Augmented Inspection Team Report - Portsmouth Fire

February 16, 1999

Mr. J. L. Adkins
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Two Democracy Center
6903 Rockledge Drive
Bethesda, MD 20817

SUBJECT: NRC REGION III AUGMENTED INSPECTION TEAM REVIEW OF THE DECEMBER 9, 1998, FIRE AT THE PORTSMOUTH GASEOUS DIFFUSION PLANT (INSPECTION REPORT 070-7002/98019(DNMS))

Dear Mr. Adkins:

The enclosed report refers to a special review by an NRC Augmented Inspection Team (AIT) from December 9, 1998, through January 8, 1999, relative to the December 9, 1998, fire in the Side Purge Cascade. The AIT was composed of Messrs. Kenneth O'Brien (Team Leader), David Hartland, and Courtney Blanchard of this office, and Charles Cox, Rex Wescott, and Albert Wong of the Office of Nuclear Material Safety and Safeguards (NMSS). The report also refers to the follow-up activities of your staff and to a discussion of our findings with you and others of your staff at a public meeting on February 5, 1999.

The enclosed copy of our AIT report identifies areas examined during the inspection. Within these areas, the inspection consisted of a selective examination of procedures and representative records, observations, and interviews with personnel.

The AIT was formed to assess information regarding the December 9, 1998, fire involving the Side Purge Cascade. Specifically, the AIT examined the circumstances surrounding the fire, the plant staff's response to the fire, and the root causes for the fire. The AIT determined that the fire's immediate safety consequences were minimal, since your staff promptly responded to the fire and provided adequate protection to site personnel and the public. However, several problems were identified regarding: 1) the training and immediate actions of some operations staff; 2) pre-fire planning and training provided to firefighting staff; 3) procedures for implementing the Emergency Plan and training provided to some

management staff; and 4) the timeliness and completeness of some of the initial compensatory and corrective measures implemented following the fire. The AIT concluded that your initial efforts to determine the root causes of the event appeared appropriate and included a consideration of corrective measures, recommended following previous similar events, that may not have been fully implemented.

It is not the responsibility of an AIT to determine compliance with NRC rules and regulations or to recommend enforcement actions. These aspects will be reviewed in a subsequent inspection.

In accordance with 10 CFR 2.790 of the Commission's regulations, a copy of this letter and the enclosed inspection report will be placed in the NRC Public Document Room.

Sincerely,

/s/ J. L. Caldwell for

James E. Dyer
Regional Administrator

Docket No. 070-7002
Certificate No. GDP2

U. S. NUCLEAR REGULATORY COMMISSION

REGION III

AUGMENTED INSPECTION TEAM

Docket No: 070-7002

Certificate No: GDP-2

Report No: 070-7002/98019(DNMS)

Facility Operator: United States Enrichment Corporation

Facility: Portsmouth Gaseous Diffusion Plant

Location: 3930 U.S. Route 23 South
P.O. Box 628
Piketon, Ohio 45661-0628

Dates: December 9, 1998, through January 8, 1999

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EXECUTIVE SUMMARY

Portsmouth Gaseous Diffusion Plant

NRC Inspection Report 070-7002/98019(DNMS)

During routine operations on the morning of December 9, 1998, operations staff observed a series of abnormal conditions associated with the Side Purge Cascade, Cell 25-7-2. The operations staff's immediate response to the abnormal conditions was not successful in restoring normal operations and an exothermic reaction was either started or propagated within the cascade. The exothermic reaction continued until sufficient heat was generated

to cause a failure of the Cell 25-7-2 cooling system, initiating a second exothermic reaction. Subsequent heat and pressure increases within the Side Purge Cascade resulted in: 1) the creation of holes within the process gas cascade boundary of Cell 25-7-2; 2) an automatic shutdown of the Side Purge Cascade; 3) the activation of a portion of the Building X-326 automatic fire suppression sprinkler system; 4) an emergency response and approximately two hours of firefighting activities by the onsite fire department; and 5) challenges to the continued operation of the remainder of the process gas cascade.

The radiological and chemical consequences of the event on plant staff were minor and well within applicable NRC requirements. Smoke inhalation, experienced by a few operational staff, and minor injuries, incurred by some of the emergency responders as a result of slipping on spilled lubricating oil, were treated at the onsite medical facility. No radiological or chemical consequences to the general public resulted from the event.

Following the initial indications of abnormal conditions within the Side Purge Cascade and the fire protection system sprinkler alarm, the plant emergency staff promptly responded to Building X-326. Over the next two hours, the firefighters extinguished fires which were internal and external to the cell housing surrounding Cell 25-7-2. During the response, the firefighting efforts were complicated as a result of: 1) operations staff's failure to isolate the hydraulic control oil supply to Cell 25-7-2; 2) low fire water pressure to foam eductors which precluded the use of foam as an extinguishing agent; and 3) weaknesses in the emergency responders' understanding of the proper techniques for fighting a fire concurrent with holes in the process gas equipment. Management's response to and oversight of the fire was also negatively impacted by weaknesses in the Emergency Plan Implementing Procedures which caused, in part, the event not to be classified as an "Alert," and the Emergency Operations Center to not be activated. Some communications between the emergency responders and management were ineffective and contributed to management not fully realizing the scope and consequences of the fire approximately six hours after the fire was extinguished. The plant staff also did not make notifications to local and state officials during the emergency response.

Following the emergency response, the certificatee appointed a recovery team to: 1) identify immediate compensatory and corrective measures; 2) determine root causes for the fire; and 3) develop long-term corrective actions. The recovery team was composed of site staff with appropriately diverse backgrounds. The initial recovery team's efforts were noted to be hampered by: 1) an assignment of personnel to the team on a part-time basis; 2) a lack of clear priorities for the team; and 3) an incomplete summary of the conditions existing prior to and immediately following the fire. As a result, some safety significant problems were not immediately addressed. As of the end of the inspection, the certificatee had not determined the root causes for the fire or the long-term corrective actions necessary to preclude a recurrence. However, interim corrective measures had been implemented to minimize the potential for and consequences of a future event.

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Report Details

1.0 Purpose of Augmented Team Inspection

Following an initial review of a December 9, 1998, fire involving the Side Purge Cascade (SPC), the NRC formed an Augmented Inspection Team (AIT) to examine the circumstances surrounding the event. The AIT Charter included evaluations of plant equipment performance, plant personnel response to the event, the effectiveness of the certificatee's root cause investigation, and the effectiveness of associated corrective actions. The AIT Charter is included as Attachment 1 to this report.

2.0 System Description

The SPC is an interconnected arrangement of low and high speed motors, compressors, and converters located in the south end of Building X-326. Auxiliaries, such as lubricating and hydraulic control oil, are also associated with the SPC. The purpose of the SPC is to separate, in the converters, low molecular weight gases ("lights") from the process gas (uranium hexafluoride) and to remove the light gases from the cascade. The light gases consist of oxygen, nitrogen, fluorine, and chlorine trifluoride which have either leaked into the process gas cascade or were placed into the cascade following the completion of off-line cell maintenance activities, such as unplugging or drying. The light gases are extraneous to the overall enrichment function of the process gas cascade.

The SPC components are organized into five smaller groupings of equipment called "cells." Each cell consists of six motors, compressors, converters, and associated piping. The cells are further organized into smaller groupings termed "stages." A stage consists of a single motor, compressor, converter and associated piping. The SPC is connected to and operates as a part of the overall process gas cascade. The SPC receives an input gas flow from the process gas cascade and provides output gas flows to an atmospheric vent and back to the process gas cascade. The SPC input gas flow is normally received in Cell 25-7-2, Stage 4 and consists of process gas (uranium hexafluoride) and light gases. The SPC output gas flow to the atmospheric vent normally leaves from Cell 25-7-10, Stage 6 and consists almost exclusively of light gases. The SPC output gas flow back to the process gas cascade normally leaves from Cell 25-7-2, Stage 1 and consists almost exclusively of process gas (uranium hexafluoride).

3.0 Event Description [Charter Item No. 1]

The event description and sequence of events were independently developed and validated by the inspectors based upon:

- a review of area and main control room logs, fire department and emergency response logs, operator round sheets, and other plant documents;
- interviews with operations, emergency response, and management personnel; and
- walkdowns of the areas and equipment involved in the fire.

(A detailed sequence of events is included as Attachment 2 to this inspection report.)

On December 9, 1998, the Portsmouth Gaseous Diffusion Plant experienced a significant fire in the first cell of the SPC. The first indications of abnormal equipment operation occurred a few minutes after 6:00 a.m. when a Building X-326, Area Control Room 6 (ACR 6) operator observed a momentary high current demand (load swing) by Cell 25-7-2, Stage 2 motor and received a high load alarm. The operator responded to the alarm by closing the SPC vent control valve in an attempt to regain control of the gas flow. A minute or two later, the Stage 2 motor load meter again indicated a high load condition. The associated load alarm was followed by an automatic shutdown of Cell 25-7-2, at which point the operator attempted to isolated the affected cell from the rest of the cascade. Shortly thereafter, three additional SPC cells also indicated a high load condition.

While a Building X-326 operator and a front-line manager (FLM) investigated the cause of the unexpected load swing and took actions to isolate the SPC from the remainder of the process gas cascade, the main control room, located in Building X-300, and the plant fire department received a water flow alarm for Sprinkler System No. 462 in Building X-326. Almost simultaneously, an operator in the nearby steam plant contacted the main control room to report smoke coming from the south end of the building. The Plant Shift Superintendent initiated an emergency response and reported to the scene to assume overall responsibility for the response effort as the Incident Commander (IC). The IC and the plant fire department staff arrived at the scene and established a control point at approximately 6:15 a.m. The firefighters and an operator entered the cell floor to observe the status of the equipment and reported heavy smoke. As a result, the IC ordered a recall of all plant staff in the building to the area control rooms. The large amount of smoke in the south end of the building necessitated an evacuation of ACR 6.

The plant firefighters entered the cell floor with hazardous materials protective gear and reported flames as high as 20 feet from compressor motors associated with Cell 25-7-2 and a large amount of oil and water on the floor. The firefighters set up hoses and applied water to the fire present outside the cell housing. The IC ensured that the power to Cell 25-7-2 was disconnected. At approximately 7:15 a.m., the firefighters opened a door on the south end of the cell and directed water onto the fire within the cell housing. Shortly thereafter, the firefighters reported that hydraulic oil to the control valves within the cell may not have been isolated. At 7:30 a.m., the firefighters reported that the flames had been extinguished and that holes were visible in the process gas cascade piping. The firefighters left the area to discuss with the IC and other plant staff the potential for nuclear criticality concerns associated with the continued use of water (moderator) in the vicinity of open process components.

After discussions with the IC and nuclear criticality safety staff, the firefighters re-entered the building at 7:50 a.m. to cool down possible hot spots. The firefighters also isolated Sprinkler System No. 426 and established a three-hour fire watch. However, the IC did not ensure implementation of a nuclear criticality safety staff recommendation that holes in the process gas cascade equipment should be covered and an inert buffer initiated for the cell, as soon as possible. The nuclear criticality staff's latter recommendation was intended to prevent further moderation of any potential uranium deposits located within Cell 25-7-2. The hydraulic oil supply was isolated and the fire was declared extinguished at approximately 8:17 a.m. After the fire was declared out, the operators re-entered ACR 6 and resumed their duties. The emergency response activities were discontinued and recovery efforts were started.

4.0 Immediate Actions During and Following Event [Charter Item No. 2]

- Inspection Scope

The inspectors evaluated the certificatee's actions during and following the event including the immediate response to the event; the implementation and adequacy of the emergency response plan and procedures; and management's response. The evaluation was accomplished based upon:

- a review of area control room (ACR), plant shift superintendent (PSS), cascade coordinator (CC), and emergency response logs; the Emergency Plan (EP); and Emergency Plan Implementing Procedures (EPIPs);
- interviews with personnel directly involved with the fire fighting, emergency response, and recovery efforts; and
- observation of the certificatee's emergency response and recovery efforts.

- Observations and Findings

Cascade Operations Response

Early on the morning of December 9, 1998, a Building X-326, ACR 6 operator noticed a momentary high load condition on Cell 27-5-2, Stage 2, as indicated by a high motor current reading and load alarm. Immediately following the initial indications of a high load condition, the ACR 6 operator closed the SPC vent control valve. The operator's action was based upon a belief that the high load condition was caused by an excessive amount of freon coolant entering the cell. Closing the SPC control valve was expected to: 1) isolate the SPC output to the atmosphere; 2) cause a buildup of light gases in the SPC; and 3) force the suspected heavier freon coolant gases out of the SPC and back into the process gas cascade. During the next few minutes following closure of the control valve, the ACR 6 operator noted several additional indications of high load conditions on Cell 27-5-2, Stage 2. The recurring high load indications concluded when all of the Cell 25-7-2 stages exhibited a momentary high load condition and automatically shut down. In response to the automatic cell shutdown, the ACR 6 operator attempted to isolate the cell by pressing the "cell-off-split" button located in ACR 6. The "cell-off-split" button normally closes the motor-operated valves associated with an individual cell and reroutes the process gas flow to the next upstream cell in the cascade.

The inspectors evaluated the ACR 6 operator's actions immediately following the initial indications of high load conditions on Cell 25-7-2, Stage 2. The inspectors noted that the ACR 6 operator's initial response to the high load conditions and load alarm was not guided by alarm response procedures and appeared inconsistent with some plant procedures. Specifically, Cascade Off-Normal Procedure XP4-CO-CA3900C, Revision 0, "Control of Damaged Centrifugal Compressors," required the immediate shut down of a compressor experiencing "excessive" stage overloading. The procedure further indicated that a failure to immediately shut down the compressor could result in a buildup of excessive internal heat and the initiation of an exothermic reaction between the hot aluminum components and the process gas (uranium hexafluoride). The procedure did not define the term "excessive." Through followup discussions with operations staff, the inspectors determined that the operations staff did not have a consistent understanding of the term "excessive." The inspectors also noted that the ACR 6 operator's assessment of the possible cause for the high load condition was inconsistent with the mixture of gases being compressed at Stage 2. Specifically, the introduction of high concentrations of freon coolant to Stage 2 would result in a load decrease due to the normal presence of high concentrations of process gas (uranium hexafluoride), a heavy gas. Also, initial indications of high freon concentrations would normally have first occurred in Stage 4, the first stage to receive gases from the remainder of the cascade.

Shortly after Cell 27-5-2 automatically shut down, the FLM for the area arrived in ACR 6 and assisted the operator in isolating the SPC and the Top Purge Cascade from the remainder of the process gas cascade. The FLM and the ACR 6 operator then proceeded to evacuate ACR 6, through tunnels located under the building, due to smoke entering ACR 6. The inspectors noted that the FLM and ACR 6 operator could not exit the building through normal egress paths due to the presence of dense smoke immediately outside

ACR 6 and due to the storage of the FLM and ACR 6 operator's respirators outside ACR 6. As a result, the FLM and the ACR 6 operator experienced minor smoke inhalation which was treated at the onsite medical facility following the event.

In response to information received from the front-line manager in-training (FLMIT) and the fire protection system sprinkler flow alarm, the section manager (SM) responded to ACR 6 and directed a unit operator to proceed to the cell floor to identify possible causes for the sprinkler alarm. During their response, the SM, FLMIT, and unit operator donned respirators and brought spare respirators for use by individuals located in ACR 6. Once on the cell floor, the unit operator encountered smoke which became denser as the operator approached the area of Cell 25-7-2 and which precluded the unit operator from observing the full extent of the fire. While on the cell floor, the unit operator isolated the lube oil to Cell 25-7-2. Concurrent with the unit operator arriving in the area of Cell 25-7-2, ACR 4 operators activated the building recall system, a personnel accountability notification system.

The inspectors noted that the unit operator's actions to isolate the Cell 25-7-2 lube oil were consistent with directions provided in Cascade Emergency Procedure XP4-CO-CE5975, Revision 0, "Emergency Actions During a Process Building Fire." However, the procedure also required the cell hydraulic control oil to be isolated. During personnel interviews following the fire, the unit operator indicated that the failure to isolate the hydraulic oil was an oversight. Based upon post-fire discussions with the plant fire department staff and a walkdown of the Cell 25-7-2 area, the inspectors determined that the spilled oil, in part: 1) fed the fire; 2) increased the post-fire safety concerns; and 3) hampered the implementation of some post-fire corrective actions. The inspectors also noted that activation of the building recall could have been implemented in a more timely manner by the staff of ACR 6 due to their proximity and increased knowledge of the situation and circumstances associated with the fire.

Upon arrival in ACR 6, the SM observed that ACR 6 was filled with smoke and overheard on the plant radio system that the FLM and ACR 6 operator had evacuated ACR 6 through the building tunnels. Prior to evacuating ACR 6, the SM closed a motor-operated valve on the process gas cascade line which provided the Cell 25-7-2 input flow. The SM took the action based upon a personnel knowledge that the normal configuration of Cell 25-7-2 precluded the cell from being isolated using the "cell-off-split" button.

The inspectors determined that the off-normal procedure for damaged compressors did not describe the actions taken by the SM to close the valve in the process gas cascade feed line to Cell 25-7-2. As a result, the ACR 6 operator was unaware that the normal alignment of Cell 25-7-2 precluded isolation of the cell using the "cell-off-split" button. In addition, the ACR 6 operator's inability to isolate the cell using the "cell-off-split" button and failure to close the process gas cascade feed valve allowed process gases to be provided to the cell

until the SM isolated the process gas flow input line at approximately 6:21 a.m.

Emergency Response Activities

Upon receipt of the fire protection system sprinkler alarm and the emergency call from the steam plant personnel who had observed smoke coming from Building X-326, the PSS, shift engineer (SE), and the fire department responded to Building X-326 and established an on-scene command post (OSC). During emergencies, the PSS assumed the duties of IC and the SE assumed the duties of the safety officer (SO) in accordance with the EPIPs.

Once the OSC was established, the IC directed the response actions undertaken by the SO, the fire captain, the SM as the local emergency director (LED), the plant security staff, and the health physics technicians. The IC also communicated information to and received information from the main control room, located in Building X-300. During the approximately two hours that transpired between the initial fire protection sprinkler alarm and when the fire was declared out, the IC directed the resolution of issues associated with: 1) the isolation of power to equipment in the area of the fire; 2) the potential impacts on nuclear criticality safety controls of the spilled oil and water; 3) the accountability of personnel from two shifts; 4) the rescue of individuals evacuated to tunnels under the building as a result of smoke from the fire; 5) the use of foam for firefighting activities; 6) the isolation of hydraulic control oil to the cell; and 7) nuclear criticality concerns associated with spraying water on cascade components containing holes.

Assessment of Significant Actions During Fire Response

Shortly after the OSC was established, the IC, the fire captain and the LED discussed the status of electrical power to equipment in the immediate vicinity of the fire. Because of the potential safety consequences of equipment being energized concurrent with the firefighters using water to extinguish the fire, the LED requested the switchyard staff to open the electrical breaker supplying power to the Cell 25-7-2 area. The inspectors noted that firefighting activities were appropriately delayed while power to the area was secured. However, the electrical breaker was not opened until almost thirty minutes after the initial request was made.

Based upon the firefighters' observations during their initial efforts to extinguish the fire using a fog spray of water, the firefighters attempted to apply foam to the fire using portable eductor foam proportioners that were carried to the cell floor. Discussions with fire department staff after the event, indicated that the eductors could not be used to supply

foam for firefighting activities. An initial fire department assessment of problems encountered by the firefighters indicated that excessive pressure losses in the long runs of supply hoses prevented the eductors from functioning properly. The inspectors reviewed the emergency packets developed for Building X-326 and noted that the packets did not include information on the feasibility of using foam to fight a fire on the cell (second) floor of the building.

During the firefighting efforts, the firefighters questioned if the hydraulic control oil to the cell had been isolated. The IC and the LED discussed the methods available to isolate the hydraulic control oil and noted that the hydraulic control oil supply could be isolated from two locations, in the ACR and at an isolation valve on the operating floor (ground level). The IC noted that both the locations were filled with smoke and decided not to send a team into the building solely to isolate the hydraulic control oil. The inspectors reviewed Procedure XP4-CO-CE5975, Revision O, "Emergency Actions During a Process Building Fire," and determined that the hydraulic control oil could also be isolated from the main control room. The inspectors also reviewed the building emergency packet, available to the IC during the event, and determined that the packet did not provide specific information as to the locations from which hydraulic control oil could be isolated. The presence of large amounts of oil on the operating and cell floors following the fire delayed the implementation of some corrective measures and caused a continuous fire watch to be implemented for approximately 72 hours.

Approximately 45 minutes after beginning active firefighting, the firefighters opened access panels for the cell housing and directed a fog spray of water onto equipment and the fire within the cell housing. Shortly after the firefighters began spraying water directly into the cell housing, the firefighters reported the flames had been knocked down and only hot spots remained. The firefighters also observed holes in portions of the cell equipment that could allow water to enter the equipment. Based upon the presence of holes in the cascade components, the fire captain directed the firefighters to evacuate the area pending further direction from the nuclear criticality safety staff. The nuclear criticality safety staff provided additional direction to the firefighters approximately 20 minutes later. The additional direction indicated that firefighting activities could resume; however, the firefighters were cautioned to avoid spraying water directly into the holes. Subsequently, the firefighters resumed efforts to ensure that all hot spots were cooled and the fire was declared out at approximately 8:17 a.m.

The inspectors determined that the fire captain's decision to evacuate the area following the discovery of holes in the cascade equipment was appropriate and conservative. The inspectors also determined that the consequences of such an event had been previously evaluated, were discussed in the Safety Analysis Report, and were included in some plant procedures. However, the consequences and recommended course of action regarding firefighting techniques had not been incorporated into fire department training or the building emergency packets.

Health physics staff responded promptly to the fire, established contamination control points, and conducted field monitoring to determine the presence of any releases of process gas (uranium hexafluoride). The inspectors determined that the air sampling and contamination control efforts conducted by the health physics staff were appropriate. Air samples taken outside the building did not indicate any releases. The inspectors noted that the health physics staff's efforts, during the initial recovery phase of the event, were hampered by the presence of large quantities of oil and the potential for shock hazards. As a result, the OSC was not secured, and an all clear for the fire was not made until approximately 6 hours after the fire was extinguished.

Management Response

During the initial stages of the fire response, the IC, in consultation with management and staff located in the main control room, determined that the Building X-326 fire did not constitute an event for which the Emergency Operations Center (EOC) had to be activated. The IC also determined that the event did not require classification as an "Alert." As a result, a formal management team was not established to assist the IC in coordinating the emergency response efforts and to ensure that both immediate and long-term response actions were identified and prioritized. In addition, the plant management did not make formal notifications of the fire to local, state, and federal agencies until well after the fire had been extinguished.

The inspectors determined that the IC's actions were inconsistent with the EP, but were consistent with the EPIPs. Specifically, the inspectors determined that the EP defined an incident that had led to or could lead to a release of radioactive or other hazardous material as an "Alert." However, Procedure XP2-EP-EP1050, Revision 2, "Emergency Classification," included a note which indicated that fires, bomb threats, and natural phenomena did not meet the criteria for classification as an "Alert" or a "Site Area Emergency." The inspectors also determined that a table included in the procedure entitled, "Emergency Classification Matrix," required any event to result in an actual release of radioactive or hazardous material before the event would be classified as either an "Alert" or a "Site Area Emergency." The inspectors determined that the direction provided in the procedure was inconsistent with the EP and could, as in the case of the Building X-326 fire, result in some actions not being taken which would assist in mitigating the event consequences.

Based upon the continuing nature of the fire and requests for guidance received from the IC, plant management activated the production support team (PST). The PST was an ad hoc management team activated when operational issues arose and some amount of management support was needed. Once activated, the PST provided the IC with guidance, developed by the nuclear criticality safety staff, on proper firefighting methods to be used to

cool the cell components concurrent with the presence of holes in the components.

The inspectors reviewed the PST's activities and concluded that the group's functioning was informal, did not include logs or written records, and appeared to act only in response to requests. As a result, the nuclear criticality safety staff's recommended long-term compensatory actions to address the presence of holes in the cascade piping were not recorded or acted upon. In addition, several members of the PST were not aware of the holes in the cascade piping and components until some 6 hours after the fire was extinguished.

When the fire was declared out, the plant management appointed a recovery manager and formed a recovery team to assess damage caused by the fire and to identify actions necessary to return the plant to a normal operating configuration. The recovery team developed an initial recovery plan early on the afternoon of December 9, 1998. The inspectors reviewed the initial recovery plan and determined that the plan did not include the nuclear criticality safety staff's previous recommendations to immediately cover all holes in the equipment, to apply a purge gas to the equipment, and to conduct non-destructive testing to ensure that a greater-than-safe mass deposit did not exist. Through discussions with the PST members, the inspectors determined that the nuclear criticality safety staff's recommendations had not been provided to the recovery manager following the fire. The inspectors also observed that the recovery plan did not require an evaluation of the acceptability of using a noncontinuous fire watch to allow continued plant operations, in the immediate vicinity of the fire, concurrent with 3,000 gallons of spilled oil, and a fire protection sprinkler system that was partially isolated.

On the afternoon of December 9, 1998, the recovery team met with the SM. The SM informed the recovery team of the presence of holes in the cell equipment and that the holes were not developed as the result of a lubricating oil fire. Instead, the damage appeared to result from a chemical reaction. The SM also reported that an ACR 6 monitor reading, noticed after the fire, indicated that an exothermic chemical reaction could have caused the event. In response to information provided by the SM, the recovery manager activated the EOC in order to allow the recovery team to use the formal emergency response organization to assist in the recovery efforts. Management continued to use the EOC to direct recovery activities, initiating 24-hour, around-the-clock coverage of the activities and assignment of dedicated full-time recovery team members on December 10, 1998.

The inspectors reviewed activities prioritized and directed by the recovery team from the EOC. Based upon the activities identified and directed within the first 24 hours after the fire, the inspectors determined that the initial recovery efforts were not prioritized based upon safety and regulatory requirements. Specifically, the inspectors noted that the plant staff did not take prompt action to cover holes in the process equipment and to apply a purge gas to the equipment, although, the staff had objective evidence, approximately 14 hours after the fire was extinguished, that Cell 25-7-2 may contain a greater-than-always safe mass of

uranium. The nuclear criticality safety staff also did not take prompt action to develop a revised nuclear criticality safety basis for the equipment once operations staff determined that some of the current moderation controls could not be completely implemented. The recovery team also had information which indicated that approximately 3,000 gallons of oil had spilled during the event and remained on the cell and operating floors. However, the recovery team did not direct the plant staff: 1) to develop a new, management-approved safety basis for the revised fire loading present in the area; 2) to shut down other operating equipment in the area; and 3) to post a continuous fire watch for the area. The inspectors discussed the findings with plant management and noted that later recovery efforts were more clearly focused, prioritized, and directed based upon safety and regulatory significance.

c. Conclusion

The inspectors determined that the operation staff's initial response to abnormal conditions involving Cell 25-7-2 were not directed by or consistent with some plant procedures and may have allowed the abnormal condition to propagate. Subsequent actions were properly focused on limiting the extent of the fire and ensuring plant staff safety; however, these actions were also not fully consistent with plant procedures and resulted, in part, in a continued supply of hydraulic control oil to the cell throughout the fire.

Emergency response activities, directed by the IC, were determined to be properly focused on limiting personnel injuries, extinguishing the fire, controlling other hazards, and preventing unnecessary releases to the environment. However, some response activities appeared to have been delayed or were not fully implemented as a result of deficiencies in emergency procedures, pre-fire emergency packets, training for firefighters, and communications between the IC and the plant's main control room.

Management's initial response to the fire was determined to be inconsistent with the EP, though consistent with the EPIPs. Management's decision not to activate the EOC and not to classify the fire as an "Alert" increased communication problems observed in the flow of information between the IC and other management personnel. As a result, safety concerns relative to holes in the cascade piping and the presence of 3,000 gallons of spilled oil were not promptly resolved. Subsequent management oversight of the recovery process was noted to have improved following activation of the EOC and the dedication of a 24-hour, around-the-clock recovery team.

5.0 Certificatee Analysis of Root Cause and Corrective Actions [Charter Item No. 3]

- Inspection Scope

The inspectors evaluated the certificatee's initial analysis of the impacts of the Building X-

326, Cell 25-7-2 fire, compensatory and corrective actions implemented as a result of the fire, and a preliminary evaluation of root causes developed for the event. At the conclusion of the AIT inspection, the certificatee had not yet completed an overall root cause evaluation.

o Observations and Findings

On the afternoon of December 9, 1998, plant management appointed the operations manager as the recovery manager and identified specific plant technical expertise to assist the recovery manager in addressing issues developed as a result of the early morning fire involving Cell 25-7-2. The recovery manager was charged with a responsibility for ensuring that the cell and surrounding equipment was maintained in a safe condition, for determining the root causes of the fire, and for identifying appropriate compensatory and corrective measures.

The inspectors observed the initial efforts and determined that the recovery team did not have clear objectives and was not dedicated exclusively to accomplishing the recovery efforts. As a result, plant management was not immediately cognizant of the extent of damage caused by the fire and some consequences of the fire were not immediately identified or evaluated. Examples included issues identified during the fire response including a need to restore: 1) the Cell 25-7-2 nuclear criticality safety controls; and 2) fire loading assumptions for the immediate area of Cell 25-7-2. Additional issues, identified after the fire was extinguished, included: 1) questions regarding the expected operator actions in response to significant unexpected motor load changes; and 2) questions regarding the fire department staff's knowledge and training on appropriate techniques for fighting a fire concurrent with the presence of holes in process gas cascade equipment. In addition, the inspectors noted that the recovery manager and team were not aware of the physical conditions of the Cell 25-7-2 area until almost 24 hours after the fire.

Initial compensatory and corrective measures, developed by the recovery team and implemented by the plant staff as a result of the fire, included:

- once-every-three-hour fire watch in the area of the isolated fire protection sprinkler system and Cell 25-7-2 (the fire watch was later upgraded, following discussions with the NRC's AIT, to a continuous fire watch pending restoration of the fire loading conditions present in the area of Cell 25-7-2 to pre-fire status)
- administrative controls to preclude a restart of the SPC and some other plant operations pending the completion of a root cause evaluation for the fire;
- immediate and periodic vibration monitoring of other centrifugal compressors in an attempt to determine the existence of other, unstable equipment;
- the initiation of a purge gas within the damaged Cell 25-7-2 and the covering of openings created in the process gas piping and equipment of Cell 25-7-2 as a result

of the fire;
- the development of a revised nuclear criticality safety basis for Cell 25-7-2;
- interim training of cascade operators and managers to elevate their knowledge of conditions which could lead to an exothermic reaction within the process gas cascade and appropriate response actions to the off-normal operating conditions; and
- interim training of firefighters and management as to the safety risks of and the proper fire fighting techniques for a fire concurrent with holes in process gas cascade equipment.

While the initial compensatory and corrective measures appeared appropriate, the inspectors determined that some of the measures were not implemented in a timely manner and some were not comprehensive. Specifically, the plant staff did not fully implement corrective measures to address the loss of nuclear criticality safety moderation control for Cell 25-7-2 until approximately 72 hours after the fire was extinguished. Compensatory and corrective measures for the spilled oil were initially focused only on the isolated fire protection sprinkler system and did not address the significantly revised fire loading conditions present on the cell floor.

As of the end of the AIT inspection, the certificatee had not developed final corrective measures. However, the inspectors noted that some of the corrective measures being pursued by the root cause group appeared to indicate that corrective measures recommendations made as a result of previous events were not fully implemented. The inspectors reviewed the corrective measures proposed following previous similar events and determined that the previous corrective measures were focused on providing cascade operators with enhanced indications of and training on how to respond to abnormal cascade operations which could lead to an exothermic reaction within the process gas cascade.

Throughout the AIT inspection, the inspectors monitored the initial and ongoing activities of the recovery team root cause group. The group was composed of individuals from most plant disciplines and was augmented by retired plant staff and outside failure effects analysis experts. Although final root causes had not been determined, the group had concluded that the fire was not caused by excessive levels of oxidant gases in the process gas cascade or by an operational transient.

The group had tentatively determined that the most likely initiator for the event was mechanical friction within the process gas cascade equipment that generated a sufficient amount of sustained heat to begin an exothermic reaction between the aluminum compressor components and the process gas (uranium hexafluoride). Based upon a review of some of the Cell 25-7-2 components removed since the fire, the group believed that the exothermic reaction may have initiated in the Stage 2 compressor and propagated through the cell equipment to the Stage 4 compressor. In the Stage 4 compressor, the reaction was thought to have been intensified by the input gases, received from the remainder of the cascade, resulting in increasing internal process gas cascade temperatures until a failure in

the freon coolant system boundary occurred. Elevated pressure, caused by the introduction of freon from the coolant system and a second exothermic reaction between the hot metal and freon, was thought to be the final event that occurred prior to the holes being burned in the process gas cascade boundary.

The group hypothesized three possible causes for the mechanical friction, including:

- a sudden wet air in-leakage through a cracked expansion joint resulting in a "build-up" of deposits in the close tolerance areas of a compressor;

(This theory appeared to be supported by uranium deposits observed in the Stage 2 compressor following the fire.)

- the presence of loose parts or debris within the cell as a result of a previous compressor failure; and

(This theory appeared to be supported by a post-fire review of the Stage 2 and 4 compressors which were removed and replaced prior to the cell being returned to service on November 19, 1998, and were noted to have extensive internal damage, including dislodged parts.)

- cracking or metallurgical failure of a compressor first stage impeller.

(This theory appeared to be supported by cracks and failures observed in the Stage 2 compressor replaced prior to the November 19, 1998, restart of the cell.)

The inspectors determined that the methodology used by the root cause group to determine the cause of the fire was reasonable and the group included a sufficient breadth of expertise to ensure that significant facets of the event were properly considered and evaluated. However, the inspectors also noted that most of the internal components of Cell 25-7-2 had been melted during the fire, thus making a definitive assessment of the root causes for the event difficult. The initial certificatee event report is included as Attachment 3.

- Conclusion

The inspectors determined that the recovery team initially did not have clear objectives,

were not exclusively assigned to the recovery efforts, and were not fully cognizant of the immediate consequences of the fire. As a result, some compensatory and corrective measures were not implemented in a timely manner and some were not comprehensive. Despite the early lack of rigor, the certificatee's overall root cause evaluation activities were determined to be comprehensive and included an appropriate review of conditions present at the time of and prior to the event. Preliminary root cause evaluation results appeared to indicate that the fire resulted from a hot metal-process gas exothermic reaction which was initiated by an undefined source of mechanical friction.

6.0 Radiation, Chemical and Fire Protection [Charter Item No. 4]

- Inspection Scope

The inspectors evaluated the adequacy and appropriateness of radiation, chemical, and fire protection precautions and the possible radiological and chemical consequences of the fire to plant staff and the general public.

- Observations and Findings

Radiological and Chemical Protection Precautions

The radiological precautions available to emergency responders to protect and monitor against exposure to radioactive materials (various compounds of uranium) included respiratory protection (respirators and self-contained breathing apparatuses [SCBA]), air sampling capabilities, personal protective equipment designed to prevent personal contamination, and an emergency control contamination monitoring process. In general, the inspectors noted that the implementation of these precautions during the event appeared to be adequate. However, some problems were noted with the availability of respirators for cascade operators. In particular, the certificatee's respiratory protection program appropriately assigned a dedicated respirator to each cascade operator in preparation for events such as the December 9, 1998 fire, but the respirators were not pre-staged in a location that ensured the respirators would be immediately available to operators under conditions which could reasonably be expected to occur. Specifically, the respirators for ACR 6 operators were staged outside ACR 6. As a result, some operators were not able to obtain their assigned respirator during the event response due to the potential exposure or inhalation conditions outside the area control rooms.

The chemical precautions included controls to prevent explosive concentrations of various gases within the SPC and personal protective equipment to protect emergency responders from any chemicals released as a result of a fire. The inspectors determined that the certificatee's procedure for limiting the buildup of potentially explosive concentrations or mixtures in the cascade was adequately implemented. The inspectors performed an

independent review of the levels of the various gases in the cascade, as recorded by an online monitor, and determined that all levels were within the acceptable limits defined in the governing procedure. In addition, the emergency responders to the fire were appropriately protected from exposure to a release of hazardous materials by the use of Level A chemical suits and SCBAs. The inspectors determined that the certificatee took appropriate precautions to prevent unwanted chemical reactions from high concentrations of explosive gases in the SPC and to preclude personal exposures to hazardous materials which might be expected from such a fire.

Fire Protection Precautions

Fire protection precautions available to fight a fire in the cascade buildings included a high-pressure sprinkler system and an onsite fire department. The performance of the sprinkler system and fire department during the event are discussed in Section 10.0. In addition, the certificatee had prepared pre-fire plans and emergency packets for the process buildings in accordance with Compliance Plan Issue 8.

The purpose of the pre-fire plans and emergency packets was to provide information on reasonably expected fire or emergency scenarios to the event response staff. As noted in NRC Inspection Report 70-7002/98014(DNMS), however, the NRC identified in August 1998 that the pre-fire plans did not reflect the full extent of current facility configurations and operations. In particular, during this event, the hydraulic control oil supply to Cell 25-7-2 was not isolated until approximately two hours into the event. The hydraulic control oil supply could have been immediately isolated from the main control room by stopping the lube oil and hydraulic oil pumps for the unit, including Cell 25-7-2. The inspectors noted that this type of information for an expected event (oil fire) could have been included in the pre-fire plan or emergency packet for Building X-326, but was not. In addition, the inspectors noted that the pre-fire plan and emergency packets did not include discussions of how to address potential criticality safety concerns involved with the use of water (a moderator) even though Building X-326 routinely processed enriched uranium. (The off-normal operations procedure, Procedure XP4-CO-CE5975, "Emergency Actions During a Process Building Fire," did address criticality concerns, but none of the fire department personnel had been trained on the procedure.) The inspectors also noted that the emergency packet did not assign specific responsibilities for response actions or include checklists to ensure all expected response actions were performed. Finally, the inspectors' interviews with the fire department staff and management indicated that these personnel were not trained in the content or use of the pre-fire plans. As a result, the inspectors determined that a tool which could have been very useful in efficiently assigning resources and determining response strategies was not available.

Radiological and Chemical Consequences

The inspectors reviewed air sample data taken at various locations in Building X-326 immediately after the fire and post-event urine sample data collected from personnel involved in the event. The air sample results indicated that airborne radioactivity levels from uranium and technetium-99 in Building X-326 were below the 10 CFR 20 derived air concentration limits and soluble uranium levels were below the Occupational Safety and Health Administration's permissible exposure limit (PEL) of 0.05 milligrams per cubic meter. The urine samples taken from involved workers and event responders (52 samples) yielded results below the certificatee's recall limit for soluble uranium of 5 micrograms per liter. Due to the large dilution of any materials released over the large distances between Building X-326 and the site boundary and the holdup of materials in the building, no exposures to members of the public resulted from the event.

The inspectors noted that hydrogen fluoride (a process gas release product) sample results were below the detectable limit for areas on the operating floor and exterior to Building X-326; arsenic sample results from various areas in Building X-326 were below the applicable PEL; and precautionary use of respirators was directed to minimize personnel exposure to airborne nickel concentrations identified inside the cell housing after the fire was extinguished. One individual was identified with bioassay results above the retest limit for fluorides, but below any restricted work activity limit. The plant staff were following up on the bioassay results to ensure the data were accurate and take any precautionary measures which might be warranted.

In addition to the consequences discussed above, two operations staff were treated and released from the onsite medical facility for smoke inhalation which occurred during the staff's evacuation of ACR 6 without a respirator.

- Conclusion

The radiological and chemical consequences to personnel onsite were minor and no consequences to offsite members of the public were identified. Precautions taken to protect the plant population from process hazards were generally appropriate. However, some deficiencies were noted, including: 1) locating respirators for some operations staff outside the area control rooms which hindered respirator use; and 2) a lack of detailed guidance in the pre-fire plan and emergency packet for Building X-326 which could have aided emergency responders in allocating resources and developing strategies for fighting the fire.

7.0 Consequences to Safety-Related and Other Plant Equipment [Charter Item No. 5]

- Inspection Scope

The inspectors evaluated the consequences of the fire on the continued operability and operation of safety-related and other plant equipment. Safety-related equipment reviewed included cascade piping and pressure boundary components, fire protection systems in the immediate area of the fire, and a nearby criticality accident alarm system. Nonsafety-related equipment reviewed included the adjacent cell components, and the insulated housing surrounding Cell 25-7-2.

- Observations and Findings

As a direct result of the fire associated with Cell 25-7-2, several safety-related systems and components were impacted, including:

- the Cell 25-7-2 cascade piping and pressure boundary components;
- the fire protection sprinkler system for the immediate area of Cell 25-7-2; and
- a criticality accident alarm system between Cells 25-7-2 and -4.

The inspectors performed a walkdown of the affected cascade components and observed the fire impacts. The inspectors noted holes in several portions of the Cell 25-7-2 cascade piping and components. The holes were primarily located at elbows in the "B"-line portion of the cell piping, although additional holes were observed at the bottom of some cell converters and at expansion joints in the cascade piping. The inspectors noted that the holes in the cascade piping elbows appeared to have been a result of hot gases, created by the fire within Cell 25-7-2, impinging directly on the elbow as the gases changed direction. The holes located in the bottom half of some converters appeared to be a result of hot metal interacting with the converter shells. The holes at expansion joints in the cascade piping appeared to be the result of an over-pressurization of the joints from the freon released into the cell. The as-found fire impacts to the cascade piping and components precluded the piping and components from performing the assumed safety functions of containing the uranium hexafluoride and preventing moisture leakage into the piping and components.

A failure of the cascade piping to contain uranium hexafluoride during the fire would result in a release of uranium hexafluoride and associated reaction products into the building. Slightly elevated contamination levels were noted in the water and oil spilled in the building during the fire; however, air samples, taken immediately outside of the building during and

after the fire, did not indicate elevated levels of uranium hexafluoride or associated reaction products.

A loss of integrity in the cascade piping would also result in a loss of moderation control for any uranium deposits contained in the piping following the fire. The plant nuclear criticality safety program employed moderation control as a method of ensuring that greater-than-minimum critical mass cascade uranium deposits were properly managed. After the fire, the plant staff did not take prompt action to cover the holes in the cell and to reestablish moderation control. A non-destructive analysis (NDA) of the cell was performed approximately 14 hours after the fire was extinguished. The NDA results indicated that the cell contained a greater-than-always safe mass (approximately 43 percent of the greater-than-minimum critical mass), prompting the plant staff to attempt to reestablish moderation control. However, the holes in the cascade piping prevented moderation control from being reestablished consistent with the applicable nuclear criticality safety program requirements. A subsequent NDA, performed 4 hours later and over a longer time period, indicated that the mass was smaller than the always-safe mass thereby decreasing the immediate safety concerns associated with the loss of moderation control.

Through a system walkdown and discussions with the plant staff, the inspectors determined that fire impacts on the fire protection sprinkler system were primarily related to the actuation of seven sprinkler heads during the fire. Of the seven actuated heads, four were located underneath platforms and catwalks near the cells with a temperature rating of 212F. The remaining three actuated sprinkler heads were located in the high bay, about 50 feet above the cell floor, with temperature ratings of 286F. The fire protection sprinkler heads employed in the cascade buildings utilized a solder-type element which, once used, must be replaced with the system removed from service (position indicating valve closed). In addition, the solder-type sprinkler heads, once subjected to high temperatures but below their rated temperatures, often experience cold flow, solder hardening, or joint weakening which could allow the sprinkler heads to actuate under non-fire conditions.

After the fire, the fire department staff isolated that portion of the sprinkler system in the immediate vicinity of the cell. The system remained isolated until the plant staff replaced the actuated sprinkler heads (4 low and 3 high level) and 69 other heads (12 low and 57 high level) which the fire protection engineering staff determined could have been impacted by the fire's high temperatures. During the time the system was isolated, plant management initially implemented a once-every-three-hour fire watch. The fire watch was later revised, after discussions with the AIT, to a continuous fire watch approximately 30 hours after the fire was extinguished. The fire protection sprinkler system in the vicinity of Cell 25-7-2 was isolated for approximately 160 hours.

A single criticality accident alarm system (CAAS) cluster was located on a platform approximately 15 feet above the cell floor and between Cells 25-7-2 and 25-7-4. During a walkdown of the cell vicinity after the fire, the plant staff identified some minor heat impacts to the cluster housing. As a result, the cluster was tested and determined to be operable.

During discussions, the plant staff indicated to the inspectors that no unusual alarms or problem indications were received from the cluster circuits during or following the fire. As a precautionary measure, the plant staff replaced the cluster with a recently serviced and tested cluster.

The inspectors noted that nonsafety-related equipment impacted by the fire included:

- the cell housing surrounding Cell 25-7-2; and
- other operating cascade equipment in the near vicinity of Cell 25-7-2, i.e., the Top and Side Purge Cascades.

The inspectors observed that fire impacts to the Cell 25-7-2 housing included sagging of portions of the steel frame, constructed of 4 and 6 inch I-beams, and holes burned through some of the side insulating panels. The sagging steel frame was most evident in the center roof section of the housing where the frame appeared to have sagged approximately 12 inches. An engineering staff analysis of the structure's viability (Ref: "Structural Evaluation Inspection of Damaged Cell 25-7-2,"POEF-810-98-134," dated December 11, 1998) was performed within 72 hours after the fire and indicated that the structure's strength had not been significantly degraded by the fire. Although plant management was sufficiently concerned with the viability of the structure to perform an engineering evaluation, the inspectors noted that the timing of the evaluation was not sufficient to ensure that other potential safety issues were addressed in a prompt manner. Specifically, the implementation of corrective measures for the loss of moderation control was delayed by approximately 70 hours pending completion of an evaluation of the structure.

The inspectors observed that the holes in the side insulating panels were directly in line with the holes created by the fire in the cascade piping B-line elbows. The presence of the holes in the cell housing side insulating panels would have allowed materials released from the cascade to the interior of the cell housing to be more quickly released to the building and subsequently to the environs. However, the hold-up capability of the cell housing for cascade releases was not assumed or relied upon as a part of any accident analyses presented in the Safety Analysis Report.

The inspectors noted that other cells in the immediate vicinity of the fire were affected as a result of: 1) heat from the fire; 2) oil released from ruptured lubricating and hydraulic control oil lines; 3) water used to fight the fire; and 4) the loss of the cascade flow path through Cell 25-7-2. Cell 25-7-4, located immediately adjacent to the cell involved in the fire, appeared to have experienced some melting of plastic cell materials used to contain heat within the cell housing structure. However, at the time of the fire, the cell was not operating.

The inspectors determined that lubricating and hydraulic control oil, released as a part of the Cell 25-7-2 fire, created an approximate 3,000 gallon spill and associated fire hazard in the immediate area of the cell and other operating cells. Some of the spilled oil was also transported to the operating floor by the water used to extinguish the fire. Once the fire was extinguished, the plant staff initiated a fire watch in accordance with the Technical Safety Requirements. However, the plant staff did not initiate a formal safety evaluation of changed fire loading status of the area created by the spilled oil. The inspectors toured the area and observed that the spilled oil in some cases completely surrounded other operating equipment. The inspectors communicated their observations to plant management and following a reevaluation of the conditions, plant management instituted a continuous fire watch for the areas affected by the spilled oil and expedited the clean-up of the oil.

Approximately 35,000 gallons of water was used to extinguish the fire. The water also affected other plant equipment in the vicinity of Cell 25-7-2 by increasing the potential for electrical shorts in the power and instrument circuits. Following the fire, plant management shut down, inspected, and dried potentially affected equipment to preclude personnel injuries or unplanned transients for operating equipment. The inspectors did not observe any unplanned transients associated with the large amount of water present in the building.

The loss of process gas flow through the Cell 25-7-2 and the remainder of the SPC impacted routine plant operations by decreasing the plant staff's ability to remove light gases from the cascade. As a direct consequence of the loss of the SPC, the plant staff halted the withdrawal of enriched materials from the cascade and took action to resolve difficulties experienced in controlling the location of the interface between light gases and the process gas within the process gas cascade. As of the end of the AIT inspection, the plant staff were developing other cascade configurations to facilitate an efficient removal of light gases from the process gas cascade without the use of the SPC.

c. Conclusion

The inspectors determined that the Cell 25-7-2 fire negatively impacted both safety-related and nonsafety-related equipment. The safety-related cascade piping and other cascade components' ability to fulfill assumed safety functions, that is, to be a barrier to the release of process gases from the cascade and to be a barrier to the moderation of uranium deposits in the cascade, was compromised by holes created in the process gas piping and components. Other safety-related systems performed as expected or were unaffected by the fire. The fire also impacted some nonsafety-related plant equipment including the SPC and the Cell 25-7-2 insulated housing. Management's delayed assessment of the structural viability of the Cell 25-7-2 insulated housing contributed to the untimely implementation of some required corrective measures for safety-related equipment failures; however, there were no safety consequences.

8.0 Similar or Precursor Events [Charter Item No. 6]

- Inspection Scope

The inspectors evaluated the potential for a similar event to occur both at the same location and other locations within the cascade, the risk or change in risk for each location, and if there were any precursor events and how the precursor events were resolved.

- Observations and Findings

Potential for Reoccurrence

The inspectors evaluated the potential for a recurrence of the event by reviewing maintenance practices relied upon to ensure that the initiating event, overheating of rotating equipment, was avoided.

The inspectors reviewed portions of the equipment history program and determined that some equipment history information was not captured during maintenance efforts involving the replacement of failed or excessively vibrating compressors. Specifically, the maintenance records did not include as-found vibration data or equipment condition. The inspectors noted that an online or routine periodic vibration monitoring program was not conducted for all compressors. During a review of the equipment history of Cell 25-7-2, the inspectors determined that maintenance was completed on Cell 25-7-2 approximately one month prior to the event. The maintenance included a replacement of two of the cell's six compressors due to high vibrations. However, the maintenance work packages for the activities did not include either as-found or as-left vibration data for the compressors. In addition, the inspectors determined that the neither of the replaced compressors had been physically examined since being removed.

As a result of the event on December 9, 1998, the plant staff reviewed the condition of the two Cell 25-7-2 compressors that were recently replaced and observed significant damaged to the Stage 2 impeller and cracking and melting of the Stage 4 compressor impeller. Based on the event and these findings, the plant staff performed vibration reviews of all operating centrifugal compressors. The reviews did not identify any compressors with unacceptable vibration levels.

Although the exact potential for a recurrence of the events of December 9, 1998, could not be defined, the inspectors determined that some of the plant staff's equipment monitoring, maintenance, and failure analysis method would not result in the identification of an impending failure.

Risk Associated with Similar Events

The inspectors evaluated the potential risk or risk change associated with a similar event occurring at the same or other locations using information provided in the Safety Analysis Report, the Safety Analysis Report Update document, and the NRC Response Technical Manual (RTM-96) for the Portsmouth Gaseous Diffusion Plant.

Based upon information included in the referenced documents, the inspectors determined that the applicable accident analyses assumed a maximum release of 1,000 pounds (lbs) of process gas (uranium hexafluoride) as a result of a hot metal-process gas exothermic reaction. The inspectors noted that the accident analysis-assumed release quantity was independent of the equipment location. Therefore, the maximum accidental consequences and risk of a similar event were unaffected by the event location. The inspectors noted that the offsite consequences of the releases were within regulatory guidelines.

Although the maximum assumed release for a similar event was independent of location, the inspectors reviewed the factors that could affect the actual amount of material released from different locations within the plant. The inspectors noted that the amount of material available to be release during an event was a function of three primary factors: 1) the operating pressure of the equipment prior to the event; 2) the maximum operating power level prior to the event; and 3) the location of the equipment. The first two factors defined whether the equipment was operating above or below atmospheric pressures and how much material may be in the equipment at the time of the event. The third factor was somewhat related to the second factor, in that, the larger the equipment was the more material the equipment could hold at the maximum power levels.

Based upon the above factors, the inspectors determined that the largest actual releases during a hot-metal reaction would be associated with the largest size equipment ("OOO" sized), operating at above atmospheric pressures. The smallest releases would be associated with the smallest equipment (centrifugal compressors located in Building X-326), operating at below atmospheric pressures. Additionally, the smallest release would be associated with Cell-25-7-2 due to the fact that only about one half of the cell actually

contained a significant concentration of process gas.

The inspectors also noted that the probability of an event which could lead to a hot metal-process gas reaction was dependent on the type of process equipment involved. Specifically, the inspectors noted that the Building X-326 equipment was composed exclusively of centrifugal compressors versus the axial compressors utilized in most of the remainder of the plant. Although spacing tolerances between moving components in the two types of compressors were not significantly different, the inspectors noted that rubbing between the moving components in the axial compressors would normally culminate in a broken compressor blade. However, rubbing between moving components in the centrifugal compressors would continue until either the compressor was shut down, the impeller catastrophically failed, or sufficient heat was generated to begin a hot metal-process gas reaction. Further, the centrifugal compressors were monitored by only a few automatic systems, none of which would stop the compressors during the initial stages of a rubbing or heat generating event. For example, the inspectors determined that the breakers controlling electrical power to the centrifugal compressor motors would allow a sustained overload condition of greater than the maximum combined normal operational load of three motors before interrupting the power supply to the motors.

Precursor Events and Recommended Corrective Actions

The inspectors reviewed available information and determined that three similar or precursor events were documented as having occurred at the gaseous diffusion plants. One of the events was at Paducah and two of the events were at Portsmouth.

The Paducah event occurred in 1978 and involved centrifugal compressors in the depleted materials withdrawal portion of the cascade. The direct cause of the event was determined to be the failure of an automatic recycle valve control loop which caused a dramatic decrease in process gas flow and compressor heating to occur. As a result, the compressor internal components were believed to have expanded, rubbed against the compressor housing, and began a hot metal-process gas reaction. The reaction continued and propagated until the localized temperature rise was sufficient to cause a failure in the freon coolant system and to initiate a second, more exothermic reaction between the hot metal and freon. The result of both the reactions was a melting of many of the compressor internals and the creation of holes in elbows of the process gas cascade piping. The inspectors noted that an investigation of the event identified recommended corrective actions including: 1) increased operator training; 2) improved off-normal procedures; 3) online vibration monitoring of compressors used to pump process gases; and 4) online temperature monitoring of internal centrifugal compressor temperatures.

The two Portsmouth events involved axial compressors and occurred in 1991 and 1993. The inspectors noted that the 1991 event resulted in significant damage to the compressor

and converter, resulting in a release of materials from the process gas cascade. The release was confined to the cell area and a significant fire, internal or external to the cascade equipment, did not occur. The 1993 event was confined to the compressor and did not result in a release from the process gas cascade. The inspectors noted that corrective actions proposed as a result of the two Portsmouth-related events were consistent with the corrective actions developed as a result of the 1978 Paducah event.

Based upon a review of the previous events, the inspectors evaluated the plant staff's implementation of the recommended corrective actions. The inspectors noted that some of the corrective actions associated with vibration monitoring had been implemented for larger size compressors in the process cascade. However, most of the remaining recommended corrective actions had not been implemented, e.g., online temperature monitoring, automatic isolation of lubricating and hydraulic control oil, and increased operator training and awareness of normal and abnormal operating parameters and associated response actions. In addition, the inspectors were unaware of any documented evaluation of a safety basis for either implementing or rejecting the recommended corrective actions.

- Conclusions

The inspectors determined that current operational, maintenance, and failure analysis practices were not sufficient to identify impending similar events. Information provided in the Safety Analysis Report and the accident analysis approach utilized in the Safety Analysis Report indicated that the risks associated with a similar event at the same location or a different location were identical. The accident analysis assumed a maximum release of 1,000 pounds of process gas regardless of the accident location. The offsite consequences were noted to be within regulatory guidelines. Three previous hot metal-process gas reactions were identified as having occurred at the Paducah and Portsmouth plants. Recommended corrective actions were developed as a result of each of the events; however, the inspectors determined that many of the corrective actions were not fully implemented.

9.0 Entry Into Technical Safety Requirement 1.6.4, "Conditions Outside the Technical Safety Requirements" [Charter Item No. 7]

- Inspection Scope

The inspectors evaluated the certificatee's decision not to utilize Technical Safety Requirement (TSR) 1.6.4 and associated implications for continued safe operations during the event.

- Observations and Findings

The inspectors observed the certificatee's emergency response efforts during the event and initial recovery phase; reviewed area control room, PSS, CC, and emergency response logs; and interviewed management personnel involved in the fire response. Based upon reviews of the logs and discussions with the IC, the inspectors determined that the certificatee did not enter TSR 1.6.4.

During discussions with the IC and the SO, the inspectors were informed that the IC considered the need to enter TSR 1.6.4 prior to evacuation of the Building X-326, ACR 6. The IC and SO were aware that Section 3 of the TSRs required ACR 6 to be manned when equipment associated with the ACR was operating. At the time the potential need to evacuate ACR 6 occurred, the IC requested operations management and staff, located in the main control room, to review the TSRs and to determine if an entry into TSR 1.6.4 was required. Shortly after the IC requested the review, operations management informed the IC that TSR 3.2.2.a., "Facility Staff," did not require ACR 6 to be staffed under conditions requiring a facility to be evacuated.

The inspectors were also informed as a part of the discussions, that operations staff performed a post-fire review of the TSRs to determine if any TSR-required surveillances had been missed during the period of time the ACR 6 or the facility was evacuated. Results of the post-fire review indicated that no TSR-required surveillances had been missed.

c. Conclusion

The inspectors determined that the IC appropriately considered, but did not enter, TSR 1.6.4, "Conditions Outside the Technical Safety Requirements," during the fire response. Instead, the IC determined that TSR 3.2.2.a., "Facility Staffing," permitted the Building X-326 Area Control Room Number 6 to be unmanned during a facility evacuation resulting from the fire.

10.0 Event Impact on Fire Suppression System Design Basis [Charter Item No. 8]

- Inspection Scope

The inspectors evaluated the implications of the event for the design basis and requirements for the fire suppression system, including fire protection processes and procedures and associated fire analyses and equipment interaction effects, in the process at the gaseous diffusion plants.

- Observations and Findings

Design Basis Implications

The inspectors noted that the current design basis for the process building fire protection sprinkler systems required the system to mitigate a fire that could cause structural damage to the process building roofs, followed by a localized collapse of the roofs, and a release of process gas as a result of holes made in the process gas cascade boundary (TSR 2.7.3.3 Bases Statement, dated August 12, 1996). The inspectors also noted that the Safety Analysis Report, Section 4.3.2.1.3, further indicated that a hole in the process gas cascade boundary of a single cascade cell would not have consequences exceeding regulatory limits. Therefore, the fire protection sprinkler system was designed to mitigate a fire that could cause holes in multiple portions of the process gas cascade. Based upon a review of the circumstances surrounding the fire that occurred on December 9, 1998, the inspectors determined that the fire protection sprinkler system performed consistent with the current design basis. In addition, the inspectors determined that the fire protection sprinkler system was able to mitigate a fire that could cause structural damage regardless of whether the fire was initiated from within or external to the process gas cascade.

The inspectors also reviewed the Safety Analysis Report Upgrade Project proposed revision to the current fire protection sprinkler system design basis. The inspectors noted that the Safety Analysis Report Upgrade Project revised design basis was more limited in scope than the current design basis. Specifically, the Safety Analysis Report Upgrade Project proposed to require the sprinkler system to only protect against a lube oil fire that could cause a potential threat to process gas cascade boundary that could result in onsite and offsite consequences.

Fire Protection Process and Procedure Implications

The inspectors performed an initial inspection of the fire scene and observed that the fire was primarily confined to Cell 25-7-2. Indications were also present that the combustion of oil was localized to the east exterior side of the cell, based on the presence of severed (burned) lube oil lines which previously connected the supply system to motor bearings.

The inspectors' assessment of the fire's location and extent was confirmed through interviews with the firefighters. The inspectors also observed a lack of indications of significant oil burning on the west exterior side of the insulated cell housing. Following removal of some of the insulated cell housing panels, the inspectors observed the cell interiors and determined that the highest temperatures experienced during the fire were located in the center and to the east side of the cell. As a result of the temperature differences present within the cell during the fire, visible differences were evident in the sag of metal I-beams, used to hold up the cell housing metal roof, and in the condition of instrumentation tubing fastened to interior of each cell housing wall.

The inspectors noted that combustibles, within the cell and exterior to the cascade equipment, were normally limited to hydraulic control oil that leaked from the stage control valve. The hydraulic control oil was the same oil used to lubricate the compressor motor bearings and had a flash point of approximately 440F. The inspectors determined that the high oil flashpoint and water from the fire protection sprinkler system combined to limit the combustion of oil exterior to the cell to those locations where the oil was heated by the fire originating from inside the cell. As a result, significant quantities of oil were observed outside the cell housing. The combustion of oil located within the cell was observed to be nearly complete. Through discussions with operations staff, the inspectors were informed that the lubricating oil was shut off approximately 10 minutes into the fire; however, the hydraulic oil was not shut off until after the fire was extinguished. The inspectors also determined that the rate of hydraulic control oil flow into the cell could have been as high as 90 gallons per minute based on the hydraulic oil pump's capabilities. Based upon the limited supplies of oil to the cell equipment, the near absence of oil within the cell housing following the fire, and the large quantities of oil exterior to the cell housing after the fire, the inspectors determined that the hydraulic oil pumped to the cell during the fire was an ongoing source of fuel for the fire.

Through a review of the fire scene and discussions with the firefighters, the inspectors determined that the automatic response of the sprinkler system and the fire department's response to the fire limited the extent of significant property damage to Cell 25-7-2. The potential for offsite consequences was also limited by the automatic and manual fire suppression activities. Following the event, the fire safety staff determined that 7 sprinkler heads actuated as a result of the fire. From interviews with firefighters, the inspectors determined that 3 low level (underneath catwalk platforms) and 2 high bay sprinklers actuated during the early stages of the fire. One additional low level sprinkler and one additional high bay sprinkler actuated later as a result of the firefighters opening cell housing doors during firefighting activities. The inspectors noted that the location and approximate times of the sprinkler actuations were as expected from a properly designed and functioning system. The inspectors observed that three sides of the cell exterior were protected by low level sprinklers located underneath catwalks or ventilation ducts. The cell exterior east side was not protected by a low level sprinkler head and was the only cell housing side that experienced significant fire damage. Based upon the observed fire damage, the inspectors noted that the lack of low level sprinklers on the east side of the cell housings was an area that could be evaluated by the plant staff for possible improvements in regard to sprinkler head placement.

Based upon a review of the emergency response logs and interviews of firefighters, the inspectors determined that the plant fire department responded promptly after receiving an automatic alarm due to the actuation of a fire protection sprinkler system and an emergency call at about 6:09 a.m. on December 9, 1998. Once on the scene, the fire department staff evacuated operations staff from the operating floors and went to the cell floor to assess firefighting operations. The firefighters determined that the fire could not be fought with fire extinguishers and dropped a 2.5 inch hose out of an exterior door from a hose cart which was maintained on the cell floor. The firefighters then fought the fire with two 1.5 inch hoses connected to and supplied by the 2.5 inch hose. The fire was fought with fog (spray) using combination nozzles. The firefighters effectively suppressed (flaming combustion extinguished) the fire with a fog water spray after a door on the south side of the cell was opened approximately 45 minutes after the initiation of firefighting activities. The fire was declared out about forty-five minutes later at 8:17 a.m. From a review of the fire scene and interviews with firefighters and department officers, the inspectors determined that the fire department's response was adequate in terms of equipment and tactics.

Although the overall firefighting efforts were effective, the inspectors noted some implications of the fire response on current fire protection processes and procedures. Specifically:

- Initial indications of the fire occurred just prior to a shift change and the fire was fought using staff from both the off-going and on-coming shifts. Because all of the firefighters were fully engaged during the fire, a review of the current staffing levels, the response times of off-duty or off-site assistance fire personnel, and the resultant impacts for a similar magnitude fire may be appropriate.

- The firefighters experienced unexpected problems while attempting to use foam on the fire. The fire department staff performed a post-fire review of the problems and determined that the two eductor-type foam proportioners, brought to the cell floor to facilitate the use of foam, would not operate due to pressure losses in the 400 to 500 feet of hose laid between the cell floor and the pumper truck. Since foam was an effective firefighting agent for oil fires, the inspectors noted that additional planning and training were necessary to ensure that the option to use foam for a cell floor fire was properly identified in advance of a fire.

- Shortly after the firefighters extinguished the fire within the cell, the firefighters noticed holes in process components and piping. Based upon the fire captain's uncertainty of the acceptability of spraying water on holes in the process components and piping, the firefighters evacuated the area. While the firefighters response was appropriate given the uncertainties, the inspectors noted that additional training and reviews of current safety evaluations affecting firefighting activities were necessary to ensure uninterrupted firefighting of design basis events.

Fire Analyses and Equipment Interaction Effects

The decision to install sprinkler systems in the gaseous diffusion plant buildings was made as a result of a major building fire which occurred in 1956 at the Paducah Gaseous Diffusion Plant. A later incident at Paducah in 1962, which actuated 2,390 sprinkler heads, resulted in the installation of an upgraded water supply at both plants and a change to the temperature rating of the cell floor high bay sprinkler heads to 286F. Characteristics of a thermal plume within the cascade buildings and the expected operation of the fire protection sprinkler heads were determined based upon oil fire tests performed in the 1950s. The necessary density of sprinkler discharge to control a lube oil fire was also considered. Analyses were also been performed for fire scenarios at the Paducah plant with generic applicability to the Portsmouth plant. The plant staff were also conducting a review of the December 9, 1998, fire to provide additional data regarding the adequacy of the automatic suppression system and firefighting efforts.

As a part of the review of fire analysis and equipment interaction effects, the inspectors noted that recommendations had been previously made with regard to cell sprinkler systems and thermally actuated oil shutoff valves. At the time the recommendations were made, plant management determined that design changes to the systems were not necessary. As a result of the fire on December 9, 1998, the inspectors were informed that the root cause investigation team planned to reevaluate the previous recommendations.

In regard to equipment interactions, the inspectors observed that the cascade building roof vents could adversely affect the operation of the sprinkler system. Specifically, some configurations of the roof vent system could allow heat from the fire to escape. A loss of heat through the roof vent system could conceivably lower the number and change the location of sprinkler heads that actuated during a fire so as to decrease the amount of water discharged on the fire. The inspectors attempted to determine the configuration of the roof vents during the December 9, 1998, fire; however, objective evidence on the roof vent configuration was not available. Therefore, a reevaluation of the potential for the roof vent system to negatively impact operation of the sprinkler system, during possible accident scenarios, and an evaluation of the firefighter response actions during the firefighting activities may be appropriate.

c. Conclusion

The inspectors determined that the fire protection sprinkler system design basis was adequate and the system was able to perform the assumed design basis function regardless of the source of the fire, i.e., within or exterior to the process gas cascade. The inspectors also determined that a Safety Analysis Upgrade Project-proposed design basis modification was narrowly defined using only the lubricating oil as a fire initiator. The

inspectors concluded that the fire protection sprinkler system was properly designed to control a lubricating oil fire exterior to a cell and may be credited with controlling a fire until the arrival of the fire department. However, some previous design change recommendations to the sprinkler system and systems that are sources of combustible materials may require reevaluation based upon the characteristics of a fire internal to the process gas cascade.

The inspectors determined that the fire department attacked and extinguished the fire in an adequate manner. However, additional reviews and training appeared necessary to ensure: 1) the availability of a sufficient number of personnel to fight a similar fire during non-shift turnover periods; 2) the availability of proper equipment and personnel training to allow the use of foam to fight a cell floor fire; and 3) a complete understanding by the firefighters of the fire responses necessary to support the safety analysis evaluations.

11.0 Event Reporting Process and Notifications [Charter Item No. 9)

- Inspection Scope

The inspectors evaluated the certificatee's internal and external event reporting process and any notifications made for the event.

- Observations and Findings

The inspectors reviewed the certificatee's internal and external event reporting processes as described in the Safety Analysis Report, Section 6.9, "Event Investigation and Reporting," and associated plant procedures. The inspectors noted that Safety Analysis Report, Section 6.9, Table 6.9-1, included a summary of the applicable reporting criteria and concluded that information included in the table was current and correct. However, the inspectors also concluded that many of the table-listed reporting criteria required the PSS to make a reportability determination based on information or directions included in other plant documents or procedures. In particular, the inspectors noted that conditions associated with Table Items D.1 and D.2, "Emergency Conditions," were only reported if the conditions were declared an "Alert" or a "Site Area Emergency."

Based upon the information provided in the Safety Analysis Report, the inspectors reviewed the plant procedure associated with the classification of emergency conditions. The

inspectors determined that Procedure XP2-EP-EP1050, Revision 2, "Emergency Classification," did not include fires, bomb threats, or natural phenomena as conditions which would meet the criteria for classification as an "Alert" or a "Site Area Emergency." As a result, the PSS would not classify these event types as emergency conditions reportable to the local or state officials or the NRC. However, the inspectors noted that the direction provided in Procedure XP2-EP-EP1050 was inconsistent with the EP. Specifically, EP Sections 2.1 and 3.1 both describe a fire as a condition that may be classified as an "Alert."

During the course of the fire response and recovery, the plant staff made five non-emergency notifications to the NRC. The notifications included: 1) a 4-hour report under the requirements of NRC Bulletin 91-01 and applicable supplements; 2) a 24-hour report under the requirements of 10 CFR 76.120(c)(4); 3) a 4-hour courtesy report based upon a notification made to the State of Ohio of the oil spill associated with the fire; and 4 & 5) both a 24-hour and a 4-hour report that revised and then reinstated the original 4-hour report made under the requirements of NRC Bulletin 91-01. For each of the reports the inspectors reviewed the associated plant procedures and determined that the processes were appropriate and consistent with the applicable regulatory requirements. The inspectors also determined that the multiple reports made under the requirements of NRC Bulletin 91-01 were the result of a lack of rigor during the implementation of the reporting process. Specifically, the plant staff involved in making the report did not fully evaluate the conditions present in the plant against the reporting criteria.

c. Conclusions

The inspectors determined that inconsistencies between the EP and associated EPIPs contributed to the plant staff not promptly reporting to local, state, and NRC officials a fire which led or could have led to a release of radioactive materials. Other internal and external event reporting processes reviewed by the inspectors were noted to be consistent with the applicable regulatory requirements. The inspectors determined that a lack of rigor during implementation of the reporting process for a nuclear criticality safety-related issue resulted in the report being twice revised.

12.0 Exit Interview

The team met with certificatee representatives (identified below) during an exit meeting on February 5, 1999, and summarized the purpose of the AIT, AIT charter items, and inspection findings. The team discussed the likely informational content of the inspection report with regard to documents or processes reviewed by the team during the inspection. The exit meeting slides used by the inspectors are included as Attachment 4.

Attachments: 1. Augmented Inspection Team Charter

2. Sequence of Events

3. Portsmouth Event Report

4. Exit Meeting Slides

PERSONNEL CONTACTED

Lockheed Martin Utility Services

*C. Blackston, Nuclear Regulator Affairs Compliance Manager

*J. Brown, General Manager

*S. Casto, Work Control Manager

*S. Fout, Operations Manager

*P. Hopkins, Acting Engineering Manager

*P. Miner, Regulatory Affairs Manager

*J. Morgan, Enrichment Plant Manager

*M. Wayland, Maintenance Manager

United States Enrichment Corporation

*L. Fink, Safety, Safeguards & Quality Manager

J. Adkins, USEC Vice President, Production

*Denotes those present at the exit meeting on February 5, 1999.

U. S. Nuclear Regulatory Commission

James L. Caldwell, Deputy Regional Administrator, RIII

Cynthia D. Pederson, Director, Division of Nuclear Materials Safety (DNMS), RIII

Patrick L. Hiland, Chief, Fuel Cycle Branch, DNMS, RIII

Kenneth G. O'Brien, Senior Resident Inspector, Paducah, RIII

David J. Hartland, Senior Resident Inspector, Portsmouth, RIII

Courtney A. Blanchard, Resident Inspector, Portsmouth, RIII

Charles Cox, Mechanical Engineer, Special Projects Branch, NMSS

Rex Wescott, Senior Fire Protection Inspector, Special Projects Branch, NMSS

Albert Wong, Chemical Safety Inspector, Fuel Cycle Safety and Safeguards Branch, NMSS

LIST OF ACRONYMS USED

ACR Area Control Room

AIT Augmented Inspection Team

CAAS Criticality Accident Alarm System

CC Cascade Coordinator

CFR Code of Federal Regulations

EP Emergency Plan

EPIP Emergency Plan Implementing Procedure

F Degrees Fahrenheit

FLM Front-Line Manager

FLMIT Front Line Manager in Training

DNMS Division of Nuclear Material Safety

EOC Emergency Operations Center

IC Incident Commander

Lbs Pounds

LED Local Emergency Director

NDA Non-Destructive Analysis

NMSS Office of Nuclear Material Safety and Safeguards

NRC Nuclear Regulatory Commission

OSC On-Scene Command Post

PEL Permissible Exposure Level

PST Production Support Team

PSS Plant Shift Superintendent

RTM Response Technical Manual

SCBA Self-contained Breathing Apparatus

SE Shift Engineer

SM Section Manager

SO Safety Officer

SPC Side Purge Cascade

TSR Technical Safety Requirement

Augmented Inspection Team Charter

Portsmouth Gaseous Diffusion Plant Building X-326 Fire

December 9, 1998

Examine the circumstances surrounding the fire in Building X-326 which occurred at the Portsmouth Gaseous Diffusion Plant on December 9, 1998, including, but not limited to the following:

1. Develop and validate a chronological sequence of events and activities occurring just before and after the fire involving Cell 25-7-2 and determine what the plant conditions were at the time of the event.

2. Evaluate the certificatee's actions during and following the event including the immediate response to the event; the implementation and adequacy of the Emergency Plans and procedures, and management response.

3. Evaluate the extent of the certificatee's analysis and determination of the initial root cause for the event and the initial evaluation of appropriate corrective actions.

4. Evaluate the adequacy and appropriateness of radiation, chemical, or fire protection precautions taken by the certificatee and the possible consequences to the plant staff and the general public.

5. Evaluate the consequences of the fire to plant equipment, particularly any potential effects on safety-related equipment.

6. Evaluate the potential for a similar event to occur both at the same location and other locations in the cascade, determine the risk or change in risk at each location, and determine if there were any precursor events and how these were dealt with.

7. Evaluate the certificatee's decision to enter Technical Safety Requirement 1.6.4 and any associated implications for continued safe operations during the event.

8. Evaluate the implications of the event for the design basis and requirements for the fire suppression system, including fire protection processes and procedures and associated fire analyses and equipment interaction effects, in the process buildings at the gaseous diffusion plants.

9. Evaluate the certificatee's internal and external event reporting process and any notifications made for the event.

Attachment 1

Sequence of Events

Portsmouth Gaseous Diffusion Plant Building X-326 Fire

December 9, 1998

NOTE: The times provided in the following chronology are approximate and were based on results from personnel interviews and a review of event response and other logs. The time is listed using a 24-hour clock. The units are hours:minutes, unless otherwise noted.

Time Description of Event

November 19, 1998:

Operations staff returned Building X-326, Cell 25-7-2, normally the first cell in the SPC, to service following maintenance that included a replacement of the stage 2 and 4 compressors due to high vibrations.

December 9, 1998:

6:00 A unit operator performing routine checks on process equipment, including Cell 25-7-2, reported that conditions appeared normal. No abnormal noise, smells, leaks, or vibrations were noted.

6:02 The Building X-326 Area Control Room 6 (ACR 6) control room operator received a high amperage load alarm on Cell 25-7-2 and observed a momentary high load indication on the Cell 25-7-2, Stage 2 amperage meter, the indication changed from 30% to 70% of full scale. Based upon the alarm and indications, the control room operator closed the SPC vent control valve in an attempt to regain control of the load on Cell 25-7-2.

6:05 The ACR 6 control room operator observed that Cell 25-7-2, Stage 2 amperage meter again momentarily indicated a high load condition and then all of the Cell 25-7-2 stage amperage meters indicated a momentary high load condition (full scale deflection of the amperage meters). The cell automatically shutdown and the control room operator actuated the "cell off-full split" button in an attempt to isolate Cell 25-7-2 from the remainder of the cascade. Valve position lights indicated that at least one of the valves did not fully closed.

SPC Cells 25-7-6, -8, and -10 motor load amperage meters also indicated a high load condition (full scale deflection) and automatically shutdown.

The SPC vent isolation valve, ESP-7, automatically closed isolating the SPC discharge stream from the atmosphere.

6:07 A front-line manager, walking to ACR 6 from ACR 5, heard the cell motors coasting down and arrived in ACR 6 to assist the control room operator respond to the unplanned cell shutdown conditions.

6:09 The main plant control room, in Building X-300, and the fire department received a flow alarm for Sprinkler System No. 462.

An operator in the Building X-600 steam plant called "911" to report smoke coming from the south end of Building X-326.

A security guard, located in a Department of Energy storage on the cell floor near Cell 25-7-2, heard a jet-like noise, two pops, and then quiet.

6:11 The front-line manager reported to the cascade controller that Cells 25-7-2, -6, -8, and -10 had automatically shutdown.

6:15 The incident commander and fire department staff arrived on the scene. Fire fighting personnel entered the building through Door 7 and encountered light colored, heavy smoke.

6:19 The unit operator, wearing a respirator, proceeds to the cell floor to investigate the sprinkler alarm, noticed heavy smoke while approaching Cell 25-7-2, and isolated the lube oil supply to Cell 25-7-2 while leaving the area.

Building X-326 ACR 4 control room operators sounded a building recall.

6:20 The front-line manager and the ACR 6 control room operator notified staff in the Building X-300 main control room of smoke entering the ACR and their decision to evacuate the ACR through the tunnel system due to the unavailability of respirators.

6:21 The Building X-326 section manager entered ACR 6; actuated the "cell off-full split" button; observed positive indication of closed valves; pressed the closed button for valve 7ESP-1 to isolate Cell 25-7-2 from the remainder of the cascade; and evacuated the building using a respirator.

6:30 Building X-300 operations staff logged entry into the Action Statements for Technical Safety Requirement 2.7.3.14A due to the potential for a uranium deposit of greater-than-safe mass in Cell 25-7-2.

6:45 The firefighters reported 3 or 4 Cell 25-7-2 compressor motors burning with flames extending 20 feet high.

6:55 The incident commander confirmed electrical power to Unit 25-7 was disconnected after an approximate 20 minute delay.

7:15 The firefighters opened a door on the south side of the Cell 25-7-2 cell housing and proceeded to spray directly on the fire within the cell housing.

7:20 The firefighters reported the fire was confined to the cell housing. The firefighters also identified that the hydraulic control oil supply to Cell 25-7-2 may not be have been isolated.

7:30 The firefighters reported flaming combustion was suppressed. The firefighters also reported open process gas piping observed from the west side of the cell housing. The firefighters exited the area pending guidance on possible nuclear criticality safety controls necessary as a result of the observed holes in the process gas piping.

7:50 The firefighters reentered Building X-326, used fire hoses to cool down possible hot spots, in accordance with guidance provided by the nuclear criticality safety staff; isolated flow to sprinkler system 426; and, established a 4-hour fire watch in the area of Cell 25-7-2, in accordance with Technical Safety Requirement 2.7.3.3.

Nuclear criticality safety staff recommended to the incident commander the covering of holes in the process equipment and the establishment of a buffer gas to the process equipment as soon as possible.

8:15 The hydraulic control oil supply to Cell 25-7-2 was shut off.

8:17 The firefighters reported that the fire had been extinguished and no oil flows were observed.

8:30 Operations staff reentered ACR 6.

10:07 Operations staff returned the Top Purge Cascade to service.

12:10 The certificatee issued a press release relative to the fire.

12:30 The Building X-326 section manager discovered that significant damage had occurred to Cell 25-7-2. The damage was thought to be symptomatic of an exothermic reaction.

12:50 The certicatee completed development of an initial recovery plan. The recovery plan did not include direction provided previously by the nuclear criticality safety staff relative to the closure of holes in the process gas cascade equipment.

12:54 The certificatee made a verbal notification to the NRC following a courtesy call to the State of Ohio Environmental Protection Agency

14:41 The plant shift superintendent declared an "all clear" for the emergency response.

The operations manager was appointed as recovery manager.

15:47 The recovery team was briefed on visual observations of the damage to Cell 25-7-2.

22:00 The recovery team directed operations staff to provide a buffer gas to Cell 25-7-2.

An initial non-destructive analysis of Cell 25-7-2 determined that the cell may contain a greater-than-always safe mass uranium deposit.

22:17 The certificatee made a 4-hour notification to the NRC due to a nuclear criticality safety approval requirement to provide a buffer gas to Cell 25-7-2 not being completed within 8 hours after shutdown.

December 10:

AM The recovery team requested a structural analysis of the Cell 25-7-2 cell housing.

00:40 The recovery team issued a revised recovery plan which incorporated a work plan to address nuclear criticality safety issues associated with a potential Cell 25-7-2 uranium deposit.

2:02 A second non-destructive analysis of Cell 25-7-2 determined that uranium deposits contained within the cell were not greater-than-always safe mass limits.

5:12 The certificatee revised a previous 4-hour notification to the NRC relative to Cell 25-7-2 and made a 24-hour notification relative to damage to a radioactive material container (the process gas cascade equipment).

17:00 Continuous fire watches were initiated for the immediate area of Cell 25-7-2 due to the large amount of spilled oil (increased fire loading); and, the presence of operating electrical equipment.

December 11:

AM A structural analysis of the Cell 25-7-2 cell housing was completed indicating that the structure was damaged but sound.

16:43 The certificatee revised a previous 4 and 24-hour notification relative to Cell 25-7-2 to indicate that event was reportable as a 4-hour notification.

December 12:

2:30 Holes in the Cell 25-7-2 process gas piping and components were covered.

December 14:

PM Plant management approved a revised nuclear criticality safety basis for Cell 25-7-2 that accounted for the holes in the piping and the operations staff's inability to maintained an above atmospheric buffer gas pressure for the cell.

Portsmouth Event Report

January 8, 1999

Attachment 3

January 8, 1999

GDP 99-2003

United States Nuclear Regulatory Commission

Attention: Document Control Desk

Washington, D.C. 20555-0001

Portsmouth Gaseous Diffusion Plant (PORTS)

Docket No. 70-7002

Event Report 98-17

Pursuant to 10CFR76.120 (c) (4), Enclosure 1 provides the required 30 day Event Report for an event that resulted from a fire which caused damage to Cascade equipment containing radioactive material at the X-326 Building Side Purge Area at the Portsmouth Gaseous Diffusion Plant. Investigation activities are continuing to determine the root cause and corrective actions for this event. This report will be revised following completion of these activities. The revised event report is scheduled for February 18, 1999. There are no new commitments contained in this report.

Should you require additional information regarding this event, please contact Scott Scholl at (740) 897-2373.

Sincerely,

/s/ J. Morris Brown

J. Morris Brown

General Manager

Portsmouth Gaseous Diffusion Plant

Enclosures: As Stated

cc: NRC Region III Office

NRC Resident Inspector - PORTS

United States Nuclear Regulatory Commission

bcc:

J. Adkins-HQ

J. Anzelmo-PORTS

M. Boren-PGDP

D. Couser-PORTS

J. Cox-PORTS

J. Dietrich-LMUS

D. Faust-PORTS

L. Fink-PORTS

D. Fosson-PORTS

S. Fout-PORTS

P. Hopkins-PORTS

L. Jackson, PGDP

J. Labarraque-PGDP

J. Miller-HQ

P. Miner-PORTS

J. Moore-PORTS

J. Morgan-PORTS

P. Musser-PORTS

A. Rebuck-HQ

S. Routh-HQ

S. Scholl-PORTS

K. Sherwood-PORTS

R. Smith-PORTS

T. Sorrell-PGDP

R. Wells-HQ

Plant Shift Superintendents

PORTS Records Management

USEC-HQ Files

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Description of Event

On December 9, 1998, at 0610 hours, Fire Services personnel responded to a fire which occurred in Cell 25-7-2 in the Side Purge Area of the X-326 Process Building. The fire, which breached process equipment in several places, was contained by the building sprinkler system and was extinguished by plant Fire Services personnel. The fire damage was primarily limited to the Cell 25-7-2 equipment, housing, and three stages of the adjacent cell, 25-7-4. Since the fire damaged process equipment and piping which contained radioactive material, this event is reportable in accordance with 10CFR76.120 (c) (4). A description of the event is provided below.

Operations were normal on the morning of December 9, 1998. Cell 25-7-2 was the bottom onstream cell of the Side Purge cascade. The purpose of the Side Purge is to vent most of the light gases, such as oxygen and nitrogen, from the cascade. Heavier intermediate weight gases, such as R-114 (coolant), continue up the cascade until they are vented by the Top Purge equipment. Low speed cell 25-7-2 is used to create a stripping section. The B-Stream exiting cell 25-7-2 typically contains less than 10% of the low molecular weight "light" gases which enter the Side Purge. The Side Purge configuration was normal with the exception that Cell 25-7-4 was offstream and out of service. A-Stream process gas flow was into Stage 4 A-suction of Cell 25-7-2, from Stage 12 of Cell 27-1-2, through a manual block valve. B-Stream process gas return flow was from Stage 1 of Cell 25-7-2, to

the Stage 1 A-Stream of Cell 27-2-1. A coolant (R-114) "bubble" had moved up the cascade at about 0330 hours. The Unit Operator making rounds of the cell floor at about 0600 hours stated that Cell 25-7-2 equipment was running quietly with no unusual indications.

At about 0605 hours, the ACR-6 (Area Control Room 6) operator was taking hourly readings when the operator noticed the cell 25-7-2, Stage 2, Amp meter briefly deflect to about 70% full scale and then return to normal position of about 30% scale. The operator told the First Line Manager in Training (FLMIT), who was leaving the ACR, that it appeared there was another coolant "bubble" entering the Side Purge cascade. The FLMIT said he would tell the Section Manager when he reported to ACR-5. Meanwhile, the operator throttled the Side Purge vent remote control valve (CV-1261) to back the suspected coolant bubble out of the Side Purge cells.

At about 0606 hours, the Amp meter in ACR-6 again deflected, which indicated that Cell 25-7-2, Stage 2, compressor surged and then returned to normal load. Cascade Control personnel in X-300 Plant Control Facility (PCF) observed that the Cell 25-7-2 Amp meter, which indicates the total cell Amps from all six motors, was slowly climbing and called ACR-6 to determine the cause. During the phone call, at 0607 hours, Cell 25-7-2 immediately loaded up and tripped on motor overload before the operator could trip the cell motors. Adjacent Side Purge Cells 25-7-6, 25-7-8, and 25-7-10 also loaded, with seal exhaust alarms activating. The operator depressed the cell off full split button to close the three open block valves. The expected response of a green light, indicating the valves had completely closed, did not occur and the panel had a red and a green light indicating one or more of the valves was not fully closed. The cell had not been completely isolated because the internal A-Line, Stage 4, block valve used to create a stripping section remained open.

The X-326 Building CC-Shift FLM was in route to the ACR-6, when the FLM heard the cell compressors and motors wind down. The FLM then proceeded to ACR-6 and found Cell 25-7-2 shut down. Isolation valve ESP-7 had closed automatically, isolating the Side Purge vent stream from atmosphere.

At about 0610 hours, sprinkler system 462, which is located in proximity to Cell 25-7-2, alarmed in the Fire Station and the PCF. Operators in the nearby X-600 Steam Plant heard the external X-326 Building sprinkler system alarm bell, observed white smoke, smelled an electrical type odor, and heard a muffled pop. A Protective Force Officer on the cell floor heard a roar followed by two pops.

At 0611 hours, Cascade Control told the ACR-6 FLM that there were reports of smoke and flowing sprinklers in the south end of X-326. The FLM reported a cell coolant alarm, indicating high coolant temperature or low coolant pressure, but did not report smoke. The Fire Services arrived on the scene at 0613 hours. By 0615 hours, smoke was entering ACR-6. The operator and the FLM did not immediately evacuate because their respirators were stored outside the ACR. Firemen entered X-326, Door 7, and reported heavy, light colored smoke.

At 0617 hours, the Section Manager and the FLMIT en-route from ACR-5, were attempting to reach ACR-6 with four respirators, but encountered heavy smoke and called the PCF for information. The Cascade Controller reported the sprinkler 462 alarm, smoke coming out of the building and that the UF_6 front had been pushed down the cascade into the X-330 Building. The Section Manager and FLMIT continued to attempt to reach ACR-6 while avoiding the heavy smoke.

The unit operator, wearing respiratory protection, entered the cell floor and proceeded toward Cell 25-7-2. The operator saw there was smoke coming from the cell and valved off the lube oil supply located at the top of the exit stairway before he exited the building. Smoke was light but slowly becoming denser above the cell floor.

At 0619 hours, ACR-6 personnel evacuated the control room without respiratory equipment by entering the ACR-6 Basement and going into the tunnel which provided egress from the area. At 0620 hours, Fire Services personnel checked ACR-6 and determined that it had been evacuated. At 0621 hours, the Section Manager and the FLMIT entered ACR-6 by a rear door and began a search of the ACR to be certain the area was empty. The Section Manager pushed the cell off full split button and received a green light within seconds, indicating the valves were nearly fully closed by the ACR operator on the previous isolation attempt. The Section Manager closed motor operated valve 7ESP-1, the first isolation valve beyond the Cell 25-7-2, Stage 4, manual valve, which isolated Cell 25-7-2 from the Side Purge supply line and the operating cascade.

At 0622 hours, ACR-4 personnel manually activated the building recall horn. At 0623 hours, the Section Manager pushed the automatic recall button located in ACR-6. The recall signal is to alert building personnel to report to designated assembly locations. At 0625 hours, the Section Manager and FLMIT exited the building and proceeded to the Command Post.

At 0626 hours, Fire Services personnel entered the cell floor and reported a fire in progress. Flames were reported around the cell housing and from motor openings. Heavy black smoke was filling the area making visibility poor and the oil/water mixture on the cell floor created difficult footing for the firefighters. The Fire Services personnel returned to the Command Post and developed a plan to extinguish the fire.

It was later determined that seven sprinkler heads had activated. Three at the roof level, two under the bypass housing, and one in the aisle way that most likely activated when hot gas jets burned through the cell housing at Stages 1, 3 and 4. One under the coolant platform activated most likely when the cell housing door panel adjacent to Stage 6 became warped and opened. The high pressure fire water sprinkler discharge was successful in containing the fire.

At 0630 hours, Fire Services personnel proceeded to lay hoses on the east side of the building and applied water to the outside of the Cell 25-7-2 housing. Other firefighters gained access to the south door of the building and proceeded to lay hose.

At about 0730 hours, the south door of the cell housing was opened and the firefighters proceeded to spray water inside the cell housing. The fire was extinguished and upon examination for hot spots, an open process pipe was observed from the West Side of the cell. Fire fighting activities were curtailed and the firefighters returned to the Command Post. After consultation with the Incident Commander on Nuclear Criticality Safety (NCS) concerns, the firefighters went back to the cell housing and performed cool down operations while avoiding the open pipe. At 0749 hours, the sprinkler system was valved off. Total sprinkler discharge was approximately 35,000 gallons. At 0815 hours, Emergency Squad personnel valved off the Cell 25-7-2 hydraulic oil supply. The fire was declared out by Fire Services at 0817 hours.

Fire damage was limited primarily to Cell 25-7-2 and consisted of severe damage to the components in the compressors, the converters, and the R-114 coolers. A stage control valve disk was melted. Holes were burned in process piping elbows in three stages, several process pipe expansion joints were ruptured, and holes were melted in three stage converters. Minor damage also occurred in three stages of the adjacent cell, 25-7-4.

The material that outgassed was enriched UF_6 at less than 7.0% U-235. The quantity of material released during the event was estimated as approximately 5 Kg of uranium.

Cause of Event

On December 9, 1998, immediately following the event, an investigation team was established to determine the root and contributing causes for the event. Outside technical experts were added to the team to assist in the cause determination. The extensive fire damage experienced by Cell 25-7-2 equipment has made it difficult to determine the root cause. Much of the equipment has been damaged to the extent that evidence needed to determine the root cause was destroyed. As a result, investigation activities are continuing and this event report will be revised when the investigation is complete. The investigation team's current understanding of the most likely direct cause for the exothermic chemical reaction is provided below.

The investigation team reviewed plant operating conditions that existed prior to the event to

At 0617 hours, the Section Manager and the FLMIT en-route from ACR-5, were attempting to reach ACR-6 with four respirators, but encountered heavy smoke and called the PCF for information. The Cascade Controller reported the sprinkler 462 alarm, smoke coming out of the building and that the UF_6 front had been pushed down the cascade into the X-330 Building. The Section Manager and FLMIT continued to attempt to reach ACR-6 while avoiding the heavy smoke.

The unit operator, wearing respiratory protection, entered the cell floor and proceeded toward Cell 25-7-2. The operator saw there was smoke coming from the cell and valved off the lube oil supply located at the top of the exit stairway before he exited the building. Smoke was light but slowly becoming denser above the cell floor.

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The investigation team reviewed plant operating conditions that existed prior to the event to

determine if there were any abnormal conditions that could have initiated an exothermic reaction. Cascade operating parameters for the 24 hours prior to the time surging was first detected by the operator, such as purge rates, UF_6 front location, feed and withdrawal rates and surge drum bleed back information were reviewed, but did not indicate any activity which could have initiated the event. Cascade monitors such as alarms, line recorders, space recorders, oxidant monitors and cascade laboratory sample analysis did not reveal any unusual activity. A review of cascade and feed plant valving orders and operational logs also did not reveal any unusual activities that would have initiated the event. Based on these findings, the investigation team concluded that the exothermic reaction was not caused by any abnormal concentration of gases or unusual operating conditions.

The investigation team has determined that the exothermic reaction was most likely caused by rubbing of internal compressor parts. Friction, resulting from rubbing of compressor parts, is believed to have generated enough heat to reach the melting point of aluminum. The molten aluminum then chemically reacted with the UF_6 process gas generating additional heat. As the cell continued to operate onstream, additional UF_6 was available to feed the reaction and spread it to other stages. At least one gas cooler eventually ruptured releasing R-114 coolant into the cell. The release and expansion of the coolant into the cell increased the cell pressure and generated additional heat as aluminum chemically reacted with the coolant. The high temperatures and potentially elevated pressure led to the destruction of the converter tube bundles and breach of the cell boundary.

During the investigation, issues potentially related to the prevention or mitigation of an exothermic reaction were identified by the investigation team. The team identified that the design and operational characteristics of Cell 25-7-2 may have contributed to the severity and extent of the exothermic reaction. These issues are discussed below and immediate actions taken to address these issues are described in the corrective action section.

The Safety Analysis Report (SAR), Section 3.1.2.2.2, Isolation of Failures, states that, "If the Amp loading in a single stage begins increasing, the problem may have been initiated by compressor parts rubbing, deposits in the compressor, bearing failure, or some other failure associated with the motor itself, which requires immediate shutdown". The Side Purge cascade operating procedure did not contain guidance to help the operator differentiate between load changes due to controllable factors such as compressor surging and load changes due to equipment failure, and it did not contain guidance as to the type of Amp increases which would require a cell shutdown.

The investigation team also determined that Cell 25-7-2, Stage 2 and 4 compressors, had been replaced approximately three weeks before this event due to high vibrations. The compressors that were removed from the cell because of the high vibrations were examined. The Stage 4 compressor was found to have extensive first stage impeller damage. Implications of this finding are being further evaluated as it relates to this event.

Corrective Actions

A. Immediate Actions Taken

The following actions have been initiated and/or completed to address issues identified during the investigation. A complete list of corrective actions will be provided in a revised event report after the root and contributing causes have been determined.

1. On December 23, 1998, a briefing was initiated for X-326 Facility Operations personnel. The briefings included a description of what happened, how the incident was handled and what to look for as indicators that such an event is happening. The briefing emphasized the steps necessary for tripping and isolating a cell. Actions to be taken if the cell block valves do not fully close were also addressed.

2. On December 15, 1998, the development of a training module was initiated to address recognition of cell surging, cell loading and cell shutdown requirements. This training module is currently being piloted.

3. On January 6, 1999, a lessons learned was developed and issued to Cascade personnel to communicate operating conditions that may increase the possibility of a similar exothermic reaction.

4. On December 9, 1998, administrative controls were established to prevent returning the Side Purge cells to service.

5. On December 10, 1998, a vibration survey was conducted on running motors and compressors in the Top Purge Cascade. Engineering initiated weekly vibration surveys on operating purge cascade equipment.

6. The X-326 Daily Operating Instructions for January 4, 1999, emphasized the procedure administrative controls that state "upon cell startup, any cell indicating abnormal vibration shall be followed up with a full set of vibration readings unless the vibration is excessive upon which the cell shall be shut down".

7. The December 21, 1998 Daily Operating Instructions for cascade process areas contained the administrative control that, "Any centrifugal compressor that is shut down due to high vibration will not be re-started in the presence of UF_6".

8. On December 11, 1998, as a result of the damage observed on Cell 25-7-2, an ultrasonic inspection was performed on B-line elbows in the other Side Purge cells. No evidence of thinning was observed.

B. Corrective Actions Planned

Corrective actions will be provided with the revised event report

Extent of Exposure of Individuals to Radiation or Radioactive Materials

Personnel in the facility at the time of the fire, and all responders to the fire, were monitored for potential intake of radionuclides. Fifty-two personnel involved with the event submitted urine samples. Of these, nineteen personnel working in the building at the onset of the emergency were placed on precautionary restriction until their samples were evaluated. Each sample was analyzed for uranium and technetium and all results were less than 5 g/l uranium and 6,000 pCi/l for technetium. Since all samples were less than the SAR Action levels, no further actions were required. All precautionary restrictions were removed for the 19 individuals.

Area radiation readings during and following the event noted no increase over normal background readings for that area. Area posting requirements remained the same (Contamination Area). With the exception of some precautionary expansions of boundaries within already posted "Restricted Areas", only minimal boundary changes were necessary. Personnel access to the area was not restricted for radiological protection reasons nor were radiological dose reduction measures required during or following the emergency response. Air sampling results within the facility indicated slight increases in the airborne radioactivity levels during the fire, while monitors outside of the facility indicated no readings above the minimal detectable activity for the equipment. Prior to the termination of the event, airborne radioactivity levels within the facility had returned to normal.

Although the fire created several contamination control concerns, worker, environmental and public

exposures were not significantly affected. SAR, Section 5.3 requirements were maintained and normal procedural controls were effective in maintaining contamination control and returning the area back to pre-fire conditions from a radiological control standpoint.

Recovery activities have been successful in removing the oil and water from the affected area. Decontamination efforts have restored the operating floor to pre-fire entry requirements for Personnel Protective Equipment. Approximately eighty percent of area boundaries have been returned to their pre-fire positions and decontamination efforts are continuing to restore the remaining boundaries.

Lessons Learned

Lessons Learned will be provided with the revised event report.

Exit Meeting Slides

AGENDA

PORTSMOUTH AUGMENTED INSPECTION TEAM (AIT)

EXIT MEETING

February 5, 1999

- **OPENING REMARKS**

  PAT HILAND, CHIEF, FUEL CYCLE BRANCH,

  DIVISION OF NUCLEAR MATERIALS SAFETY, REGION III

- **INSPECTION TEAM RESULTS**

  KENNETH O'BRIEN, AIT TEAM LEADER

  FUEL CYCLE BRANCH, REGION III

- **USEC COMMENTS**

- **CLOSING REMARKS**

  CINDY PEDERSON, DIRECTOR

  DIVISION OF NUCLEAR MATERIALS SAFETY

  JIM CALDWELL, DEPUTY REGIONAL ADMINISTRATOR, REGION III

EVENT SUMMARY

- NO OFFSITE CONSEQUENCES OR IMPACTS TO THE GENERAL PUBLIC
- NO SIGNIFICANT PERSONNEL INJURIES
- FIRE WAS AN ANALYZED EVENT
- HOT METAL - URANIUM HEXAFLUORIDE FIRE
- FIRE IMPACT CONFINED TO IMMEDIATE AREA
- UNAFFECTED PORTIONS OF THE PLANT CONTINUED TO OPERATE

SUMMARY OF FINDINGS

- EMERGENCY RESPONSE TO THE FIRE WAS ADEQUATE
- FIRE RESULTED IN MINIMAL IMMEDIATE SAFETY CONSEQUENCES
- PROBLEMS WERE IDENTIFIED RELATED TO:
- OPERATIONS, FIRE, AND MANAGEMENT TRAINING
- PRE-FIRE PLANNING, AND EMERGENCY PACKETS
- OPERATIONS, FIRE, AND EMERGENCY PLAN PROCEDURES
- IMPLEMENTATION OF SOME COMPENSATORY AND CORRECTIVE MEASURES
- INITIAL ROOT CAUSE EFFORTS APPEARED COMPREHENSIVE

AUGMENTED INSPECTION TEAM CHARTER

- CHRONOLOGY OF EVENTS
- ACTIONS DURING AND FOLLOWING EVENT
- ANALYSIS OF INITIAL COMPENSATORY ACTIONS AND ROOT CAUSE EVALUATION ACTIVITIES
- HEALTH AND SAFETY PRECAUTIONS AND CONSEQUENCES
- CONSEQUENCES OF THE FIRE TO EQUIPMENT
- POTENTIAL FOR SIMILAR OR PRECURSOR EVENTS
- TECHNICAL SAFETY REQUIREMENT 1.6.4
- EVALUATION OF FIRE SUPPRESSION SYSTEM
- EVENT NOTIFICATION PROCESS

CHRONOLOGY OF EVENTS

6:05 a.m. Process equipment automatically shuts down

6:09 a.m. Fire department receives sprinkler system flow alarm from building X326

6:21 a.m. Operations staff isolated equipment

6:31 a.m. Active firefighting activities begin

7:30 a.m. Flames extinguished, holes in equipment identified

7:50 a.m. Cool down of equipment reinitiated

8:17 a.m. Fire declared out
2:41 p.m. “All-Clear” declared on the emergency response; recovery

manager appointed

December 10, 1998

5:00 p.m. A continuous fire watch initiated for equipment

December 12, 1998

3:00 a.m. Holes in process equipment closed

ACTIONS DURING AND FOLLOWING EVENT

- Operation personnel's response was not guided by specifc response procedures
- Personnel evacuation hindered by a lack of respiratory protection equipment
- Emergency response activities effective in confining the fire and limiting safety consequiences
- Problems identified with pre-fire plans, emergency packets, and some staff training
- Management's initial response was inconsistent with the Emergency Plan and was hampered by communication problems

ANALYSIS OF INITIAL COMPENSATORY ACTIONS AND ROOT CAUSE EVALUATION ACTIVITIES

- Process and nearby equipment promptly shut down
- An initial fire protection compensatory measure non-conservative
- Some nuclear criticality safety controls not reestablished for an extended period of time
- Immediate compensatory training was provided on abnormal conditions

and the Emergency Plan

- Ongoing root cause evaluation activities were properly focused and included an appropriate level of technical expertise

HEALTH AND SAFETY PRECAUTIONS AND CONSEQUENCES

- No impact to the public as a result of the event
- Only minor injuries to onsite personnel
- Emergency response personnel were appropriately attired for potential radiological and chemical hazards
- Inadequate pre-staging of respiratory protection equipment
- Problems were noted with the content of some pre-fire plan and emergency packets

CONSEQUENCES OF THE FIRE TO SAFETY-RELATED AND OTHER PLANT EQUIPMENT

- Safety-related plant process equipment, associated with Cell 25-7-2, sustained significant damage
- Seventy-six safety-related fire protection sprinkler heads affected by the fire and replaced
- Minor external heat damage to a safety-related criticality accident alarm system
- Significant damage sustained by the nonsafety-related insulated housing surrounding Cell 25-7-2

POTENTIAL FOR SIMILAR OR PRECURSOR EVENTS

- Probability for similar events highest for the centrifugal compressors
- Consequence of a similar event increases with size of the equipment
- A single maximum risk is assumed in the Safety Analysis Report
- Similar events have occurred previously at Paducah and Portsmouth
- Some current operational, maintenance, and failure analysis practices may not identify precursors to an impending event or indications of a near miss

TECHNICAL SAFETY REQUIREMENT 1.6.4

- An evaluation of the need to enter Technical Safety Requirement 1.6.4, “Conditions Outside the Technical Safety Requirements,” performed
- Current Technical Safety Requirements facility manning limits allowed an area control room to be evacuated during an emergency
- A pro-active post event review of other Technical Safety Requirements was conducted

EVALUATION OF FIRE SUPPRESSION SYSTEM

- The current sprinkler system design basis is adequate
- The fire protection sprinkler system responded as designed
- The fire department attached and extinguished the fire in an appropriate manner
- Some fire department equipment, procedure, and training problems were identified

EVENT NOTIFICATION PROCESS

- Emergency Plan and implementing procedures inconsistent
- Actual event not properly classified as an “Alert”
- Two non-emergency issues were properly reported to the NRC
- One non-emergency issue was incorrectly reported to the NRC on two occasions

SUMMARY OF FINDINGS

- **EMERGENCY RESPONSE TO THE FIRE WAS ADEQUATE**
- **FIRE RESULTED IN MINIMAL IMMEDIATE SAFETY CONSEQUENCES**
- **PROBLEMS WERE IDENTIFIED RELATED TO:**
- **OPERATIONS, FIRE, AND MANAGEMENT TRAINING**
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- **IMPLEMENTATION OF SOME COMPENSATORY AND CORRECTIVE MEASURES**
- **INITIAL ROOT CAUSE EFFORTS APPEARED COMPREHENSIVE**
- **NO OFFSITE CONSEQUENCIES OR IMPACTS TO THE GENERAL PUBLIC**
- **NO SIGNIFICANT PERSONNEL INJURIES**