

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

Docket No: 70-7001
Certificate No: GDP-1
Report No: 70-7001/98-203
Certificate Holder: United States Enrichment Corporation
Location: Paducah Gaseous Diffusion Plant
Paducah, Kentucky
Dates: March 30 to April 3, 1998
Inspectors: Garrett Smith, Lead Inspector, NRC Headquarters
Albert Wong, Inspector, NRC Headquarters
Approved By: Philip Ting, Chief
Operations Branch
Division of Fuel Cycle Safety and Safeguards, NMSS

Enclosure

9805040318 980428
PDR ADOCK 07007001
C PDR

UNITED STATES ENRICHMENT CORPORATION
PADUCAH GASEOUS DIFFUSION PLANT
NRC INSPECTION REPORT
70-7001/98-201

EXECUTIVE SUMMARY

Areas Inspected

A NRC Headquarters team conducted an announced chemical process safety inspection of the Paducah Gaseous Diffusion Plant (PGDP) in Paducah, Kentucky, March 30 to April 3, 1998. The focus of the inspection was to review the Accident Analysis section of the Safety Analysis Report (SAR) to determine if the assumptions and controls relied on for the high risk chemical safety accidents are in place, that they match the requirements of the SAR, and that they are adequately maintained to ensure they are available and reliable. Based on a review of Section 4.3, Toxic Material Release, of the SAR, the inspectors determined that the following areas constituted risk significant uses of chemicals at PGDP and were reviewed as part of this inspection:

- Chlorine (Cl_2) systems at the four Recirculating Cooling Water (RCW) houses and Cl_2 use at the C-611 (Water Treatment) complex. Cl_2 is used in 1-ton cylinders at these areas and inventories could be as high as 8,000 pounds at the C-611-B, C-633 and C-637 Chlorinator Rooms.
- The accumulators located in the C-315 Tails Withdrawal facility. These vessels have the capacity to hold 40,000 pounds of liquid uranium hexafluoride (UF_6). The inspectors reviewed the accident analysis associated with these accumulators described in Section 4.3.4 of the SAR. The inspectors also reviewed the implementation of the compensatory measures transmitted to the NRC on March 27, 1998, regarding the potential consequences of postulated seismically induced failures in the liquid withdrawal facilities.

Results

- The Cl_2 systems inspected have been adequately evaluated to determine the risks, and the dominant controls for those risks. Although one non-cited violation (NCV) was identified in response to the failure to locate maintenance documents, the maintenance program has been established to effectively minimize the risks associated with Cl_2 gas use onsite.
- Two unresolved items (URIs) were opened due to apparent weaknesses in the "as-exists" plant conditions regarding the accumulators. Based on the information generated by the regulatee regarding these URIs, an evaluation will be made to determine if NRC requirements were violated.

Report Details

1. High Risk Chlorine (Cl_2) use at PGDP

a. Inspection Scope

The inspectors reviewed Cl_2 use on site at the C-631, C-633, C-635, and C-637 RCW Pump House; and at the C-611 Water Treatment facility. This review was a verticle slice of the entire Cl_2 risk control process to ensure that:

1. The accident analysis, Process Safety Information (PSI) and Process Hazards Analysis (PHA), were effective in evaluating the risks associated with Cl_2 use, and established adequate controls to control these risks.
2. Operations personnel were knowledgeable of the risks associated with these systems, and procedures were effective and properly implemented the relied on administrative controls to minimize the risks.
3. Maintenance activities were effective and properly implemented to ensure the controls relied on in the safety basis would be available and reliable in the future.

b. Observations and Findings

Section 4.3.7.1.10 of the SAR, Chlorine System Ruptures, states that the Cl_2 systems were evaluated as part of the OSHA Process Safety Management (PSM) program to identify potential accidents. Table 4.3-12, Summary of Potential Cl_2 Accidents, states that as much as 2,000 pounds of Cl_2 could be released in 10 minutes as a result of a cylinder rupture in the RCW Pump House or in the C-611 Chlorinator Rooms.

The OSHA PSM program utilizes PSI and PHA documents to evaluate highly hazardous chemical systems and determine the safety basis associated with those systems. Specifically, PGDP has developed the following documents, that were reviewed as part of this inspection:

- Document KY/S-257, Revision 2, "Paducah Gaseous Diffusion Plant Process Safety Information for the Water Treatment Plant, Pump House Chlorination Systems, and Cl_2 Container Storage Yards," dated October 1997.
- Document KY/S-263, Revision 1, "Paducah Gaseous Diffusion Plant Process Hazards Analysis for Water Treatment Plant and Pump House Chlorination Systems," dated May 1996.

The PSI document adequately defines the Cl_2 process and equipment. This document also clearly defines the toxicity information, permissible exposure limits, and physical and reactivity data for chlorine. In general, the document is effective in determining the

risks that are associated with chlorine and identifies the process equipment (i.e., controls) that are needed to prevent and/or mitigate the release of this highly hazardous chemical.

The PHA further evaluates the Cl_2 systems and effectively addresses the hazards posed by the handling and storage of chlorine at PGDP, and the systems used to control these hazards and the consequences associated with a chlorine release.

The inspectors toured the chlorination rooms at C-611B, and C-635 to verify that operations personnel were knowledgeable of the risks associated with these systems and the procedures and practices were effective and properly implemented the relied on administrative controls documented in the PSI and the PHA. In general, procedures were adequate and when questioned by the inspectors, operations personnel exhibited adequate knowledge of the risks associated with Cl_2 , the dominate controls that were in place to minimize those risks, and the actions that they were tasked to complete as part of normal and abnormal operations to properly implement those controls.

On March 25, 1998, the chlorine sensor in C-635-1 detected a chlorine leak and sounded the alarm. During response activities, the chlorine concentration in the air was determined by a hand held chlorine meter to be around 2-3 ppm. The next day the chlorine alarm again sounded when personnel were checking the pigtail between the chlorine cylinder and the piping. The operator immediately evacuated from the room. No chlorine could be detected in the air by the hand held chlorine meter. In both incidents, plant personnel took the correct steps to respond to the alarms. Additionally, when questioned by the inspectors, the plant personnel correctly identified the precautionary steps to be taken prior to entering the Chlorine Room.

Due to the safety significance, the chlorine detection systems at each facility have alternative power sources. The 611 Water Plant is equipped with a diesel generator to provide back-up power upon power failure. When questioned as to what actions are taken in the event of a power failure, operations personnel indicated the diesel generator would be started per procedure CP4-CU-UW2403, "Operation of C-611 Emergency Diesel Generator." The RCW Pump Houses, on the other hand, do not have a diesel generator as back-up power. They receive power from two different sources. When the power from the primary source is lost, the operator manually energizes the secondary source to restore power.

In general, all chlorine augmented quality components received timely maintenance. No overdue maintenance activities were discovered. The only exception was the chlorine piping ultrasonic test (see next paragraph for detailed discussion). The Chlorine alarm system was calibrated per CP4-GP-IM6111, "Calibration and Functional Testing of the C-611-B, C-611-S, C-615, and RCW Pump House Chlorine Gas Detectors." The data sheet indicated the alarm had met the calibration frequency requirements, and the results had been properly reviewed by Maintenance, Operations, and Engineering.

The Mechanical Integrity (MI) program [29 CFR 1910.119(j)] requires piping systems to be inspected according to a frequency, consistent with good engineering practices. Per the regulatee's maintenance requirement, defined in procedure CP2-EG-EG1047, "Mechanical Integrity Program - Piping Systems, Rev. 0, dated April 3, 1998, all chlorine piping shall be ultrasonically tested (UT) semiannually to determine the pipe thickness. The entire chlorine piping was first base-lined by an outside contractor in July 1996 and then repeated by onsite technicians on May 30, 1998. The onsite technician manager, and the systems engineer both recalled that a second UT had been completed in October 1997. However, no inspection document could be located. Upon learning the fact that the second UT test results were missing, facility management immediately initiated inspection of the piping, compared the data to previous inspection results, and found no pipe thinning had occurred. The six-month inspection interval resumed by PGDP for steel piping is substantially more conservative than the industry practice, which is normally once every three to five years for steel piping. Due to the fact that the facility has a higher than-normal inspection frequency and no pipe thinning was detected, the misplacement of these maintenance records constitute a violation of minor safety significance. Hence, it is treated as **NCV 70-7001/98-203-01**, consistent with Section IV of the NRC Enforcement Policy.

c. Conclusion

In general, the Cl_2 systems inspected have been adequately evaluated to determine the risks, and the dominant controls for those risks. Although one NCV was identified in response to the failure to locate maintenance documents, the maintenance program has been established to effectively minimize the risks associated with Cl_2 gas use onsite.

2. Liquid UF_6 Accumulators

a. Inspection Scope

The inspectors reviewed the liquid UF_6 system in the C-315 Tails Withdrawal facility. The accumulator vessels in this process have the capability to store the largest volume of liquid UF_6 onsite and, therefore, pose a significant chemical safety risk. Specifically, the inspectors focused on reviews of the accident analysis to assure that the controls outlined in Chapter 4.3 of the SAR were consistent with the "as exists" conditions in the plant.

b. Observations and Findings

The inspectors toured the C-315 building, specifically focusing on the UF_6 piping and equipment from the Normetex pumps to the liquid cylinders. The discharge Normetex pumps have several safety features to help ensure the safe handling of hazardous, high pressure, UF_6 . During this inspection, two Technical Safety Requirements (TSR), covering safety systems, were evaluated to determine the effectiveness of these safety devices in controlling the risks associated with high pressure UF_6 and to determine if the "as exists" conditions of the safety features were consistent with the TSRs and safety basis.

Safety Limit (SL) 2.3.2.1 states that the Normetex pump discharge bellows pressure shall not exceed 45 psia. The Normetex pumps are positive displacement pumps and could, if a discharge valve was inadvertently closed, build excess pressure in the discharge line. The discharge piping of these pumps have expansion joints that are only rated to 45 psia. The Limiting Control Setting (LCS) ensures that the discharge pressure does not exceed 42 psia. The pump's high discharge pressure system limits automatically trips the pump at 42 psia to ensure the SL of 45 psia is not reached. This safety system is calibrated and functionally tested annually.

TSR 2.3.4.3 defines the Normetex pump UF_6 release detection system. This system is important, in that it shuts down the Normetex pump, if a release of UF_6 is detected by two adjacent detector heads. The system is functionally tested annually by activating each combination of two adjacent detector heads with "smoke" to ensure that the pump discharge valves close and the pump trips. These actions will minimize the release and place the system in a safe condition.

The inspectors noted that the two safety systems reviewed appeared adequate to effectively implement the safety controls relied on in the SAR. Also, the "as-exists" conditions of these safety systems matched the descriptions in the SAR and TSRs, and there was no evidence that any surveillance requirements were missed over the last year. Finally, the inspectors noted that the performance of functional tests adequately "tested" the safety systems to ensure proper function in the event of an actuation.

Both of the reviewed safety systems rely on plant electrical power to operate. During a loss of electrical power to the C-315 building, these safety devices would no longer function. Additionally, Normetex pumps would no longer operate. Therefore, in effect, the system would essentially fail safe during the loss of power event.

Next, the inspectors focused on the two 10-ton nickel-lined steel accumulators located down stream from the condensers in the Tails Withdrawal facility. These vessels are available as a surge space to temporarily store liquid UF_6 , if needed during a cylinder charge or other flow upsets to the system. Specifically, the inspectors reviewed the system to compare the "as-exists" conditions to those expected and documented in Chapter 4.3, Toxic Material Release, of the SAR.

Section 4.3.3.1.2 of the SAR states that the UF_6 accumulators are built in accordance with the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code, Section VIII, that was in effect at the time of fabrication. It also states that they are inspected at five-year intervals in accordance with the current edition of the National Board of Inspection Code (NBIC).

The inspectors noted, and USEC personnel agreed, that the current "as-exists" configuration of the accumulators in C-315 was not in compliance with the 1995 (Version A) of ASME B&PV. Furthermore, plant personnel stated that the version of this code that was in place when the vessel was fabricated was not available onsite and therefore, compliance with that version could not be readily established. The ASME B&PV code requires pressure relief devices as an important safety feature for any

pressure vessel. These devices are not intended to control the pressure in the system during normal operations. Instead, they are intended to function when normal operating controls fail or abnormal system conditions are encountered. Additionally, since the current configuration of the accumulators does not include pressure relief devices, no inspection of these devices has ever occurred as required by NBIC.

On March 27, 1998, USEC transmitted a letter to the Office of Nuclear Material Safety and Safeguards, concerning PGDP potential consequences of postulated seismically induced failures in the liquid withdrawal facilities. This letter included the "Justification for Continued Operations (JCO) 98-01," Rev. 1.

The inspectors reviewed the JCO compensatory measures associated with this JCO to ensure their effectiveness in maintaining the accumulators within the seismic accident analysis chemical inventory limits and evaluated their proper implementation. Based on this review and several interviews with area operations personnel and the Plant Shift Superintendent's office, it appears that these compensatory measures should, if properly implemented, maintain the liquid UF_6 inventories in the C-315 accumulators at less than 10,000 pounds.

Appropriate implementation of these compensatory measures ensures that one accumulator in the C-315 building will remain empty while the other remains less than half full (i.e., less than 10,000 pounds). Also, current operational procedures require that a vent line be maintained open to the Hortonsphere. These current operating conditions provide adequate safety to help ensure that the vessel will not experience unacceptable pressure increases, but **URI 70-7001/98-203-02** has been opened, so that the regulatee can address the following questions (for each accumulator in C-310 and C-315).

1. What were the code (ASME) requirements for these vessels when they were designed and built, and what are they as they currently exist?
2. In accordance with ASME B&PV requirements for Pressure Relief (PRel) Devices, what specific relief mechanism is PGDP utilizing and why does this meet the code? Any valves in the line between the vessel and the relief device and its requirements (i.e., locked, opened) should also be addressed. The use of support utilities to operate parts of the PRel Device and the code requirement associated with such utilities should also be addressed.
3. What surveillance, tests, calibration, and maintenance programs were in place or will be in place to meet the requirements of the National Board of Inspection Code?

Next, the inspectors reviewed the accident scenarios described in Section 4.3.4.1.2 and 4.3.3.1.2 of the SAR. These sections describe a leak in the drain line to the accumulators that could result in a leak of liquid UF_6 , but in no case would that leak be greater than 1,000 pounds. The inspectors noted that this accident scenario appeared to be inaccurate, in that a break in the drain line could possibly release more than 1,000 pounds. Once again the compensatory measures outlined in JCO 98-01, Rev. 1 will, if properly implemented, maintain the liquid UF_6 levels in the accumulators at less than the

analyzed release for a seismic event, therefore, bounding this event. **URI 70-7001/98-203-03** has been opened to evaluate the actions taken by the regulatee given the above mentioned sections of the SAR contain discrepancies.

c. Conclusions

The inspectors noted that the sampling of TSR related safety systems evaluated appeared adequate to effectively ensure acceptable risk levels associated with the operations of the Normetex pumps.

Two URIs were opened due to apparent weaknesses in the "as-exists" plant conditions regarding the accumulators. Based on the information generated by the regulatee regarding these URIs, an evaluation will be made to determine if NRC requirements were violated.

3. Closeout of Previously Identified Items

Inspector Followup Item (IFI) 97-202-01 (Closed)

During a previous inspection, it was noted that the Accident Analysis section of the SAR (4.3.7.1.7) did not accurately describe the nitric acid concentration that was used onsite. Specifically, the SAR quoted 50% nitric acid, when in fact 68% is used onsite. This was of concern because the higher the concentration of nitric acid the greater the health and safety risk if a release occurred. Also, the concentration described in the Emergency Plan was lower than the actual acid concentration used onsite. To close this IFI, the regulatee performed a 10 CFR 76.68, Plant Change Review. This review adequately addressed the concerns documented in the IFI and changes to the SAR and Emergency Plan were properly implemented. This IFI should be considered closed.

Inspector Followup Item (IFI) 97-202-02 (Closed)

During a previous inspection, a discrepancy was noted in that the alarm for the C-350 ClF_3 building annunciated in the C-300 building (main control room), whereas the alarm for the C-410K F_2 facility did not. Engineering performed an analysis and determined that the existing alarm features were adequate to alert local personnel of a F_2 release. This review adequately addressed the concerns documented in the IFI. This IFI should be considered closed.

Inspector Followup Item (IFI) 97-202-03 (Closed)

During a previous inspection, it was not clear what controls were in place to control the computer and software used to calculate the pounds of F_2 in the storage tanks. During this inspection, the computer and software program was reviewed to determine the engineering accuracy of the equations used. Additionally, procedure CP2-EG-EG1035, "Engineering Software Control," was reviewed to evaluate the effectiveness of this procedure in controlling the F_2 calculation program. Based on inspector reviews yielding acceptable results, this IFI is considered closed.

Inspector Followup Item (IFI) 97-202-04 (Discussed)

During a previous inspection, it was noted that a new C1F₃ detection and alarm system was being installed in the C-350 building. The inspectors noted that the new system was declared operational on March 13, 1998. The inspectors will review this new system to assure its effectiveness during a future inspection, therefore this item will remain open.

Inspector Followup Item (IFI) 97-202-05 (Discussed)

During a previous inspection, it was noted that the Job Hazard Analysis (JHA) program described in procedure CP2-SH-IS1057 was not being adequately implemented onsite. Additionally, the plant managers from both sites committed to modify the JHA programs at both sites to better evaluate the hazard potential of work activities. The inspectors noted that a new procedure, UE2-SH-IS1038, "Job Hazard Analysis Program," was issued on December 23, 1997, to document the new JHA program for both sites. The inspectors will review this new program to assure its effectiveness during a future inspection, therefore this item will remain open.

4. Exit Meeting Summary

The inspector presented the inspection results to members of the plant staff and management at the conclusion of the inspection on April 3, 1998. The plant staff acknowledged the findings presented. The regulatee did not identify any of the information discussed at the meeting as proprietary.

ITEMS OPENED, CLOSED, AND DISCUSSED

Opened

70-7001/98-203-01	NCV	Failure to maintain maintenance records for UT of chlorine piping systems.
70-7001/98-203-02	URI	The SAR states that the UF_6 accumulators are in accordance with the ASME B&PV Code, Section VIII, that was in effect at the time of fabrication. The SAR states that accumulators are inspected at five-year intervals in accordance with the current edition of the NBIC. The regulatee could not demonstrate code compliance, therefore a URI was opened.
70-7001/98-203-03	URI	Section 4.3.4.1.2 and 4.3.3.1.2 of the SAR describe a leak in the drain line to the accumulator that could result in a leak of liquid UF_6 , but in no case would that leak be greater than 1,000 pounds. The inspectors noted that this accident scenario appeared to be inaccurate in that a break in the drain line could possibly release more than 1,000 pounds.

Closed

70-7001/97-202-01	IFI	The Accident Analysis section of the SAR (4.3.7.1.7) did not accurately describe the nitric acid concentration that was used onsite. During this review, the inspectors determined that the regulatee adequately addressed the concerns documented in the IFI, and changes to the SAR and Emergency Plan were properly implemented.
70-7001/97-202-02	IFI	The alarm for the C-350 ClF_3 building annunciated in the C-300 building (main control room) where as the alarm for the C-410K F_2 facility did not. Engineering performed an analysis and determined that the existing alarm features were adequate to alert local personnel of a F_2 release. This review adequately addressed the concerns documented in the IFI.
70-7001/97-202-03	IFI	A program was not in place to control the computer and software used to calculate the pounds of F_2 in the storage tanks. During this inspection, the computer and software program was reviewed to determine the engineering accuracy of the equations used. Additionally, procedure CP2-EG-EG1035, "Engineering Software Control," was reviewed to evaluate the effectiveness of this procedure in

controlling the F_2 calculations computer and software. Based on inspector reviews yielding acceptable results, this IFI was closed.

Discussed

70-7001/97-202-04	IFI	A new alarm system was being installed in the C-350 building. The inspectors noted that the new system was declared operational on March 13, 1998. The inspectors will review this new system to assure its effectiveness during a future inspection and therefore this item will remain open.
70-7001/ 97-202-05	IFI	The JHA program defined in procedure CP2-SH-IS1057 was not being adequately implemented onsite. Additionally, the plant managers from each site committed to upgrade the JHA programs at both sites. The inspectors noted that a new procedure UE2-SH-IS1038, "Job Hazard Analysis Program," was issued on December 23, 1997, to implement the JHA program for both sites. The inspectors will review this new program to assure its effectiveness during a future inspection, therefore this item will remain open.

LIST OF ACRONYMS USED

ASME	American Society of Mechanical Engineers
B&PV	Boiler and Pressure Vessel
Cl ₂	Chlorine
JCO	Justification for Continued Operations
JHA	Job Hazard Analysis
LCS	Limiting Control Setting
MI	Mechanical Integrity
NBIC	National Board of Inspection Code
NCV	Non-Cited Violation
NRC	Nuclear Regulatory Commission
PGDP	Paducah Gaseous Diffusion Plant
PHA	Process Hazards Analysis
PRel	Pressure Relief
PSI	Process Safety Information
PSM	Process Safety Management
RCW	Recirculating Cooling Water
SAR	Safety Analysis Report
TSR	Technical Safety Requirements
UF ₆	Uranium Hexafluoride
URI	Unresolved Item
UT	Ultrasonically Tested

PARTIAL LIST OF PERSONS CONTACTED

G. Smith	NRC	NRC-HQ
A. Wong	NRC	NRC-HQ
J. Jacobson	NRC	Resident Inspector
K. O'Brien	NRC	Resident Inspector
L. Jackson	USEC	Nuclear Regulatory Affairs
S. Penro	USEC	Nuclear Regulatory Affairs
S. Cowne	USEC	Nuclear Regulatory Affairs
L. Albritton	USEC	Nuclear Regulatory Affairs
D. Stadler	USEC	Nuclear Regulatory Affairs
S. Shell	USEC	Environmental Safety and Health
K. Potter	USEC	Industrial Health and Safety
T. Reynolds	USEC	Industrial Health and Safety
D. Snow	USEC	Industrial Health and Safety
K. Willett	USEC	Engineering and Maintenance
H. Anderson	USEC	Engineering and Maintenance

- All personnel listed attended the exit meeting.