

U. S. NUCLEAR REGULATORY COMMISSION

REGION III

Docket No: 040-03392
License No: SUB-526
Report No: 040-03392/96007(DNMS)
Licensee: AlliedSignal, Inc.
Facility: Metropolis Works
Location: P.O. Box 430
Metropolis, IL 62960
Dates: December 16, 1996, through January 10, 1997
Inspectors: J. Jacobson, Resident Inspector
Paducah Resident Inspector Office
T. Tella, Senior Electrical Inspector
Approved by: G. Shear, Chief, Fuel Cycle Branch
Division of Nuclear Materials Safety

EXECUTIVE SUMMARY

AlliedSignal, Inc., Metropolis Works
NRC Inspection Report 040-03392/96007(DNMS)

This inspection involved a review of a release of fluorinator offgasses containing some uranium hexafluoride (UF_6) from the ash dust collector on December 16, 1996, that resulted in the licensee declaring an Alert. The following findings were identified:

- The event was terminated within approximately 30 minutes after operations personnel returned the fluorination unit valves to the normal line-up, and emergency response personnel using appropriate personal protective equipment ensured the Feed Materials Building (FMB) was safe for continued operations. No additional sources for chemical releases were identified subsequent to the release from the ash dust collector on the sixth floor of the FMB.
- The radiological and chemical consequences of the event were minor and limited to personnel involved with the event or emergency response. The maximum intake was less than 1 milligram of soluble uranium and 3 millirem committed effective dose equivalent, both of which were below licensee action levels for consideration of work restriction. No elevated concentrations of uranium were noted at the restricted area fenceline.
- The failure to shut off the fluidizing air for the fluorination reactors which resulted in a release from the ash dust collector, after its capacity for handling offgasses was overcome, was identified as a violation. The violation was another example of a concern noted in previous inspection reports regarding the rigor of the licensee's program for procedure development and review. (VIO 040-03392/96007-01)

PARTIAL LIST OF PERSONS CONTACTED

Licensee Personnel

B. Bass, Electrical Maintenance Supervisor
P. Gasperini, Customer-Linked Manufacturing (CLM) Manager
*M. Kosmider, Plant Manager
H. Roberts, Supervisor, Safety and Health Physics
M. Shephard, Regulatory Affairs Manager
S. Stewart-Powers, Supervisor of Health Physics Technicians
T. Story, Reliability Supervisor

*Senior licensee official at the exit meeting on January 10, 1997. Other licensee personnel were contacted as part of the reactive inspection.

NRC Personnel

C. Blanchard, Fuel Facility Inspector, Region III
J. Jacobson, Resident Inspector, Paducah Resident Inspector Office
R. Krsek, Fuel Facility Inspector, Region III
T. Reidinger, Senior Fuel Facility Inspector, Region III
G. Shear, Chief, Fuel Cycle Branch, Region III

Report Details

1. Event Summary

Inspection Scope

The inspectors held discussions with personnel involved in the event, performed a tour of the affected areas, and reviewed the licensee's incident report to understand the sequence of events for the incident.

Observations and Findings

The release event began at approximately 9:02 a.m. on December 16, when the electrical breaker (FF-2) supplying power to the licensee's distillation vacuum pumps tripped. The pumps provided the motive force (source of vacuum) to draw fluorine from the fluorine plant through the fluorination reactors (fluorinators) where uranium hexafluoride (UF_6) was produced. The gaseous UF_6 product and associated offgasses were then drawn from the fluorinators through filters to cold traps where the gaseous UF_6 was solidified. The licensee normally operated two fluorinators and maintained one in standby.

At the time the power to the distillation vacuum pumps was lost, the fluorination operator and his foreman were in the control room of the Feed Materials Building (FMB). The foreman left the control room on the second floor of the FMB to check the breaker which was located outside the building. When he arrived at the electrical substation, he found an electrician had already arrived. The electrician subsequently reset the FF-2 breaker, and power to the distillation pumps was restored at approximately 9:12 a.m. The foreman returned to the control room after helping a fluorination assistant operator restart pumps on the "south pad," located directly outside the FMB, and resetting the distillation vacuum pumps. The foreman and an assistant operator also noted that the number 3 alkali pump for the scrubber on the south pad would not start.

While the foreman was outside the FMB control room, the fluorination operator entered into the long-term loss of power procedure. This involved calling the fluorine generation plant to have the fluorine supply shut off, then leaving the control room to valve the offgasses from the fluorinators to the ash dust collector on the sixth floor of the FMB, and to close the outlet valves on the tertiary cold traps (the last part of the system of cold traps). The next step of the procedure called for the operator to shut off the fluidizing bed air and pneumatic injectors for the fluorinators. The operator did not accomplish this step because when he returned to the control room, the foreman had returned from the substation and informed him that power had been restored. The operator noted that the vacuum pumps were running again and directed an assistant operator to go into the building and return the fluorinator and cold trap valves to their normal lineup.

At approximately 9:20 a.m., the Customer-Linked Manufacturing (CLM) Manager, who happened to be walking in and around the FMB, noticed that "smoke" was emanating from the sixth floor and concentrating over the south pad directly outside the FMB. (A heavy rain occurred during and after the event.) The CLM Manager called the control room and had the fluorination operator sound the evacuation alarm at approximately 9:21 a.m.

2.0 Licensee Response to Event

2.1 Inspection Scope

The inspectors evaluated the licensee's response to the event and its consequences by discussions with a number of the personnel involved, review of the incident report, attendance at the post-event critique, and review of the notification records and sampling records for the event.

2.2 Emergency Response

The licensee's event response appeared to be timely and well-coordinated. Accountability of personnel on-site was accomplished in a timely manner. Response teams attired in chemical suits and supplied compressed-air breathing apparatuses re-entered the building from the control room (under positive pressure) to ensure that the valve line-up from the fluorinators to the cold traps was the correct line-up and to look for other potential sources of the release. After approximately 30 minutes, the haze had cleared, a walk-through was performed by the Chief Control Officer, and clearance for reentry with half-face piece respirators was given. The inspectors noted that notifications of off-site agencies were made within the required one-hour timeframe. No offsite assistance was required as a result of the event.

2.3 Radiological Protection Consequences

The licensee placed two portable air samplers in the affected areas after the release was secured. In addition, a health physics technician collected the filters from the licensee's fixed area air samplers in the FMB. Two-hour fixed air samples were taken after the event in accordance with licensee procedures. Elevated air concentration results were obtained for all floors of the FMB and the area directly outside the building near the south pad. However, all sample results were less than 20 percent of the derived air concentration (DAC) for soluble uranium. The DAC defines the airborne concentration for an Airborne Radioactivity Area (ARA). Pursuant to 10 CFR 20, licensees are required to consider implementation of additional protective measures such as use of appropriate respiratory protection for ARAs. As a precautionary measure, licensee procedure required personnel to wear half-face piece respirators for FMB floors with average concentrations of 30 percent of the DAC for uranium green salt (UF_4), a more conservative DAC than that for UF_6 .

A review of the urinalysis results for individuals working in the building or involved in the event indicated that of the 51 personnel sampled for potential exposure to UF_6 , 14 had urine uranium concentrations above the licensee's resample level of 15 micrograms per liter (ug/l). The maximum concentration obtained for any individual was 210 ug/l. This concentration was calculated to result in an internal dose of 3 millirem and an intake of less than 1 milligram of soluble uranium, both of which are below the action levels for consideration of work restriction required by the license. (1.5 REM or 10 milligram soluble uranium/week)

In addition to the air samples inside and near the FMB, the inspectors reviewed the air sample results for the licensee's fence line (environmental) fixed air samplers. Sample results were below 5 percent of the annual average concentration for UF_6 and no abnormal concentrations were observed. Based on the sample results and the heavy rain which occurred during and after the event, the inspectors concluded that none of the material released reached the boundary of the licensee's restricted area.

2.5 Conclusion

The release caused elevated uranium concentrations in the FMB, but did not affect areas offsite. The licensee's emergency response actions were conducted in accordance with procedures and notifications of offsite agencies were made in a timely manner. There were negligible consequences as a result of the event to responders. The licensee implemented precautionary measures after the release was terminated to ensure there were no additional consequences to workers in the FMB.

3.0 Root Cause Investigation

3.1 Inspection Scope

The inspectors reviewed the licensee's investigation of the event and performed an independent assessment of the circumstances surrounding the release. The assessment was based on:

- Discussions with the operations and maintenance staff involved.
- Discussions with members of the investigation team.
- Review of the incident and investigation reports.
- Observation of as-found conditions in the FMB.
- Review of applicable procedures in the Fluorination Manual, including Section 2.0, "Emergency Shutdown."

3.2 Findings and Observations

The licensee's formal investigation began promptly on the day of the event. The licensee's investigation identified the root cause of the event as the failed connection on the number 3 alkali pump associated with an offgas scrubber. The current overload due to the bad connection

(in conjunction with a ground in a cable conduit for one of the distillation pumps) caused the FF-2 breaker to trip. The trip caused a loss of power to the vacuum pumps providing the motive force for the fluorination product and offgasses. The licensee also identified a weakness in the loss-of-power procedure in the Fluorination Manual. The long-term power outage procedure required the operator to valve the fluorinator offgasses to the ash dust collector before shutting off the fluidizing air to the fluorinators.

The inspectors' review of the event indicated that a root cause of the release was the ambiguity of the guidance provided in the emergency shutdown procedure for the fluorination operator which led to the operator valving the fluorinators to the ash dust collector without shutting off the fluidizing air. The emergency procedure was divided into two parts: one for a long-duration power failure and one for a short-duration power failure. The operator was required to make a judgment as to which part of the procedure applied based on whether or not the emergency power system (standby diesel generator) was activated (usually for an outage lasting 10 minutes or more). However, operators indicated that, based on the limited knowledge available, they often assumed the power failure was going to last for a significant period of time and entered into the long-duration part of the procedure as a precaution. The inspectors also noted that the procedure only addressed the loss of power for the entire plant, not the partial loss of power caused by the failure of a breaker or substation.

The inspectors also learned that the same breaker (FF-2) had tripped three times during the previous month of November 1996, causing power outages of 5-10 minutes. These trips also occurred during periods of rain. However, the operations staff indicated that the long-duration power failure part of the emergency procedure had not been implemented during these outages, and no releases occurred. The Plant Manager stated that the cold traps maintained the capacity to handle the offgasses from the fluorinators for a period of time after loss of the vacuum on the system. The similar FF-2 breaker trips in November without implementation of the long-duration power failure procedure and without a subsequent release indicated to the inspectors that the implementation of the long-duration power failure procedure for the December 16 event was the root cause for the release. These events also indicated that different operators apparently had different understandings of which part of the emergency shutdown procedure to enter upon a partial loss of power due to the FF-2 breaker trip.

The Fluorination Manual section for the long-duration power failure specified that fluidizing air was to be turned off after valving the fluorinators to the ash dust collector. The operator completed the first few steps of the procedure, but did not complete step 4 of Section 2.2.1 requiring that fluidizing air and the pneumatic injectors for the fluorinators be shut off. When he returned to the control room, he learned that power to the distillation pumps had been restored. As a result, he entered into the "power returns" section of the manual and

instructed an assistant operator to return the fluorinator valves to the normal line-up. The volume of offgasses/air which reached the dust collector during this interval overwhelmed its capacity and a release occurred.

License Condition 10 requires the licensee to use licensed source material (UF_6) in accordance with the statements, representations, and conditions in Chapters 1 through 7 of the application dated July 11, 1994, with supplements. Section 2.6 of Chapter 2 of the application requires that plant operations be conducted in accordance with "Standard Operating Procedure Manuals." The failure to shut off the fluidizing air to the fluorinators in accordance with the instructions in the Fluorination Manual is considered a violation. The violation, stemming from the ambiguity in the procedure manual section for emergency shutdown, was another example of a concern noted in previous inspection reports regarding the rigor of the licensee's program for procedure development and review. (VIO 040-03392/96007-01)

A contributing cause for the event was the FF-2 breaker trip caused by a ground in the motor junction box of the alkali circulation pump number 3 (a non-critical load) and a ground in the cable conduit for one of the distillation vacuum pumps (B1). The subsequent loss of power to the critical loads connected to the breaker caused the fluorination operator to enter the emergency shutdown procedure for the fluorination unit. The licensee stated that potential causes for the junction box ground were age-related corrosion and moisture ingress into the junction box, but the amount of charring from the ground precluded the identification of the root cause. Potential causes for the ground in the cable conduit were vibration of the cable (with subsequent degradation of the insulation) and moisture in the conduit.

Another contributing cause for the event was the lack of good communication between the shift foreman and the fluorination operator at the start of the event. Both individuals were in the control room at the time the FF-2 breaker tripped. However, the shift foreman initiated a course of action to quickly reset the breaker and did not communicate his assessment to the operator. The operator assessed the situation as a potentially long-duration power outage and initiated a course of action under the power failure procedure to shut down the fluorination unit. Had the operator been aware that the power outage was potentially short-term, he may have entered the short-duration power procedure or not taken any immediate actions at all. This appeared to be the response to the previous breaker trips which did not result in a release.

During the review, the licensee identified to the inspectors that an ash dust collector switch in the control room was not shown on the plant's electrical drawings. The inspectors reviewed the plant's electrical drawings and noted this discrepancy. Even though two switches were installed (in parallel) to start the Ash Dust Collector pump (P-454), only one switch (P22-1) was shown on the electrical wiring diagram (No. 510398, Revision P, issued in 10/95). The second start switch had

been installed in the control room a few years earlier, but the drawing was not revised to reflect this modification. The licensee's electrical staff indicated that keeping electrical drawings current was an ongoing concern.

3.3 Conclusion

The licensee's root cause investigation identified the basic causes of the event, i.e., the problem with the sequence of steps in the fluorination emergency shutdown procedure and the electrical grounds which tripped the breaker and caused the loss of power to the distillation vacuum pumps. The ambiguity in the procedure in terms of providing clear guidance for the operator for a partial loss of power and weak communications between the shift foreman and the fluorination operator led to the failure of the operator to shut off the fluidizing bed air, a violation of the Fluorination Manual procedure.

4. Corrective Actions

4.1 Inspection Scope

The inspectors reviewed the recommendations for corrective action that were developed by the formal investigation team and documented in the licensee's investigation report for the event.

4.2 Findings and Observations

The licensee developed a number of corrective actions to address the causes for the event and to improve conduct of operations during a loss of power incident. These included:

- Fixing the electrical grounds which caused the FF-2 breaker to trip.
- Modifying the procedure for emergency shutdown of the fluorinators to improve its clarity, simplify it by combining sections, and ensure prompt shutoff of the bed fluidizing air for the fluorinators.
- Training fluorination personnel on the revised procedure.
- Establishing a production operator/supervisor team to evaluate the plant's loss of power procedures for additional improvements or clarification.
- Conducting a review with the UF₆ process hazard analysis team to analyze electrical substation outage effects on the electrical distribution to critical areas of the UF₆ process.
- Checking all electrical enclosures on the exterior equipment on the south pad of the FMB for additional problems with connections, insulation, conduits, etc.
- Establishing a routine inspection program by electricians for ground detection on the electrical feeder cables from the F substation.

- Placing weep holes in cable conduits/junctions where water could collect.
- Replacing and potentially relocating the F substation during 1997. (This had been scheduled prior to the event.)
- A plant-wide effort to review and upgrade all plant procedures with completion expected in February 1997.

4.3 Conclusion

The inspectors concluded that the licensee's corrective actions addressed the causes identified for the event. The revision to the emergency shutdown procedure addressed the immediate concern over the sequence of steps the operator was required to take in shutting down the fluorination unit and clarified the procedure by combining the power failure sections into one set of actions. A production team was tasked to provide a long-term review of the structure and guidance in the loss of power procedures. The identification of the electrical grounds which caused the FF-2 breaker to trip and the establishment of a routine ground inspection program by the electricians addressed the electrical problems associated with the event.

5. Exit Meeting Summary

The inspector presented the inspection results to the Plant Manager and others at the conclusion of the inspection on January 10, 1997. The inspector summarized the scope and findings of the inspection including the potential for a violation.

The licensee did not indicate that any of the items discussed during the exit meeting were considered proprietary.