



July 22, 1998
GDP 98-2036

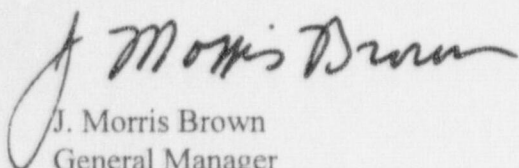
United States Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555-001

Portsmouth Gaseous Diffusion Plant (PORTS)
Docket No. 70-7002
Event Report 98-08, Revision 1

Pursuant to the Safety Analysis Report Section 6.9, Table 6.9-1, J (2), Enclosure 1 provides a revised 30-day Event Report for an event that resulted from the actuation of CADP smokeheads in the X-330 Tails Withdrawal room due to an unplanned release of UF_6 . This event was also reportable in accordance with the 10CFR 76.120(c)(1) because additional radiological controls were imposed in the Tails area for more than 24 hours. The revised event report includes the root cause and corrective actions. Enclosure 2 is a list of commitments contained in the report. Changes from the previous report are marked with a vertical line in the right margin.

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

Sincerely,



J. Morris Brown
General Manager
Portsmouth Gaseous Diffusion Plant

Enclosures: As Stated

cc: NRC Region III Office
NRC Resident Inspector - PORTS

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Description of Event

On May 8, 1998, at 1732 hours, with Tails operating in Mode II (Liquefaction) pressure transmitter PBM-1678 failed allowing depleted UF_6 to release to the Tails Withdrawal room and the immediate vicinity. The resulting UF_6 smoke actuated CADP and Pyrotronics smokeheads in the Tails Withdrawal room. Operations personnel vented the Tails station below atmosphere to limit the amount of material released, and the steam heat for the process piping was valved off. The Fire Department responded and contained the release in about 3 hours by crimping the instrument lines and by using dry ice to freeze out material. Tails was taken out of service and Tails Withdrawal operations were transferred to the Low Assay Withdrawal (LAW) station.

Initial air samples outside the area were less than detectable. Initial Tails Withdrawal room air samples were greater than Plant Allowable Limits. The area was secured by boundaries and a Radiation Work Permit was put in place to control entry/exit of the Tails area. A Recovery Manager was assigned to recovery efforts. This event was reported as a valid actuation of a safety system in accordance with the Safety Analysis Report (SAR) Section 6.9, Table 6.9-1, J (2) and also reported as an unplanned contamination in accordance with 10CFR 76.120(c)(1).

On May 8, 1998, at 0530 hours, steam heating to Tails was taken out of service to perform repairs on a 6" steam valve servicing the north end of the X-330 Process Building. Repairs to the 6" steam valve had been planned for some time and the Work Packages had been previously prepared. The evolution had been delayed several times due to the importance of the Tails operation to the overall operation of the Cascade. On May 7, 1998, X-330 operations personnel recognized that there would not be enough feed Autoclaves available to supply the feed requirements needed for the current production level and that this would create a shortage of Tails material in the Cascade. Given this information, it was determined that this would be an opportune time to conduct the steam line repairs. The evolution was placed on the Plan of the Day for May 8, 1998, and was worked on that date.

On May 5, 1998, at 0510, the Feed Autoclaves had been declared inoperable. This prevented the feeding of Normal and Paducah Product feeds to the Cascade. As a result, SWU production and plant power load gradually decreased, reducing downflow of material to Tails. At the time the Autoclaves were again operable the plant load had decreased from 1100 MW to 966 MW. The Normal feed was resumed on May 8, 1998, at 0515 hours and the Paducah Product feed was resumed at 0525 hours. However, regular downflow rates were not reestablished because inventory was building up in the cells.

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On May 8, 1998, at 0530 hours, Utilities operators valved off the steam to the north end of X-330, including Tails Withdrawal. By 0830 hours during normal shift rounds, the temperature inside the steam heated housings containing the liquid UF_6 piping had fallen to 172 F, below the usual operating range of 180 F or higher. No further temperature readings were taken during the day. Starting at 1321 hours, Operations began to receive the first of three CADP alarms from smokehead SSWG inside the Tails housing. Operators responded, but no evidence of outgassing was detected. The three actuations were determined to be hardware alarms caused by changing temperature of the smokeheads inside the housing.

During the day of May 8, 1998, the Area Control Room (ACR) #2 Operator experienced difficulty obtaining the desired Tails withdrawal rate due to a lack of feed on the Cascade. Although feeding had been resumed, the first several hours of feed were used to return the cell pressures to normal to restore the plant power level. The lack of material caused low pressure in the Bottom Surge Drums during this time. This caused the Tails withdrawal rate to drop to 40 lbs. for the hour between 1200 and 1300 hours. Then at 1300 hours the withdrawal rate dropped to 0 lbs/hr for the next three hours. The accumulator level and bottom drum pressure readings were low, indicating that there was very little material available to withdraw. At 1338 hours the steam header maintenance was completed and the steam was cracked back in at 1430 hours.

At 1640 hours a mode change was approved by the Plant Shift Superintendent (PSS) and the Tails Station was placed in recycle to allow the pressure in the Bottom Surge Drums to increase. At 1730 hours UF_6 condensation was resumed and the Tails Operator was instructed to valve in the UF_6 cylinder. As the Tails Operator entered the Tails Withdrawal room to valve in the cylinder, multiple smoke heads fired. The Operator observed smoke and exited the Tails Withdrawal room to the Tails Porch and closed the doors. He then sounded the gas release alarm.

By 1742 hours, the Fire Department arrived at the scene. The Tails compressors were placed on recycle and the station was vented to below atmospheric pressure. At 1755 hours, Fire Department personnel wearing impermeable suits and self-contained breathing apparatus (SCBA) entered Tails and reported smoke. A possible steam leak was also suspected due to earlier maintenance on the steam system. At 1811 hours, all smokeheads reset. At 1823 hours, the steam was valved off to Tails. Responders determined that smoke was coming from the instrument cabinet that contained pressure transmitter PBM-1678. At 1946 hours, they crimped the instrument lines to the pressure transmitter. By 2027 hours, the smoke was stopped using dry ice to freeze out the instrument lines. At 2312 hours, an all clear was given for the Tails release.

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Cause of Event

The direct cause of the UF₆ release was the rupture of a pressure transmitter high-pressure bellows, which failed allowing UF₆ to release to the Tails Withdrawal room and the immediate vicinity. The pressure transmitter is connected by ¼ inch copper tubing to the 1 ½ inch liquid waste line which drains liquid UF₆ from the Tails condenser area to the Tails Withdrawal cylinders. An engineering evaluation of the failed pressure transmitter concluded that expanding liquid UF₆ created enough hydraulic pressure to rupture the pressure transmitter bellows. It is believed that a solid UF₆ plug existed between the expanding UF₆ and the Tails Withdrawal accumulator. A hydraulic force was created when solid UF₆ that had been frozen out could not expand while being reheated.

The root cause of the event was inadequate planning by operations personnel to identify and implement the necessary monitoring and controls to prevent Tails from freezing out during a steam outage. Operations gave approval to begin the steam outage without establishing a requirement to monitor liquid UF₆ housing temperatures or establishing actions to take if the temperature fell too low. As a result, Tails withdrawal operations continued until the UF₆ housing temperatures dropped to below the UF₆ freezing point. The Daily Operating Instructions for May 8, 1998, contained an instruction that Tails should be monitored closely. However, the instructions were not adequate to describe what should be monitored, how it should be monitored, or what actions to take to prevent a Tails freeze-out.

A contributing cause for the event was inadequate management oversight and control of the steam outage. The plant conditions that existed prior to and during the steam outage were unusual for the plant. No feed material, except a small amount of HEU feed, was being fed to the cascade. The lack of feed is an abnormal condition. When a steam outage is conducted with normal feed rates, Tails temperatures and work progress are closely monitored and the outage time is limited to prevent a freeze-out. Since a freeze-out at Tails would halt plant production, a steam outage normally results in a high level of Management attention and concern.

In this steam outage, due to the location of the maintenance work, there was no alternative steam flow path to Tails Withdrawal. In addition, the autoclaves were out of service for an extended time period. The extended autoclave shutdown was viewed as an opportunity to perform the steam heating system work since Tails withdrawal rates would already be at a minimum due to the lack of downflow. This particular steam outage had been delayed in the past because of concerns that the maintenance activity duration would have exceeded the amount of time that Tails could operate without freezing out. Since the Tails withdrawal rate was already low, it was believed that there would be less risk to production if the steam outage were conducted while the autoclaves were shutdown. The perception of less risk lowered Management's level of attention and concern with the effects of the steam outage. In addition, Management proceeded with the steam outage without

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adequately evaluating the effect that the unusual plant conditions would have on the plant. Management did not recognize that liquid UF_6 would freeze-out more quickly with reduced UF_6 flow. As a result, this steam outage received less management focus in the planning stages and during operations than past steam outages.

A contributing cause was inadequate procedure guidance regarding steam outages at Tails. Procedure XP4-CO-CA3944, "Operations During A Steam Failure" states that the conditions necessary for entering the procedure are a steam failure or impending steam failure. This procedure notes that Tails withdrawals are affected when steam is unavailable for 2 to 3 hours. The procedure also notes that "When a steam outage is necessary, an evaluation should be made to determine what section(s) of the plant is/are affected and to estimate the duration of loss of heat. Temperature survey will determine when critical temperatures are involved." The procedure is confusing because it indicates that it is applicable to steam failures but contains guidance for steam outages. Operations has not previously required the procedure to be used for planned steam outages.

A contributing cause was a lack of procedural guidance for operation of Tails withdrawal during a loss of heat. Procedure XP4-CO-CA2380, "Operation of the Tails Station", did not include actions for loss of steam conditions and did not reference XP4-CO-CA3944. There were no restrictions on maintaining withdrawal during steam outages or requirements for monitoring temperatures. No minimum temperature monitoring was set at which the liquid UF_6 system should be evacuated to prevent freeze-out. Current procedures assumed burping the cylinder to remove accumulated gases would correct a loss of flow into the cylinder. There were no precautions to check for conditions that could indicate a freeze-out in the liquid manifold.

A contributing cause was a lack of procedural guidance to assure liquid line clarity before initiating heat to a zone which could have frozen out material. Tails equipment and piping is enclosed in several separate heating zones consisting of housings heated by indirect steam or electric heaters. The Tails liquid line runs through four steam heated zones. The instrument line to the failed PBM runs through two steam heated zones and one electrically heated instrument cabinet. While in operation, the heaters maintain the zones at fairly constant temperatures. However, there is no documentation as to the rate at which each zone cools or heats up to the UF_6 melting point.

Approximately eight hours after steam was isolated from Tails, the Tails operator observed that the Tails withdrawal rate went to zero. The ACR operator also observed that the accumulator level was not rising and concluded that the loss of flow was due to lack of downflow caused by the reduced level of feed from the autoclaves. The operator was focused on the abnormal feed condition and did not consider that a loss of tails withdrawal could also indicate that freeze-out had occurred. At 1605

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hours, Tails was valved off after the ACR operator requested a Mode change because of low pressure in the bottom drums. The Tails operator suspected that the pigtail might have frozen out which would also be a cause for the lack of flow. The pigtail was valved to the evacuation header per procedure and Tails was placed on recycle. Both operators were aware that the steam had been valved off earlier, but did not recognize that the liquid UF_6 manifold had also frozen out.

Laboratory analysis was conducted on the failed PBM transmitter, manufactured by the Taylor Instrument Companies of Rochester, NY, series 339RA, size 00 (100 psia maximum pressure rating). The analysis concluded that the transmitter high pressure bellows failed by ductile overload resulting from a pressure rise. The pressure rise was attributed to the volume expansion of UF_6 during the phase change from solid to liquid as it was heated. The rupture of the bellows occurred circumferentially adjacent to the high pressure inlet fitting to bellows braze joint. The circumferential, rather than longitudinal, nature of the failure may be attributed to the stress concentration of the joint, the stiffening of the convolutions of the bellows, and the wall thickness in the vicinity of the failure. The estimated pressure required to cause this failure exceeded 2000 psia.

The low pressure chamber from instrument PBM-1678 failed by ductile impact loading. The source of the impact was attributed to a sudden pressure rise and possibly the force of liquid impingement as a result of the high pressure bellows rupture inside the low pressure chamber.

A preliminary Engineering evaluation was conducted on the hydraulic failure of the transmitter bellows. The evaluation determined that it was possible for enough solid UF_6 to freeze out in the $\frac{1}{4}$ inch copper instrument line to have created the volume of liquid UF_6 necessary to have ruptured the transmitter bellows. The evaluation also determined that it was possible that liquid UF_6 formed in the $1\frac{1}{2}$ inch liquid line and created sufficient volume and pressure to cause the failure. The evaluation identified that different rates of heating in different portions of the heated housings could cause one portion of the equipment to heat faster and liquefy UF_6 before an adjacent solid UF_6 plug melted, causing hydraulic pressure. The evaluation results are considered preliminary since additional testing and inspection of Tails equipment is needed to confirm the suspected failure mechanism. Following completion of this work, an Engineering evaluation of the test and inspection results will be performed. If the evaluation results in significant new findings, conclusions or corrective actions, this report will be updated to include this information.

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Corrective Actions

A. Corrective Actions Taken

1. On May 9, 1998, Operations issued a Daily Operating Instruction to require that procedure XP4-CO-CA3944 be implemented during any steam outage.
2. On May 19, 1998, a Lessons Learned Bulletin was issued to operations personnel describing the event and the initial lessons learned.
3. On May 19, 1998, upon receiving the draft engineering evaluation describing the cause of the failure, Operations issued a Daily Operating Instruction to specify the actions to be taken if heat is lost and/or housing temperatures associated with liquid UF₆ drop below the desired temperature. This action provides guidance to operations personnel until the procedure revisions are implemented.
4. On May 27, 1998, revisions to XP4-CO-CA3944, XP4-CO-CA2340 "Operation of the ERP Station", XP4-CO-CA2360 "Operation of the LAW Station", and XP4-CO-CA2380 were initiated to provide guidance regarding temperature monitoring during steam outages and actions to be taken prior to reestablishing heat if temperatures fall below the desired level.
5. On June 26, 1998, Operations implemented a procedure for establishing Management Control of infrequently performed tests or evolutions within the Operations Organization.
6. On July 6, 1998, Operations revised Cascade Withdrawal Station procedures (XP4-CO-CA2380, XP4-CO-CA2360, XP4-CO-CA2340) to provide actions to be taken when housing temperatures are falling but >160 F, or when temperatures decrease to <160 F.
7. On July 6, 1998, Operations revised Cascade Withdrawal Station procedures (XP4-CO-CA2380, XP4-CO-CA2360, XP4-CO-CA2340) to provide actions for performing liquid line clarity checks related to a loss of heat condition and to provide process indications that may be indicative of a liquid line freeze-out.

B. Corrective Actions Planned

1. By November 30, 1998, Operations will revise procedure XP4-CO-CA3944, "Operations during a Steam Failure," to incorporate instructions for planned steam outages in addition to steam failures.

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Extent of Exposure of Individuals to Radiation or Radioactive Materials

The UF_6 release at Tails had no impact on the environment and little impact on personnel. Health Physics performed monitoring for hydrogen fluoride outside Tails during the release and no HF was detected in the outside areas surrounding Tails. A radiological air sample was performed on the Tails loading dock during the release and no airborne radioactivity above the site limit of 1×10^{-11} uCi/ml was detected. The Tails loading dock, exhaust ducts on the X-330 roof above Tails, the ventilation louver and ground under the louver on the north side of Tails were surveyed for removable contamination attributed to the release. No contamination above the site limit of 1000 dpm/100 cm^2 was detected. There was a small amount of contamination found on the operating floor of the X-330 on the nearest supply fan and on the floor around the supply fan. There was also a small amount of contamination found on the cell floor in the vicinity of the discharge from the supply fan. This contamination was all contained within the building.

The Tails withdrawal area was contaminated due to the release and a boundary was established surrounding the entire withdrawal area. The maximum removable contamination levels found by the initial Health Physics surveys in Tails was 7000 dpm/100 cm^2 beta and 4000 dpm/100 cm^2 alpha. Subsequent surveys performed by HP after the emergency response found a maximum level of 21,000 dpm/100 cm^2 removable alpha contamination in the PBM-1678 instrument cabinet. Additional radiological controls were implemented for access to the Tails area, which included full anti-c clothing and a full face respirator.

The Tails operator who initiated the "see and flee" submitted a urine sample for analysis. The Radiological Intake Assessment for the operator indicated that the intake of soluble uranium was 0.003 mg of U. This is well below the limit of 10 mg of soluble uranium per week. The operator was assigned a dose of 0 mrem based on this assessment. A Radiological Intake Assessment was also performed for the operations FLM who responded to the scene. His intake was determined to be 0.004 mg of uranium with an assigned dose of 0 mrem. The emergency responders from the Fire Department wore SCBA upon entry into Tails and the HP entry team for the emergency response wore full face respirators upon entry into Tails. Based on air samples in Tails and the peak reading on the Continuous Air Monitor that was located in Tails, this level of respiratory Protection was adequate for the amount of airborne radioactivity in Tails during the incident and no urinalysis was required for the emergency responders.

The exact quantity of UF_6 released during the event could not be determined. However, Engineering has estimated that approximately 39 pounds of UF_6 was released.

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Lessons Learned

Systems, such as withdrawal stations, which are designed with baffles and zone heat application provide the greatest risk when reapplying indirect heat to the UF₆ system. The reapplication of heat to a system with a solid UF₆ plug has the potential to damage/rupture the equipment. Procedure guidance must be provided to operating personnel to assist them in recognizing plant conditions that may lead to a UF₆ freeze-out and to direct the necessary actions to ensure safe plant conditions are maintained.

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List of Commitments

1. By November 30, 1998, Operations will revise procedure XP4-CO-CA3944, "Operations during a Steam Failure," to incorporate instructions for planned steam outages in addition to steam failures.