UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
SAM NUNN ATLANTA FEDERAL CENTER
61 FORSYTH STREET SW SUITE 23T85
ATLANTA, GEORGIA 30303-8931

February 3, 2004

Mr. Rory J. O'Kane
Plant Manager
Honeywell Specialty Chemicals
P.O. Box 430
Metropolis, IL 62690

SUBJECT: AUGMENTED INSPECTION TEAM REVIEW OF THE DECEMBER 22, 2003, SITE AREA EMERGENCY (INSPECTION REPORT NO. 40-3392/2004-001 - HONEYWELL)

Dear Mr. O'Kane:

This report refers to a special review by an NRC Augmented Inspection Team (AIT) on December 22, 2003, through January 6, 2004, at the Honeywell Specialty Chemicals facility. The purpose of the AIT was to review the circumstances regarding the December 22, 2003, release of uranium hexafluoride and subsequent Site Area Emergency. A copy of the AIT Charter is included as Enclosure 1. The inspection consisted of a selective examination of procedures and representative records, observations of activities in progress, and interviews with personnel. At the conclusion of the inspection on January 6, 2004, the NRC inspectors discussed the findings with members of your staff during a meeting open to the public.

The AIT objectives were to: (1) determine the facts surrounding the specific event; (2) assess the licensee's response to the event; (3) assess the licensee's activity during their event review and recovery; (4) identify root causes; and (5) assess the public health and safety impact of the event. The AIT determined that the event's immediate safety consequences were minimal based on the results of air, soil and vegetation samples and bioassays taken after the release event, release calculations, and the fact that there were no significant injuries to plant employees or members of the public. However, several issues were identified regarding the lack of rigor in implementing both your routine operations and emergency response activities. The AIT also concluded that immediate corrective actions taken in response to several previous events were ineffective in preventing the latest incident.

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

In accordance with 10 CFR 2.790 of the NRC's "Rules of Practice," a copy of this letter, its enclosures, and your response will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's document system (ADAMS), accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html. To the extent possible, your response should not include any personal privacy, proprietary, or safeguards information so that it can be made available to the Public without redaction.

If you have any questions concerning this inspection, please contact Jay L. Henson at (404) 562-4731.

Sincerely,

/RA/

Luis A. Reyes
Regional Administrator

Docket No. 40-3392
License No. SUB-526

Enclosures:
1. AIT Charter w/attachment
2. NRC Inspection Report No. 40-3392/2004-001 w/attachment

cc w/encls:
Gary Wright
Emergency Management Agency
Division of Nuclear Safety
1035 Outer Park Dr., 5th Floor
Springfield, IL 62704

Distribution w/encls: (See Page 3)

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DATE	1/28/2004	1/28/2004	1/28/2004	1/2004	2/2/2004	2/2/2004	2/3/2004
E-MAIL	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO
PUBLIC	YES NO						

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December 22, 2003

MEMORANDUM TO: Jay L. Henson
Team Leader
Augmented Inspection Team

FROM: Luis A. Reyes **/RA/**
Regional Administrator

SUBJECT: AUGMENTED INSPECTION TEAM CHARTER

An Augmented Inspection Team (AIT) has been established to inspect and assess the Honeywell uranium hexafluoride (UF6) release of December 22, 2003. You are hereby designated as Team Leader.

The team composition is as follows:

Team Leader: J. Henson (RII)

Team Members: M. Baker (NMSS)
R. Gibson (RII)
M. Crespo (RII)
D. Hartland (RII)

The objectives of the inspection are to: (1) determine the facts surrounding the specific event; (2) assess the licensee's response to the event; (3) assess the licensee's activity during their event review and recovery; (4) identify root causes; and (5) assess the public health and safety impact of the event.

For the period during which you are leading the inspection and documenting the results, you shall report directly to me. The guidance of NRC Inspection Procedure 93800, "Augmented Inspection Team," and Management Directive 8.3, "NRC Incident Investigation Procedures," apply to your inspection. If you have any questions regarding the objectives of the attached charter, contact me.

Attachment: AIT Charter

cc w/attachment:
C. Paperiello, EDO/DEDMRS
M. Virgilio, NMSS
R. Zimmerman, NSIR

Enclosure 1

AUGMENTED INSPECTION TEAM CHARTER
HONEYWELL INTERNATIONAL, INC.
URANIUM HEXAFLUORIDE RELEASE

Basis for the formation of the AIT - On December 22, 2003, during changes in operations of the fluorinators, there was a UF6 leak that lead to an offsite release. This resulted in the declaration of a Site Area Emergency and the evacuation and sheltering of members of the public off site. This event meets the criteria of Management Directive 8.3 for an Augmented Inspection Team, in that the event resulted in a release of source material that resulted in occupational exposure and exposure to members of the public.

Objectives of the AIT - The objectives of the inspection are to: (1) determine the facts surrounding the specific event; (2) assess the licensee's response to the event; (3) assess the licensee's activity during their event review and recovery; (4) identify root causes; and (5) assess the public health and safety impact of the event.

The following will be performed:

- Develop a sequence of events associated with the event of concern.
- Assess the performance of plant systems and equipment during the event, including any pre-existing conditions that may have contributed to the event..
- Assess the performance of operators and supervision before and during the event.
- Assess procedures, training and operator tools and aids used during the evolution leading to the event.
- Assess the licensee's evaluation of the health and safety impacts of the event to workers, members of the public, and environment.
- Assess the licensee's activities related to the event investigation (e.g., root cause analysis, extent of condition, precursor event review, etc.) and evaluate the effectiveness of the licensee's event review team. In assessing the licensee's root-cause analysis, the team shall consider the areas reviewed under the recently conducted restart inspection. Given the similarity of this event to earlier events, it is not clear that the licensee conducted a complete root-cause investigation or implemented effective corrective actions.
- Assess the licensee's activities related to event emergency response including coordination with offsite organizations and notifications to the public.
- Conduct an exit meeting open to the public.
- Document the inspection findings and conclusions in an inspection report within 30 days of the inspection.

Attachment

U.S. NUCLEAR REGULATORY COMMISSION

REGION II

AUGMENTED INSPECTION TEAM

Docket No.	40-3392
License No.	SUB-526
Report No.	40-3392/2004-001
Licensee:	Honeywell International, Inc.
Facility:	Metropolis Works
Location:	P. O. Box 430 Metropolis, IL 62960
Dates:	December 22, 2003 through January 6, 2004
Inspectors:	David J. Hartland, Senior Fuel Facility Inspector, Region II Merritt N. Baker, Senior Fuel Facility Inspector, NMSS Manuel G. Crespo, Fuel Facility Inspector, Region II Richard Gibson, Jr., Health Physicist, Region II
Approved By:	Jay L. Henson, Chief Fuel Facility Inspection Branch 2 Division of Fuel Facility Inspection

Enclosure 2

EXECUTIVE SUMMARY

Honeywell International, Inc.
NRC Inspection Report 40-3392/2004-001

The purpose of the Augmented Inspection Team (AIT) was to review the circumstances regarding the December 22, 2003, release of uranium hexafluoride and subsequent Site Area Emergency. To accomplish this purpose, the AIT objectives were to: (1) determine the facts surrounding the specific event; (2) assess the licensee's response to the event; (3) assess the licensee's activity during their event review and recovery; (4) identify root causes; and (5) assess the public health and safety impact of the event.

Event Description

Shortly after midnight on December 22, 2003, licensee staff in the Feed Materials Building (FMB) were in the process of reconfiguring the piping in the fluorination and pollution control systems so that they could change from operating just one of the three available lines (lines A, B, and C) to operating two simultaneously (A and C lines). The plant was in a hot stand-by condition and was not in the process of producing uranium hexafluoride (UF_6). During the second part of the reconfiguration process, a licensee employee failed to place two valves (dust collector and system valves) on each line in the appropriate positions (e.g., open or closed) and as a result, the equipment and piping running from the fluorinators to the valves downstream of the cold traps became pressurized with fluidizing air and UF_6. The UF_6 came from the distillation units which were in the recycle mode. When in recycle, approximately 300 pounds per hour of UF_6 enters the system and under normal operating conditions (system under negative pressure), flows into the cold traps. At approximately 2:00 a.m., the increasing pressure caused the C-minus control valve to leak UF_6 into the FMB. A shift supervisor observed evidence of the leak and initiated the licensee's emergency response procedures. The first team sent in to stop the UF_6 release opened the dust collector valves and closed the system valves, which was the position these valves should have been in during the second part of the reconfiguration process. When the dust collector valves were opened, the UF_6 that had migrated into the piping and equipment from the distillation system, overcame the dust collection system and was exhausted out of the building. The UF_6 cloud that formed after the release was observed going beyond the site boundary, and the licensee declared a Site Area Emergency.

Licensee Event Response

The licensee's initial response actions were consistent with the Radiological Contingency Plan. Communications to off-site agencies regarding the Site Area Emergency (SAE) declaration were made within the required time frame. The licensee informed the local emergency responders to evacuate everyone in the surrounding area. However, communications with local emergency responders were not maintained and were not complete in that they did not provide additional information that would have assisted local authorities in their response decisions. In addition, the individual designated to make recommendations regarding the SAE declaration was unaware of his responsibilities, and the licensee did not apply any further assessment to determine further recommendations.

Assessment of Licensee' s Investigation and Corrective Actions From Recent Events

The inspectors concluded that the time line and sequence of events developed by the licensee's investigative team was accurate and consistent with the sequence of events developed by the inspectors. The inspectors determined that the licensee's estimate of a seven pound uranium hexafluoride release also appeared to be reasonable. The licensee's efforts to determine the root causes and implement effective corrective actions were still in progress at the end of the inspection.

The inspectors concluded that enhanced expectations regarding adherence to procedures that were implemented in response to previous events were not followed, as activities related to dual train fluorinator operation were not covered by a procedure and operators did not stop work and have a procedure developed or revised as required.

Root Causes/Contributing Factors

The failure to place the dust collector and system valves in the proper positions during the second part of the fluorinator reconfiguration effort resulted in a pressurization of the system and the eventual release of UF_6 primarily from the C-minus control valve and from a few other minor release points in the system. The licensee employee who was responsible for the correct placement of the valve positions had received the required training to perform his job duties as an Assistant Flourine Operator (AFO).

The licensee relied upon the AFO's training and experience to ensure the reconfiguration was appropriately accomplished. The reconfiguration of the fluorinator system was an infrequently performed activity (e.g. one or two times per year) and was not always performed on the same shift or by the same employees. The AFO was provided a special work permit that included a "lock-out/tag-out" list of 21 items that he was required to place in specific conditions for the second part of the reconfiguration. The dust collector and system valves were not included in this list. In addition, there was no other procedure or checklist for use by the AFO that described the correct positions of these valves for this reconfiguration and there was no supervisory oversight or other staff review of the valve positions during the reconfiguration process to ensure they were in the proper position. The AFO was working a double shift, and fatigue could have contributed to his failure to remember to place the valves in the correct positions.

Equipment failures did not directly cause the event, but did have some impact on the release of UF_6. The failure of the bellows in the C-minus control valve allowed the pressurized UF_6 to leak from the system. After the UF_6 leak was detected on December 22, 2003, the failure of the seal liquor pump/motor coupling, which was required for restart of the Nash pollution control pumps, delayed re-establishment of system vacuum. If these pumps could have been started in a timely manner, the duration of the release would have been reduced. An equipment design issue did contribute to the failure of the licensee to detect the pressurization of the system before it reached a level to cause the UF_6 to leak from the system. The system pressure indicator instruments required direct observation by operators to monitor pressure conditions. There were no visible or audible indicators of the change in pressure. In addition, the Distillation Operator and assistants were not informed of the reconfiguration that was to occur and were therefore not aware that the system relied upon to maintain a negative pressure would be taken off line.

Impact on Public Health and Safety

Based on air, vegetation and soil samples, bioassays of workers and members of the public, and calculations of the quantity of UF_6 released from the system, the inspectors concluded that the release had minimal impact on worker and public health and safety and any exposures were below NRC regulatory limits. The inspectors had to prompt the licensee to perform environmental samples as required by the Radiological Contingency Plan.

REPORT DETAILS

1. Event Description

The event description was independently developed and validated by the inspectors using a review of control room and emergency response logs and interviews with personnel directly involved with activities prior to and during the release.

On December 21, 2003, at the end of the 3:00 p.m. to 11:00 p.m. shift (A-shift), the A-train of the fluorinator system in the Feed Materials Building (FMB) was placed in a stand-by condition so that members of the following shift could reconfigure the system. Beginning on the 11:00 p.m. to 7:00 a.m. shift (B-shift), on December 21, 2003, production and maintenance personnel were tasked with reconfiguring the fluorination system so that they could run two of the three fluorinators instead of just one. The C-train fluorinator had remained in a hot stand-by condition since December 6, 2003, and was going to be brought back on line with the A-train fluorinator after the system was reconfigured.

While the fluorination systems were in stand-by, they were purged with fluidizing gas (nitrogen) that enters the system at a pressure of 90 psi. Both the A and C-trains were under purge when an assistant fluorine operator (AFO) was assigned the task of preparing the A and C-train fluorinators so maintenance staff could reconfigure the fluorine feed piping in the system to allow for dual operation. While performing this part of the reconfiguration, the routine pollution control system, which used negative pressure provided by four Nash pumps to move the UF_6 and associated waste material through the system, would remain on line. The AFO accomplished his tasks associated with the fluorinator piping reconfiguration at approximately midnight.

The second part of the system reconfiguration required that the Nash pump system be taken off line so that the piping could be rerouted to connect each of the two fluorinator lines with two Nash pumps to provide the required negative pressure. The AFO was provided a special work permit that included 21 lock-out/tag-out steps to accomplish this task. The first step required closing and locking the tertiary cold trap outlet valves which isolated the fluorination system from the vent path provided by the Nash vacuum pumps. Prior to doing so, the AFO should have opened the dust collector isolation valves and closed the system valves to the cold traps on all three fluorinators to provide a vent path for the purge gas. However, the AFO failed to place the valves in those positions prior to isolating the Nash vacuum pumps. After closing the tertiary cold trap outlet valves, the fluorination system pressure began to increase due to the loss of the purge gas vent path.

In support of the reconfiguration effort, the distillation columns were placed in the “recycle” mode. While in this mode, UF_6 would ordinarily enter the system and flow into the cold traps at a rate of approximately 300 pounds per hour and a pressure of 70 psi. The collapsing of the UF_6 from a gas to a solid in the cold traps initially provided a source of vacuum to draw the UF_6 towards the cold traps, but as the system pressure dynamics changed from negative to positive, UF_6 began to flow into the fluorination system. Control room strip charts indicated that the system pressure began to increase at approximately 12:50 a.m., on December 22, 2003, and that positive pressure was reached in just a few minutes.

At approximately 2:15 a.m., while performing a verification of the lock-out/tag-out task performed by the AFO, the Fluorine Foreman noticed the smell of hydrofluoric acid (HF) and, as he was approaching the fourth floor, he noticed a white cloud. The foreman immediately went to the control room, looked at the video cameras that monitored each floor in the FMB, and noticed that white clouds were present on both the fourth and fifth floors. The foreman informed the control room staff of the leak, and the Lead Fluorinator Operator isolated the purge gas to the fluorinators.

At approximately 2:20 a.m., the foreman activated the Radiological Contingency Plan and began evaluating potential causes of the release. The area alarms were sounded and personnel were evacuated from the area. Evacuated staff assembled in the designated areas and the licensee implemented its accounting procedures to ensure all staff were present. As designated in the Emergency Response Plan, the night shift Production Shift Leader became the Crisis Manager and Incident Commander. The first pair of emergency responders donned their protective clothing and entered the building at approximately 2:28 a.m., and closed the system valves on all three fluorinator trains which isolated the source of UF_6 to the system. They also opened the dust collector isolation valves on all three trains which allowed the UF_6 that was present in the piping system under pressure to flow to the dust collectors. They then opened the isolation valves from the tertiary cold traps to the vacuum pumps, which were off line at the time.

The dust collectors were overcome with the volume and pressure of the UF_6 and purge gas in the system, and UF_6 was discharged through the dust collector exhaust system. The horizontal exhaust stack exited the FMB from the southwest side of the building, 86 feet above the ground. At the time of the release, the wind was out of the south/southeast direction and had an average velocity of approximately 6.2 miles per hour.

At approximately 2:34 a.m., the Incident Commander requested that the Security Department notify the local authorities of the UF_6 release. The Sheriff's Department was notified of the release and was told to evacuate everyone in the surrounding area. The Sheriff's Department dispatched officers to evacuate personnel from homes in the area surrounding the facility. Local authorities evacuated approximately 25 members of the public and approximately 75 were advised to shelter-in-place.

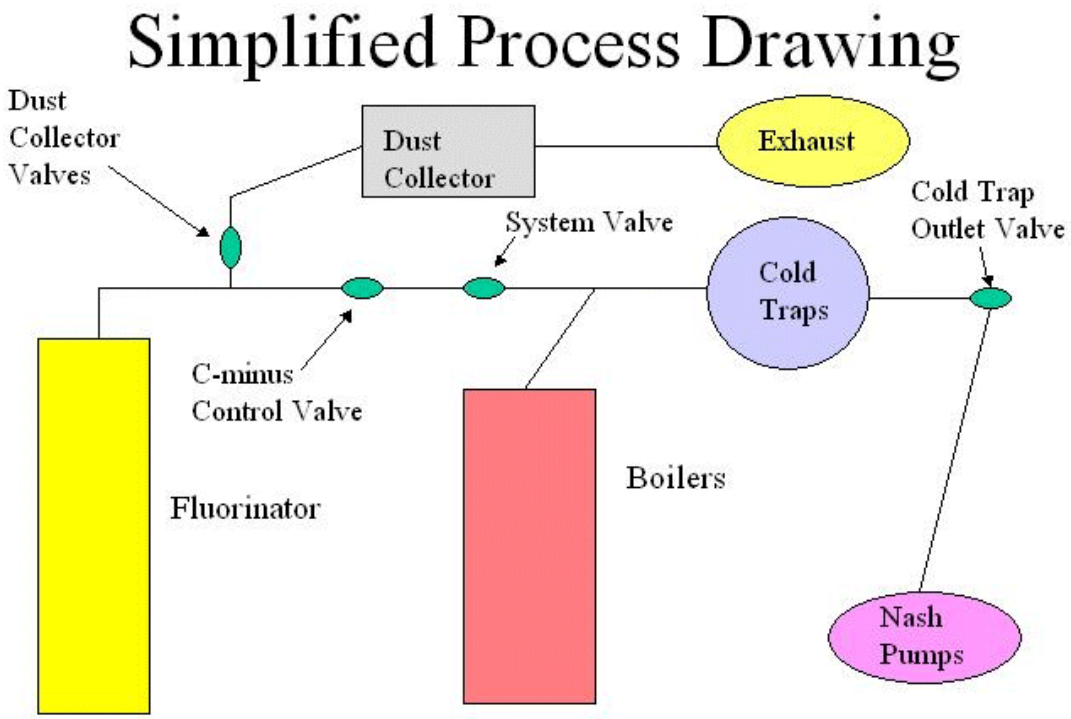
At approximately 2:40 a.m., a second response team entered the area and tried to unlock and restart the vacuum pumps to re-establish a negative pressure in the system. A third and fourth team subsequently entered the FMB to bring this system back on line. This would have provided a release pathway that would have taken any material that remained in the lines through the pollution control scrubbing system. However, a pump that provided seal liquor to the vacuum pumps failed, which delayed system restoration until approximately 3:15 a.m. The amount of UF_6 that remained in the system at the time the licensee first tried to start the Nash pumps is unknown, but had the system been brought back on line immediately, the duration of the release would have been reduced.

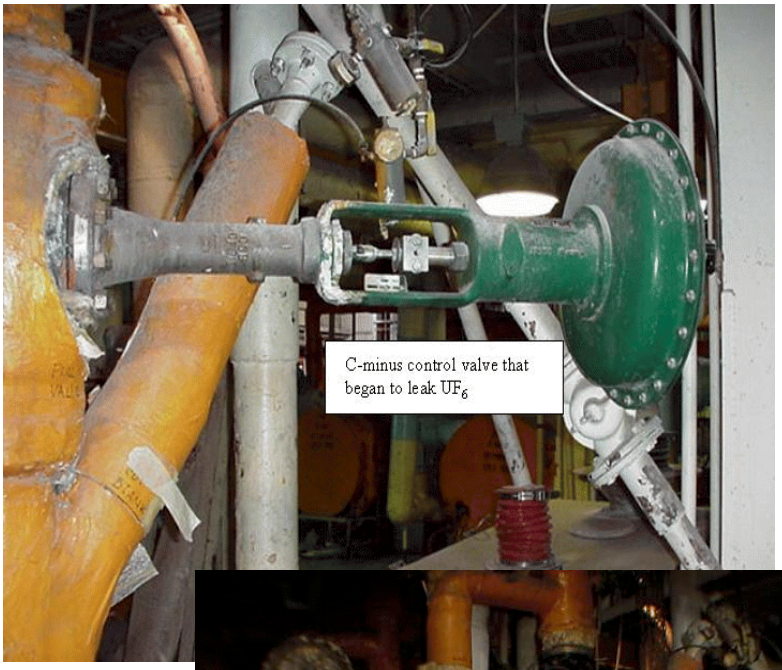
At about 3:15 a.m., the fifth team to enter the FMB searched the area for leaks and found that the only visible leak was a wisp of white "smoke" coming from the C-minus control valve on the fifth floor. They tightened down on the valve packing and

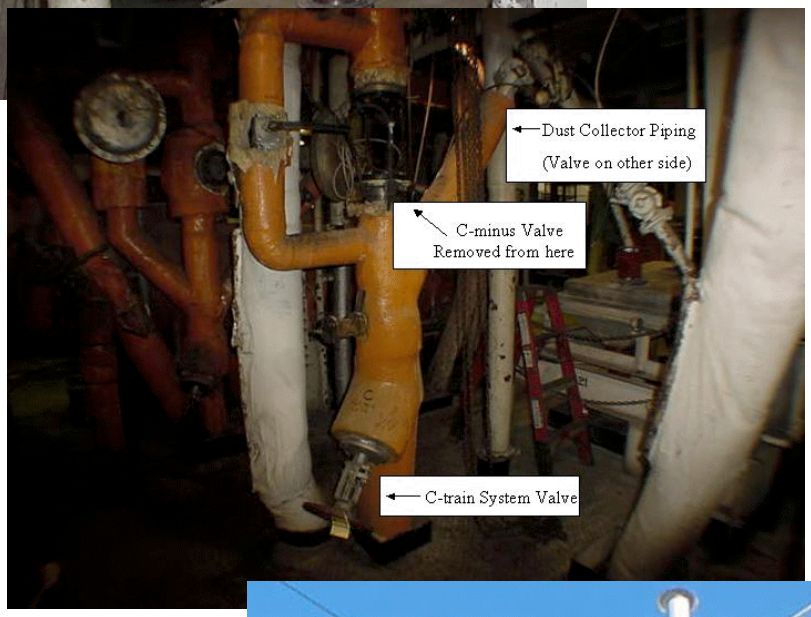
the leak stopped. The inspectors determined that this valve was the primary source of the UF_6 that leaked into the FMB. Several minor leak points were detected throughout the system later during subsequent plant walkdowns.

At approximately 3:30 a.m., the Incident Commander noted that there was no visible "smoke" leaving the FMB and informed plant management that the release had been contained. At approximately 3:45 a.m., the sixth entry team entered the FMB to reset some breakers and at approximately 3:50 a.m., a seventh team entered to place the distillation system on total reflux. When on total reflux, UF_6 from the distillation system does not flow out of the distillation system. At approximately 4:05 a.m., the eighth response team to enter the building performed a walk-through of all floors and verified that there was no further evidence of any leaks. At approximately 4:15 a.m., an "all clear" was announced.

A simple drawing of the process that illustrates the relationship of the various valves, piping and equipment involved in the release is provided below. Pictures of the C-minus control valve, the system valve and piping and the dust collector exhaust stack are on the next page.




C-minus control valve that began to leak UF_6


Dust Collector Piping
(Valve on other side)
C-minus Valve Removed from here
C-train System Valve


Dust Collector Exhaust Point

2. Event Response

a. Inspection Scope

The inspectors reviewed the licensee's Emergency Response Plan and Radiological Contingency Plan, interviewed licensee personnel and reviewed applicable control room and emergency response logs to assess the effectiveness of the response to the emergency.

b. Observations and Findings

The licensee described its emergency response organization and procedures for all emergencies in its Emergency Response Plan (ERP). Emergency response procedures that specifically applied to its licensed activities were described in the Radiological Contingency Plan (RCP). Through interviews with emergency responders and review of records, the inspectors determined that the Fluorine Foreman took timely action to implement the RCP after identifying the UF_6 release in the Feeds Material Building (FMB). Operators initiated the immediate actions required by the RCP including activation of the FMB evacuation and disaster alarms, shutting down the building exhaust fans, and activating the stairwell pressurization fan and control room fresh air blower. The operators also appropriately valved off the purge gas to the fluorinators from the control room in a timely manner.

As described in the ERP, the Production Shift Leader assumed the duties of both the Crisis Manager and the Incident Commander because the event occurred during a night shift. As such, the Production Shift Leader was responsible for establishing and maintaining communication with local, State and federal agencies and for overall coordination of the emergency plan implementation. During the day shift, the Plant Manager is the Crisis Manager and would be responsible for all off site communications. The plant Emergency Response Team assembled in a timely manner and donned the appropriate protective clothing and self contained breathing apparatus. The Incident Commander set up the control point at the phone booth south of the distillation door which was upwind from the UF_6 release point. An accountability of plant personnel was also completed in a timely manner. However, the Incident Commander did not appoint a recorder to keep a log of all response activities as required by the ERP, and this log was created based on interviews with emergency responders at the conclusion of the event.

When the Incident Commander (IC), acting as the Crisis Manager, became aware that the plume was observed exiting the site boundary, he requested that the Security Department notify the local authorities. The Sheriff's Department was notified of the release and was told to evacuate everyone in the surrounding area. This decision was based solely on the observation of a white haze or cloud going beyond the site boundary, and the licensee did not use a process or procedure to further assess plant conditions and the release circumstances to determine if other response actions were more appropriate (e.g., shelter-in-place).

The RCP required that the wind speed and direction be provided to local emergency response personnel so that the authorities could determine which sector(s) needed to

be evacuated. The RCP also stated that communications received from the plant should be verified by a return call to the plant. The meteorological conditions were not provided and after the initial notification, off-site emergency response personnel had difficulty contacting the licensee until the “all clear” was declared. The licensee did not establish consistent communications to ensure off-site response personnel received any additional information needed to assist them in their response decisions in a timely manner, but all other communications to state and federal agencies regarding the Site Area Emergency declaration were made within the required time frame.

During follow-up interviews with the Health Physics Technician, on site at the time, the inspectors noted that he was not aware of his duties as the Radiation Officer on the Emergency Response Team on the off-shifts. Among those duties was the requirement that he notify the Incident Commander if the plume was passing over the North plant fence and instruct the security guard to implement the “Procedure for Alerting Residents of Plant Emergencies.”

The inspectors noted that this procedure no longer existed and that the licensee did not have another procedure for determining what recommendations to make to local government officials regarding evacuation or sheltering-in-place of the public. However, the inspectors noted that the failure of the Radiation Officer to perform those duties did not delay the plant’s call to the Sheriff’s Department.

The first entry team appropriately closed the system valves on all three fluorinator trains, which isolated the source of UF_6 from the distillation columns, and opened the isolation valves from the tertiary cold traps to the vacuum pumps. However, the first team also opened the dust collector valves on all three trains, which allowed the UF_6 that was present in the system under pressure to be discharged out of the building.

As discussed above, emergency responders encountered delays in establishing negative pressure in the system. By that time, the majority of the release had occurred and only a small amount of material remained in the fluorination system. The IC granted an “all clear” after a building walk-through was performed of all floors and no evidence of any leaks was discovered. Later, after discussion with NRC officials, the Crisis Manager downgraded the SAE.

c. Conclusions

The licensee’s initial response actions were consistent with the Radiological Contingency Plan. Communications to off-site agencies regarding the SAE declaration were made within the required time frame, but communications with local emergency responders were not maintained and were not complete in that they did not provide additional information that would have assisted the local authorities in their response decisions. In addition, the individual designated to make recommendations regarding the SAE declaration was unaware of his responsibilities.

The initial leak of the UF_6 from the C-minus control valve was the event that caused the initiation of the RCP. However, one of the subsequent mitigating actions resulted in the release of a plume out of the FMB from the dust collector exhaust system and was the primary contributor to the material that crossed the site boundary.

3. Assessment of Licensee' s Investigation and Corrective Actions From Recent Events

a. Inspection Scope

The inspectors assessed the licensee's activities related to the event investigation and the effectiveness of corrective actions taken in response to other recent events.

b. Observations and Findings

The licensee initially established an investigation led by a TOP (Triangle Of Prevention) representative with assistance from a process engineer. The licensee later supplemented that investigation with another team that included the Operations Manager and representatives from the corporate office. The initial objectives of the team were to determine the facts regarding the event and calculate the amount of UF_6 released. The team completed those objectives, and the inspectors concluded that the time-line developed by the licensee's team was accurate and consistent with the sequence of events developed by the inspectors. The inspectors determined that the estimate of a seven pound release also appeared accurate.

The licensee team's other objectives, to determine the root causes and implement effective corrective actions, were still in progress at the end of the NRC's inspection. The team's investigation was being supplemented by corporate and contractor personnel and included programmatic reviews of process hazard safety, training and procedures, preventive maintenance, corrective action, and emergency preparedness. Licensed operations remained shut down pending completion of these reviews.

The inspectors reviewed corrective actions implemented in response to previous events as documented in Inspection Report 40-3392/2003-005 to determine why those actions were not effective in preventing this event. In response to the previous events, as documented in the report, licensee management revised plant policies and conducted training regarding expectations for adherence to procedures.

The licensee's expectations included the requirement that if an operation was not covered by a procedure or if a procedure was not adequate, operators were to stop work and have the procedure prepared or revised to accurately reflect actual conditions. In addition, management intended to enhance oversight of plant activities to ensure that these expectations were being implemented. The inspectors determined that activities related to preparation for dual train fluorinator operation were performed infrequently. This activity was not recognized as one that had not been reviewed and considered for coverage under an approved procedure when the licensee implemented its corrective actions in response to previous events. When planning and implementing the dual fluorination reconfiguration, neither management nor staff recognized this as an activity that should be described in an approved procedure and the activity was initiated without such procedures.

c. Conclusions

The licensee's investigation results, such as the sequence of events, the amount of material released and the health consequences to workers and members of the public appeared accurate and were consistent with the inspectors' findings. The inspectors were unable to evaluate the licensee's root causes and corrective actions because they were still in progress.

Enhanced expectations regarding adherence to procedures that were implemented in response to previous events were not followed. Activities related to dual train fluorinator operation were not covered by a procedure, and operators did not stop work and have the procedure revised as required.

4. Root Causes/Contributing Factors

a. Human Factor and Procedural Issues

(1) Inspection Scope

The inspectors interviewed FMB control room operators and reviewed control room log books, procedures, and other records to assess the rigor of control room operations including adequacy of written guidance and other human factor considerations.

(2) Observations and Findings

The inspectors determined that, upon completion of the reconfiguration of the fluorine feed piping to the fluorinators, the AFO should have opened the dust collector valves and closed the system valves on all three fluorinator trains prior to beginning the lockout/tagout of the Nash vacuum pump system. However, the AFO failed to place the valves in those positions prior to beginning that task. This step in the process was not included in a written procedure or checklist.

The inspectors confirmed that lockout/tagout activities required to support the reconfiguration of the Nash vacuum pump system were performed using a checklist produced by the Taglink system. The inspectors noted that the lockout/tagout card contained a comment that stated that the fluorinator "minus" (source of negative pressure) would be lost during the evolution. However, there was no annotation regarding the dust collector and system valve positions, and there was no requirement to coordinate plant configuration activities (e.g., fluorine feed piping and Nash vacuum pump reconfiguration) to ensure that a vent path was maintained.

The inspectors reviewed the fluorination procedure manual and determined it contained procedures for initial startup and final shutdown of a fluorinator. However, no standby functions or configuration changes (activities performed prior to the event) were found in the procedure manual. The licensee staff stated that the shutdown procedure for the fluorinator was intended for complete long-term shutdown of the fluorinator and confirmed that there were no procedures for placing the fluorinator in a standby condition.

In addition, although the reconfiguration of the fluorination system to operate two trains in parallel was an infrequently performed evolution, there was no supervisory review or verbal or visual confirmation to ensure the valves were properly configured. The inspectors noted that the Fluorination Operator logbook stated that the dust collector valves for A and C fluorinators were opened prior to the event. It was later determined the entry was an assumption the Fluorination Operator had made without verifying the status with the Assistant Fluorination Operator after he returned from completing the lockout/tagout card.

The inspectors also noted that, in general, logbook entries were not standardized with regard to format and information required. For example, the operators documented that the valve packing on the C-minus control valve was leaking on December 6, 2003, but did not document how the leak was dispositioned. In addition, the Radiological Contingency Plan required that a recorder keep a log of all response activities. The inspectors noted that most of the response activities were not logged and that a time-line was created based primarily on responder interviews.

During interviews, the inspectors also noted that the Distillation Operator and his assistants were unaware that the reconfiguration of the Nash vacuum pumps was taking place, even though both the distillation and fluorination units were connected by process piping and were impacted by the removal of the vacuum source. Operators and foremen stated that there are no shift briefings at the beginning of each shift to discuss activities planned for that shift. Turnover among operators was limited to one-on-one briefings of the current plant status.

Had the distillation operators been aware that the vacuum pumps had been removed from service, they could have monitored the system pressure at a more frequent interval and would have discovered that system pressure was trending upward. In addition, the inspectors noted that there were no warning lights or alarms on the system to alert the operators that the negative pressure was being lost.

The inspectors reviewed the training records for the AFO and confirmed that all required training was current. After discussions with the inspectors, and a “walk through” of his activities that evening, the AFO realized that he had forgotten to place the dust collector valve in the open position and the system valve in the closed position as he began to implement the second part of the reconfiguration process. The individual had worked the 3:00 p.m. through 11:00 p.m. shift as a Fluorination Operator-in-training under the direct supervision of a qualified Fluorination Operator. Following that shift, the individual began working an additional shift as the AFO, where he was fully qualified. The AFO did not indicate that he was tired at the beginning of his second consecutive shift. However, the inspectors concluded that fatigue could have been a contributing cause to his failure to reposition the valves.

(3) Conclusions

The licensee’s failure to recognize the infrequent reconfiguration process as an activity that should be described in a procedure or to establish some other means of ensuring this process was appropriately accomplished was identified as the root cause(s) of the

event. No requirement existed to coordinate plant configuration activities (e.g., fluorine feed piping and vacuum pump reconfiguration) to ensure that a vent path was maintained. In addition, no standby functions or configuration changes (activities performed prior to the event) for fluorination system operation were found in the procedure manual. Although the reconfiguration of the fluorination system to operate two trains in parallel was an infrequently performed evolution, there was no supervisory review or check to ensure the valves were properly configured.

Poor communications between supervisors and staff within the same group and with other work groups who may be impacted by their activities contributed to the conditions that led to the event. Operator log entries varied in content and completeness and there was no feedback between the AFO, the Lead Fluorination Operator and the Fluorination Supervisor as to what actions needed to be accomplished or had been accomplished to reconfigure the system. The Distillation Operator and assistants were unaware that the reconfiguration of the vacuum pumps was taking place and that the source of vacuum to their system would be lost for some time. In addition, there were no alarms that would have alerted the operators of the system pressure increase. Fatigue could have been a contributing cause as the AFO was on an overtime status.

b. Equipment Failures

(1) Inspection Scope

The inspectors examined control room logbooks and reviewed the maintenance history of the C-minus control valve, which was the main source of the UF_6 release in the FMB, and the seal liquor pump required for operation of the vacuum pumps.

(2) Observations and Findings

Control room logbooks for the FMB Foreman and Fluorination Operator indicated that the C-minus control valve exhibited in-leakage during the day shift on December 6, 2003. The inspectors discovered from interviews that the packing on the valve had been tightened shortly after the discovery of the leak to remedy the in-leakage. A repair notifications list was reviewed to see if a work order was issued for the valve at that time. No record of a notification was found. Therefore, no work order was written to repair the valve, although in-leakage of the valve packing indicated that the bellows had failed. Following the event, a repair notification was issued as a part of the event recovery activities. When the valve was examined, the licensee discovered that the bellows had completely ruptured due to the pressure that built up in the system and this caused the valve to begin leaking UF_6.

Upon further review, the inspectors noted that operators typically performed a leak check of the fluorination system, including the minus control valves, prior to start up to determine if the system was in an acceptable condition. Licensee personnel stated that fluorinator system components were satisfactorily leak tested to 10 psig during system startup in October 2003 following an extended outage. The licensee engineering staff estimated that the maximum pressure the system achieved during the event was 7.2 psig, which indicated that none on the system components were over-stressed.

During the mitigating phase of the event, the coupling on the seal liquor pump, which was required for operation of the Nash vacuum pumps, failed during attempts to restore the system and resulted in a delay in re-establishing vacuum. By the time these pumps were placed back in service, much of the release had occurred and only residual material was left in the fluorination system. Periodic vibration readings taken on the seal liquor pump prior to the event as part of the plant's predictive maintenance program indicated normal levels. The coupling was replaced shortly after the event, and the licensee staff's investigation into the failure was ongoing.

(3) Conclusions

The equipment failures did not significantly contribute to the cause of the event. The failure of the C-minus control valve resulted in the initial UF_6 release event, but most of this material would have been contained within the FMB. It is not known if this valve would have leaked had a work order to repair the bellows on the minus control valve been prepared and the valve repaired when the packing leak was first discovered in early December. The coupling failure at the seal liquor pump delayed re-establishment of system vacuum. If system vacuum could have been immediately re-established, the duration of the release would have been reduced.

5. Impact on Public Health and Safety

a. Inspection Scope

The inspectors assessed the public health and safety impact from the event. The inspection consisted of interviews with licensee personnel and a selective examination of the emergency procedures and radiation survey data.

b. Observations and Findings

The inspectors determined that at the time of the release, it was not raining, but moisture in the atmosphere was high due to rain in the surrounding area. It did begin to rain at the plant shortly after the release ended. When the released UF_6 gas mixed with the moisture in the atmosphere, it reacted to form uranyl fluoride (UO_2F_2) and hydrogen fluoride (HF). When this reaction occurs, it creates approximately three parts UO_2F_2 and one part HF. The HF is the more hazardous of the two chemicals. The licensee monitored the uranium concentrations that resulted from the release as one means of determining the potential impact on worker and public health and safety. The approximate concentration of HF released could be estimated by multiplying the uranium concentration released by 0.336.

In support of the event, the Incident Commander utilized the on-shift Health Physicist Technician to assist as the First Aid Officer and the Laboratory Technician to monitor the wind speed and direction. The Health Physics Supervisor and other Health Physics personnel arrived at the plant at approximately 4:00 a.m., and began assessing the impact of the release to the plant and the public.

The licensee collected air samples from several fixed stations including downwind sampler locations along the fence line, the Metropolis Airport, and the nearest residence. The licensee also collected air samples from the inlet and outlet of the dust collectors. The licensee did not analyze the inlet sample due to too much material on the sample, which could contaminate their instruments. However, the licensee did analyze the outlet sample, and it indicated levels of 16,300 disintegrations per minute (dpm). Wet chemistry of the outlet sample indicated 18,701 micrograms of uranium. According to the licensee, the levels of uranium on the samples from the dust collectors were not unusual for normal operations.

The licensee obtained wipe samples from vehicles, the parking lots, and in surrounding buildings near the FMB. Bioassays were also taken from all personnel in the building and the first responders to the release. Additional environmental samples were taken by a contractor for the licensee and from the State of Illinois.

Air Samples

Table 1 below provides the results of the stationary air samples collected by the licensee after the release on December 22, 2003, at the plant boundary, the local airport, and the nearest residence. These air samplers are monitored weekly and the reported concentrations are based on total sample run time for each sampler.

Table 1 - Air Samples Results Outside Boundary of Plant

Station	Location of Samples (distance in feet from release point) [direction from release point]	Concentration (uCi/ml) Alpha for total sample time
6	Metropolis Airport (5300)[NNE]	3.40 E-13
7	Nearest Residence (1850)[NNE]	1.42 E-12
8	Near Railroad Tracks (1035)[ENE]	1.97 E-13
9	Protective Fence Line (775)[NNW]	3.71 E-15
10	Near Ponds (950)[SW]	1.09 E-15
11	Near Railroad Tracks (1250)[True N]	8.24 E-14
12	Near Drum Station Pad (655)[SSE]	4.03 E-15
13	Employee Parking Lots Outside Fence (655)[NE]	4.94 E-13

Note:

1. Licensee's Plant Investigation Limit is 2.0 E-14 uCi/ml
2. NRC Effluent Monthly Average Limit for Natural Uranium is 3.0 E-12 uCi/ml
3. Wind Direction at 2:20 a.m. on December 22, 2003, was 6.2 mph going From SSE at 40.8 Degrees F
4. Stationary Air Sample Results Before the Release, Collected on 12/10/2003 Indicated Less Than the Licensee's Investigation Limits

Table 2 below provides air sample results collected from each stationary air sample on the floors, including the basement, of the FMB. (NOTE: calculation was based on two hour air sample results).

Table 2 - Air Samples Results Floors of The Feed Material Building

Station	Location of Samples	Concentration (uCi/ml) Alpha
1	Basement	2.62 E-09
2	First Floor	2.44 E-09
3	Second Floor	2.32 E-09
4	Third Floor	2.72 E-09
5	Fourth Floor	2.98 E-09
6	Fifth Floor	3.13 E-09
7	Sixth Floor	3.12 E-09

Note:
1. Licensee's Plant Investigation Limit is 2.0 E-14 uCi/ml
2. NRC Effluent Monthly Average Limit for Natural Uranium is 3.0 E-12 uCi/ml

Illinois Emergency Management Agency (IEMA), Bureau of Environmental Safety, maintained five low-volume air samplers around the community surrounding the Honeywell plant. On December 22, 2003, IEMA staff members retrieved the five air samples for filters that were replaced on December 16, 2003. In addition, they collected three soil samples and four vegetation samples. Table 3 below provides the air sample results from IEMA.

Table 3 - Air Samples Results From IEMA

Station	Location of Samples	Concentration (uCi/ml) Alpha
1	Metropolis Airport	2.95 E-13
2	Across US 45 (North of Plant; nearest resident)	8.33 E-13
3	Southwest of Plant Near Ohio River	1.7 E-15
4	Downtown Metropolis	3.1 E-15
5	Northeast of Plant	1.9 E-15

Note:
NRC Effluent Monthly Average Limit for Natural Uranium is 3.0 E-12 uCi/ml

The highest fixed area boundary air sample result of 1.4 E-12 microcuries per milliliter (uCi/ml) was taken from a local residence by a licensee sampler. Although higher than the licensee's action limit for effluent, the reported concentration, which was for the total sample time (represents an average concentration for the entire time the filter had been in the air sampler), was below the NRC effluent monthly average limit of 3 E-12 uCi/ml. Other licensee and state air samples showed airborne uranium concentrations about 100 times above normal for samplers nearest the site but below NRC monthly average effluent limits.

To estimate the uranium concentration during the release, IEMA calculated the concentration at their Station 2 (nearest resident) that was present during the release. The estimated concentration was 1.2 E-10 uCi/ml, which is equivalent to a concentration of 0.18 milligrams of uranium per cubic meter (mg/m^3). The 0.336 factor for estimating the HF concentration from the uranium concentration primarily applies to the concentration ratios at the point of release and its relative value for estimating HF concentration diminishes as the material gets further from the release point. However, applying it to the estimated uranium concentration at Station 2 is one means of assessing the potential concentration of HF at that point. Based on the 0.336 factor, the estimated HF concentration at this point was 0.06 mg/m^3. This is equivalent to a concentration of 0.07 parts per million (ppm), which is below the American Industrial Hygiene Associations's Emergency Response Planning Guideline ERPG-1 level of 2 ppm for HF. The ERPG-1 level is the maximum airborne concentration of a chemical below which it is believed that nearly all individuals could be exposed for up to one hour.

The inspectors noted that the Radiological Contingency Plan required that environmental samples be collected from the path of the plume to measure actual environmental impact and determine what remediation actions were necessary. The inspectors discussed this requirement with the licensee and, in response, the licensee hired a contractor to conduct additional environmental samples (i.e., water, vegetation, and soil) and bioassays of some members of the public in the areas down wind from the release. The analytical results of the licensee's and IEMA's environmental samples indicated that levels of uranium on vegetation and soil after the event were similar to levels routinely found on vegetation and soil before the event. From discussion with licensee representative and review of the records from the environmental and bioassay samples, the inspector determined that the quantity of UF_6 released from the event was low and that exposures to members of the public were below the NRC regulatory limits of 25 millirem.

Wipe Samples

The licensee performed surveys with a "pancake" Geiger Mueller tube equipped survey meter of surfaces within the licensee's facility that were down wind of the release. These instrument surveys and wipe samples were taken by the licensee in areas of the FMB, the Health Physics Laboratory, surrounding buildings and areas, the parking lot and vehicles, off-site fallout boxes, guard sheds, and roadways after the release. The instrument surveys did not detect any levels of radiation above background levels. The results of the wipe samples taken from these areas were at or a few counts above background levels periodically obtained from these areas before the release.

Bioassays Samples

The licensee conducted bioassays of the first responders, individuals involved with the release, and a few members of the public. A 24-hour urine sample was taken from each individual and analyzed. The inspectors reviewed the results of the urine samples which indicated the highest dose was to the Fluorine Foreman with a Committed Effective Dose Equivalent (CEDE) of 1.132 millirem, a derived air concentration-hour (DAC-hr) of 0.454 for that shift, and a fraction of an annual limit on intake (ALI) of 2.3 E-04. The dose to the member of the public, 24 hours after the release, was 0.015 (1.5 E-02) millirem CEDE, which was two times above minimum detectable activity but well below public dose limits. Additional bioassay samples taken by the licensee from members of the public were determined to be below minimum detectable activity.

Release Estimates Based on System and Release Conditions

Based on the pressurized system volume and the temperature and pressure conditions within the system, licensee engineers estimated that about seven pounds of UF_6 were released to the environment. This is well below the 440 pound limit requiring notification to the National Response Center. NRC staff reviewed these assumptions and calculations and determined them to be reasonable. Based upon the release quantity of seven pounds and the associated release conditions, NRC staff used a radiological consequence assessment code, RASCAL 3.0.3, to estimate a probable 1-hour maximum downwind concentration of uranium following the release. They calculated the predicted concentrations at the nearest resident and the airport to compare to the air sampling data obtained by IEMA. The NRC staff determined that at these two points, the air sampler based estimated concentrations were approximately six times greater than the mathematically predicted concentrations. Given the large amount of uncertainty associated with many of the factors which are used to calculate atmospheric dispersion of short-term releases, differences of less than a factor of ten between sample results and model predictions represent good agreement between the two methods.

Worker and Public Injury Reports

There were no injuries to plant employees. Four members of the public reported to the local hospital. Three were examined and released. The fourth individual, who did exhibit some skin reddening, was treated for symptoms due to potential low level exposure to hydrofluoric acid and was released after 24 hours.

c. Conclusion

The release had minimal impact on worker and public health and safety. The inspectors had to prompt the licensee to perform environmental samples as required by the Radiological Contingency Plan. Although some air sample and bioassay results were above normal, all were well below regulatory requirements for workers and members of the public. Worker and public doses that received as a result of this release event were determined to be well below regulatory limits.

6. Exit Interview

The inspection scope and results were presented to members of the licensee management at the public exit meeting on January 6, 2004, with those persons indicated in the Attachment. Although proprietary documents and processes were occasionally reviewed during this inspection, the proprietary nature of these documents or processes has been deleted from this report. No dissenting comments were received from the licensee.

ATTACHMENT

1. PARTIAL LIST OF PERSONS CONTACTED

Honeywell Specialty Chemicals

*Rory J. O'Kane, Plant Manager
*Phil Bryan, Operation Manager
*Michael Ginzel, Health Physicist Supervisor
Joe Johnson, Safety Supervisor
Jeffrey Malanowski, Engineer and Maintenance Manager
*Darren Mays, Health and Safety & Regulatory Affairs Manager
Mark McPhee, Human Resource Manager

* Denotes those present at the exit meeting on January 6, 2004.

2. INSPECTION PROCEDURES USED

IP 93800 Augmented Inspection Team

3. PARTIAL LIST OF DOCUMENTATION REVIEWED

- Special Work Permit # F2N-01095 and associated tags
- Printout of "A" Primary Cold Trap inlet pressure vs. time
- Time-line from licensee investigation
- Printout of maintenance notifications for the fluorination system
- Fluorinator operating procedures
- Control room logbooks for Fluorination Operator, Assistant Fluorination Operator, and Foreman
- Licensee's UF_6 Release Engineering Findings
- Security Guard Incident Report and Shift Log
- Licensee health physics sample results
- IEMA report of air sampling and environmental sampling results

4. LIST OF ACRONYMS USED

ADAMS	Agency Document Access and Management System
AFO	Assistant Fluorination Operator
AIT	Augmented Inspection Team
ALI	Annual Limit on Intake
CEDE	Committed Effective Dose Equivalent
CFR	Code of Federal Regulations
DAC	Derived Air Concentration
DFFI	Division of Fuel Facility Inspection
dpm	disintegrations per minute
ERP	Emergency Response Plan
FMB	Feed Materials Building
IC	Incident Commander
IEMA	Illinois Emergency Management Agency
IP	Inspection Procedure
IR	Inspection Report
mg/m^3	milligrams per cubic meter
ml	milliliter
mrem	millirem
NRC	Nuclear Regulatory Commission
PARS	Publicly Available Records
ppm	parts per million
RCP	Radiological Contingency Plan
SAE	Site Area Emergency
TOP	Triangle Of Prevention
UF_6	Uranium Hexafluoride
uCi	micro-curie
μg/L	micrograms per liter