two day plus one hour (49 hours) cool down time was selected in lieu of the required five day plus one hour (121 hour) cool down time.

- This resulted in an incorrect cylinder cool down expiration date/time of September 7, 2008 at 2215 hours determination.

- After independent verification of the required cylinder cool down expiration date/time, the cylinder was placed in the Liquid UF_6 Cooling Area (LUCA).

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Chronology (cont.)

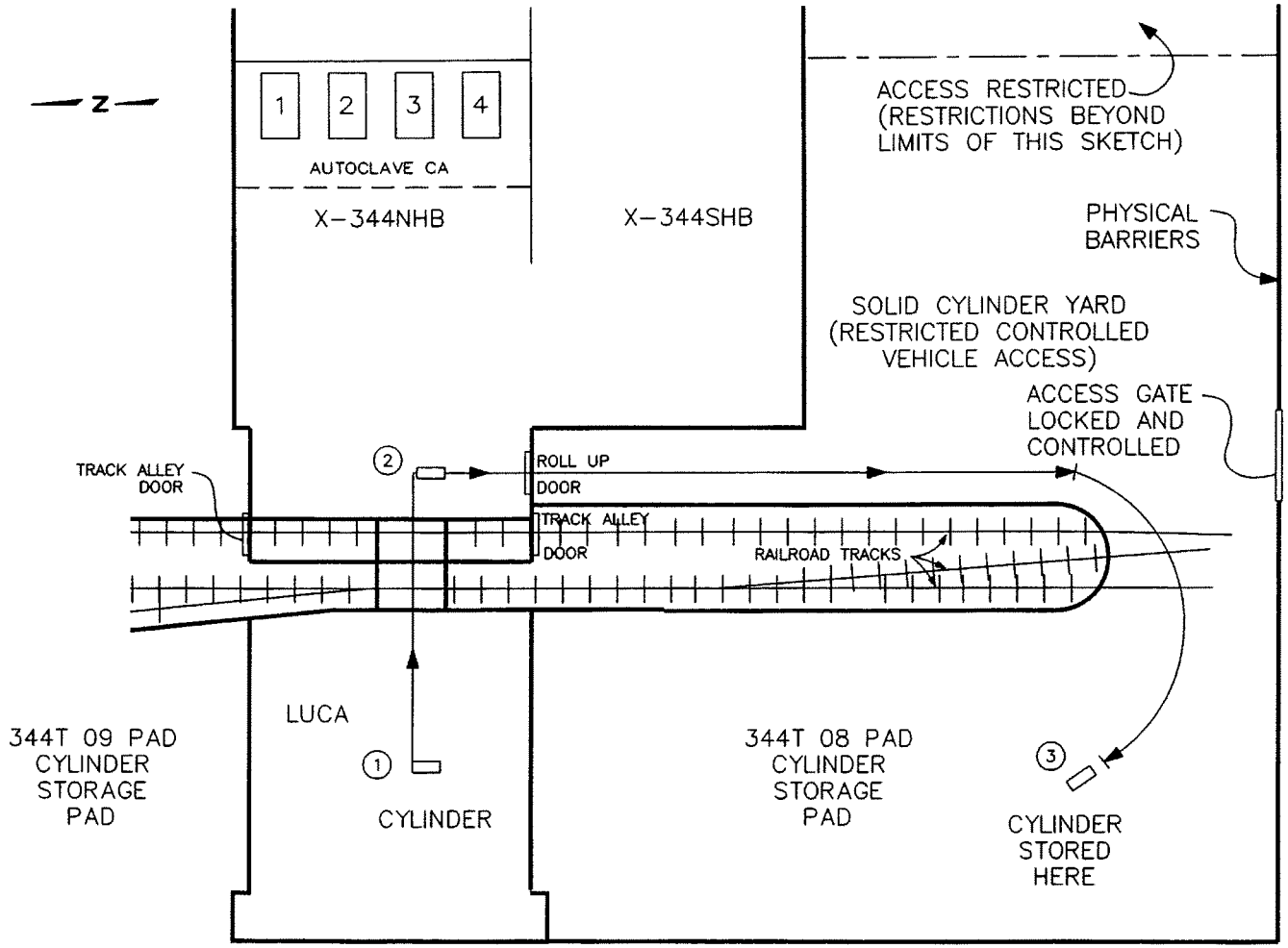
- On September 8th mid-shift one of the routine shift operations activities was performed; removing cooled cylinders from LUCA.

- Based on the incorrectly determined cool down expiration, the cylinder was removed from LUCA on September 8, 2008 between 0105 and 0130 hours (after approximately 52 hours of cooling).

- The cylinder was moved approximately 330' to 344T 08 PAD using a grapple type straddle buggy; the entire route is a concrete area used for cylinder storage isolated from routine vehicle traffic by the Vehicle Barrier System to which access was controlled.

CYLINDER PATH

Cylinder moved by straddle carrier approximately 330 ft within restricted solid cylinder handling area



① INITIAL CYLINDER LOCATION IN LIQUID UF_6 COOLING AREA (LUCA).

② CYLINDER REMOVED FROM LUCA BY BUILDING LIQUID UF_6 HANDLING CRANE.

③ CYLINDER MOVED FROM BUILDING TO CYLINDER YARD BY GRAPPLE TYPE STRADDLE CARRIER.

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Chronology (cont.)

- On September 8, 2008 (approximately 1450 hours) during a daily review the Process Engineer conducts to track cylinder evolutions, she noticed that cylinder PP5256, which she expected to be in the LUCA cooling, had been removed from the LUCA.

- The Process Engineer conferred with the Facility Manager and it was determined that a violation of TSR 2.1.3.14, "Liquid UF_6 Movement" had occurred.

- Cylinder locking devices and Lockout Tagout (LOTO) were re-installed on cylinder PP5256 at 1504 hours on September 8, 2008. A boundary was also established around the cylinder on the 344T 08 PAD.

- A temporary LUCA was approved by the Plant Shift Superintendent for cylinder PP5256 on 344T 08 PAD at 1700 hours on September 8, 2008; these conditions were maintained until the correct cool down time had elapsed.

Chronology (cont.)

- Compliance with procedure XP3-CO-UH2077, "Management of Liquid UF_6 Cylinders While Undergoing Solidification" was regained at 1700 hours on September 8, 2008 upon approval of the temporary LUCA.

- A stand down was initiated on all liquid UF_6 cylinder movement with mobile equipment on September 8, 2008. Briefings were conducted with employees working in liquid UF_6 cylinder handling areas to communicate the stand down conditions.

- Daily operating instructions for all affected areas updated to provide:
  - Independent Front Line Manager (FLM)/Process Engineer review of the amount of liquid UF_6.
  - Facility Manager authorization required prior to releasing any cylinders from a LUCA for mobile equipment handling.

Chronology (cont.)

- A training restriction was placed on the employee directly involved with the event thereby suspending all liquid cylinder operations by this individual.
- All UF_6 solidification-related forms completed by this employee since July 2008 were reviewed (no additional errors identified).
- All other cylinders removed from LUCA from September 2, 2008 to September 8, 2008 were verified as solidified prior to movement with mobile equipment.

Event Investigation

- Assembled investigation team
  - An independent investigator from the Technical Services Organization was assigned.
  - Support was provided to the investigator by the Nuclear Regulatory Affairs (NRA), Nuclear Safety, Training, and Feed Cleanup Operations Organizations.
  - NRA provided an independent review of the extent-of-condition determination which involved examination of all TSRs for the potential for similar events to occur and provided support to other areas of the investigation as requested.
  - Obtained Corrective Action Review Board approval of the investigation event cause determination and corrective actions to prevent recurrence of similar events.

Event Investigation (cont.)

- Results of the Extent-of-Condition Determination
  - All TSRs (over 100) and implementing procedures were reviewed to determine if the potential for similar incidents existed.
  - Review identified three additional TSRs with implementing procedures that required further evaluation of the need for independent verification of important parameters needed to ensure compliance with the associated TSR.

Event Investigation (cont.)

- Problem Reports were generated as a result of these findings and are being handled as separate issues under the corrective action process:
  - Daily Operating Instructions updated to provide independent verification until adequacy of procedures could be evaluated for two of the three TSRs.
  - The third TSR involved equipment that is no longer in use and the procedure that governs the operation of the equipment was placed on hold.

Cause of Event

- A transcription error by the operator led to the premature movement of a partially cooled 10-ton cylinder by mobile equipment.

- The TapRoot© investigation concluded that the root cause of the incident was the lack of independent verification of the liquid UF_6 net weight in procedure XP3-CO-UH2077, "Management of Liquid UF_6 Cylinders While Undergoing Solidification" and associated cylinder solidification verification form, A-3845.

- The investigation also identified the following contributing causes:

  - Specific proceduralized instruction on where to obtain the liquid UF_6 net weight was lacking.

  - Training on the completion of LUCA paperwork needs improvement.

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Corrective Actions

- Immediate Corrective Actions Taken
  - Cylinder locking devices and Lockout Tagout (LOTO) were re-installed on cylinder PP5256 at 1504 hours on September 8, 2008. A boundary was also established around the cylinder on the 344T 08 PAD.
  - A temporary LUCA was approved by the Plant Shift Superintendent for cylinder PP5256 on 344T 08 PAD at 1700 hours on September 8, 2008; these conditions were maintained until the correct cool down time had elapsed.
  - Compliance with procedure XP3-CO-UH2077, "Management of Liquid UF_6 Cylinders While Undergoing Solidification" was regained at 1700 hours on September 8, 2008 upon approval of the temporary LUCA.
  - A stand down was initiated on all liquid UF_6 cylinder movement with mobile equipment on September 8, 2008. Briefings were conducted with employees working in liquid UF_6 cylinder handling areas to communicate the stand down conditions.

Corrective Actions (cont.)

- Immediate Corrective Actions Taken (continued)
  - Daily operating instructions for all affected areas updated to provide:
    - Independent FLM/Process Engineer review of the amount of liquid UF_6.
    - Facility Manager authorization required prior to releasing any cylinders from a LUCA for mobile equipment handling.
  - A training restriction was placed on the employee directly involved with the event thereby suspending all liquid cylinder operations by this individual.
  - All UF_6 solidification-related forms completed by this employee since July 2008 were reviewed (no additional errors identified).
  - All other cylinders removed from LUCA from September 2, 2008 to September 8, 2008 were verified as solidified prior to movement with mobile equipment.

Corrective Actions (cont.)

- Subsequent Corrective Actions
  - The employee directly involved with the incident received a concentrated regimen of training remediation including:
    - Classroom Training in the areas of liquid UF_6 handling and LUCA operations.
    - Remedial on-the-job training on practical factors that involve placing a cylinder in and removing a cylinder from LUCA and completion of associated paperwork.
    - Three shifts of supervised duty performing LUCA-related paperwork during which the employee was accompanied by a qualified employee at all times.
    - Completion of an oral interview with the Shift FLM.
    - Completion of an oral interview with the Facility Manager.
    - Following completion of this training regimen, the employee directly involved with the incident had his training restriction removed.

Corrective Actions (cont.)

- Subsequent Corrective Actions Taken (cont.)
  - All other Uranium Material Handler employees who completed initial training qualifications during 2008 were interviewed by the Facility Manager to assess proficiency and determine whether operations could be conducted safely.
    - Review of three months of historical data indicated that no similar errors in the determination of cylinder cool down expiration date had occurred.
    - Based on the data review and assessment of proficiencies during interviews, the Facility Manager concluded that LUCA operations could be performed safely by these employees.

Corrective Actions (cont.)

- Subsequent Corrective Actions Taken (cont.)
  - Revised procedure XP3-CO-UH2077, "Management of Liquid UF_6 Cylinders While Undergoing Solidification" to provide independent verification of all parameters that could affect liquid UF_6 cylinder cool down determination. The procedure was also revised to standardize cylinder cool down time based on cylinder size. Using standard times removes the liquid UF_6 net weight vulnerability from the calculation process. Procedure revision was implemented on January 19, 2009.
  - Revised procedure XP3-CO-UH2077, "Management of Liquid UF_6 Cylinders While Undergoing Solidification" to provide specific direction on where to obtain information necessary to determine liquid UF_6 cylinder cool down expiration date and time. Procedure revision was implemented on January 19, 2009.
  - Revised Form A-3845, "Cylinder Solidification Verification" to document the independent verification of all parameters that affect liquid UF_6 cylinder cool down time. Form was revised on January 19, 2009.
  - Completed continuing training on practical factors associated with LUCA operations including paperwork. Training was completed on January 7, 2009.

Corrective Actions (cont.)

- Planned Corrective Actions
  - NRA assess the type, scope, venue and format for guidance on the requirements and application of independent verifications performed in conjunction with TSR-related and other important safety-significant activities.
    - Completion by 2/6/2009
  - NRA document findings and recommendations associated with the assessment on guidance for independent verifications and determine whether any additional corrective actions are necessary.
    - Completion by 3/6/2009
  - Training Organization review TSR-related initial and continuing training to determine whether current programs provide an adequate level of detail and rigor needed to provide the proficiency needed to perform TSR-related activities safely.
    - Completion by 3/6/2009
  - If the review of TSR-related training identifies weaknesses in the current training programs, Training Organization pursue appropriate corrective measures to address.
    - Completion by 4/6/2009

Corrective Actions (cont.)

- Planned Corrective Actions (cont.)
  - Augment Practical Factors 4066 and 4067 contained in the General UMH Qualification Standard (OMH06.01.01) to provide more emphasis on determination of cylinder cool down expiration date and time and completion of Form A-3845.
    - Completion by 4/6/2009
  - Perform an Endpoint Assessment to determine whether corrective actions were effective to prevent recurrence of similar incidents and document results.
    - Completion by 8/7/2009

TSR Basis

- Equipment reliability of straddle carriers and forklifts and road traffic conditions increase the risk of having a liquid UF_6 release. The handling of liquid UF_6 cylinders with cranes or scale carts is more reliable and therefore represents a lower risk.

TSR Basis

- Probability of a cylinder breach per movement
  - Crane movement 10x lower than straddle carrier movement
- Thousands of liquid cylinder movements per year by crane
- Thousands of solid cylinder movements per year by straddle carrier/forklift
- If moving 1000 liquid cylinders by crane, probability of liquid cylinder breach would be ~10^{-3}/yr
- If moving 1000 liquid cylinders by straddle carrier, probability of liquid cylinder breach would be ~10^{-2}/yr

Safety Significance

Key Factors in Evaluating Safety Significance

- Cylinder was partially cooled (52 hours of cooling)
- One movement with unapproved equipment before fully cooled
- Controls reestablished quickly
- Path of movement – south of LUCA and within VBS area
- About 0100 in morning
- E1 stability conditions

We will now discuss how these factors influence the overall safety significance.

Safety Significance (cont.)

Low Probability of Breach

- Grapple type straddle carrier used.
- Moved in area where cylinder cradles are not used.
- Traffic limited to cylinder handler – within VBS.
- Conservative estimated probability of drop and breach is <3 E-05 per movement. This analysis is based on the SAR and its supporting documents and is documented in USEC Engineering Evaluation.

Safety Significance (cont.)

Smaller Source Term From Breach

- Cylinder partially cooled – estimated that 59% of UF_6 was solidified.
- Solid UF_6 was on bottom of cylinder – remaining liquid was top layer.
- UF_6 at Triple Point: Pressure, 22 psia; Temperature, 147°F.
- If cylinder wall breached, solid UF_6 would initially block liquid from exiting; would likely have sealed opening.
- If all liquid was released, 41% of liquid released would flash to vapor; solid would remain at cylinder location.
- Maximum vapor source term estimated at 3500 lbs.

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Safety Significance (cont.)

Consequence Assessment

- Used maximum estimated source term, actual meteorological conditions, actual distance to site boundary and representative surface roughness.
- Calculated intake of ~3 mg soluble uranium at site boundary (<<30 mg SAR E.G.); HF concentration of ~2 ppm (<<ERPG-2 level of 20 ppm); no adverse health effects.
- Straddle carrier operator and other plant personnel; "See and Flee" would have been effective to prevent significant exposure.
  - "See and flee" is effective control credited by SAR to protect site workers in event of significant UF_6 release.
  - In 1978 event of fully liquid UF_6 cylinder drop and rupture (6 times greater than release postulated here).
    - Straddle carrier operator followed "see & flee" and received no harmful intake (<2 mg U).
    - No detectable intake to the public – no significant intakes to plant personnel.

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Safety Significance (cont.)

The conclusion of the analysis (Engineering Evaluation) is as follows:

- A cylinder drop and breach was very unlikely from the incident - estimated $<3 \times 10^{-5}$.
- Had an accident occurred, no adverse health effects would have been likely to occur to the public or plant workers.
- SAR had considered probability of such an event; overall operations remained within Certificate risk envelope.

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Safety Significance (cont.)

Assessment of Different Conditions

- Cylinder tare weight was lowest weight that could be transcribed – always have 2 days cooling time
- Consequences offsite remain below significant levels for less favorable weather conditions, release location
- More cylinder movements in less controlled areas: Probability of cylinder rupture still $<10^{-4}$.

Overall Assessment

This incident and the potential for such an event to occur during NRC Certified Operations would not have resulted in undue risk to the public or site workers; plant operations remained within the approved safety basis.

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Mitigating Factors

- USEC self-identified and self-reported the cylinder movement. Upon identification, immediate interim compensatory measures were taken.
  - Completed LOTO to re-affirm control of the cylinder.
  - Established LUCA for balance of cool down time.
  - Initiated stand-down on all movement of liquid UF_6 cylinders by mobile equipment.
  - Revised Daily Operating Instructions to provide independent review.
  - Notified Senior Fuel Facility Inspector by phone and provided copy of problem report and available information.

Mitigating Factors (cont.)

- USEC took prompt and comprehensive corrective actions.
  - Immediate corrective actions focused on restoring compliance and preventing recurrence.
  - A thorough root cause analysis of the incident was conducted.
  - Subsequent corrective actions taken to address root cause and contributing factors and to prevent recurrence.
  - Additional actions have been identified for potential improvements to USEC's overall TSR driven processes.

Mitigating Factors (cont.)

- NRC should consider the following in determining the severity of any violation:
  - No radiation or contamination was released nor was there a substantial potential for it to occur.
  - No safety related systems were inoperable.
  - No failures to establish, implement, or maintain all criticality controls existed.
  - No potential was present for significant injury or loss of life due to loss of control over a licensed activity.
    - Potential off-site consequences would have been within the SAR evaluation guidelines.
    - Potential consequences to site personnel would have been minimal.
    - Operations remained within the Certificate safety envelope.

Mitigating Factors (cont.)

- USEC does not believe that a civil penalty should be assessed for this Apparent Violation in that:
  - The incident was not willful.
  - It's been more than 2 years since any previous Severity Level III Violation.
  - The incident was self-identified and self-reported.
  - Prompt and comprehensive corrective actions were taken.