

**Specialty Materials**  
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April 21, 2006

UPS: 404-562-4731

Region II, US Nuclear Regulatory Commission  
Attention: Mr. Jay L. Henson  
Sam Nunn Atlanta Federal Center  
23 T85, 61 Forsyth Street, S.W.  
Atlanta, GA 30303-3415

Dear Mr. Henson:

As per your request, attached is the Apollo Incident Report prepared by MTW Honeywell related to the UF<sub>6</sub> leak from PI-fluidizing Air purge line that occurred on April 4, 2006.

If you have any questions regarding this correspondence, please contact Mr. Jack Riley at 618-524-6221.

Sincerely,



David B. Edwards  
Plant Manager

cc: J. Riley  
D. Mays  
Turner Plunkett, Director Integrated Supply Chain, Morristown, NJ  
Jeff Neuman, Legal

U.S. Nuclear Regulatory Commission  
Attention: Mr. Michael Raddatz,  
Fuel Cycle Licensing Branch, Mail Stop T-8A33  
Two White Flint North, 11545 Rockville Pike  
Rockville, MD 20852-2738

(UPS: 301-415-6334)

# APOLLO INCIDENT INVESTIGATION REPORT

Purpose: To prevent recurrence, not place blame.

Report Date: 4/10/2006  
Date Investigation Started: 4/4/2006  
Report Number: IRS #658

## I. PROBLEM DEFINITION

WHAT: UF6 Leak From PI-fluidizing Air purge line

WHEN: 04/04/2006 at 12:35 PM

WHERE: 1st floor

Location: Feed Materials Building

Department: Distillation

Facility: Honeywell-Metropolis Works

SIGNIFICANCE: Activation of plant ERP & notification regulatory agencies.

Safety: Potential employee UF6 exposure

Environmental: Release to air-Approximately 7-8 grams

Revenue: Unknown

Cost: Unknown

Frequency: Unknown

## II. CAUSE & EFFECT SUMMARY

The investigation of this event identified the following root causes:

1. Failure to believe instrumentation (pressure gauge) until proven unreliable.
2. Failure to stop when unexpected conditions occurred while loosening the gauge.
3. Inadequate guidance for utility/process interface boundary work.

### Corrective Actions

1. Root Causes 1 & 2 - Complete documented small group training (by senior management) with operations and maintenance personnel on applying the applicable principles of conduct of operations with emphasis on STAR and Stop Work.
2. Root Cause 3 - As a temporary measure, immediate action was taken by issuing a standing order to require additional review and approval of hazardous line breaks by senior management. Development and implementation of a guidance policy on work at utility/process interface boundaries will be developed and issued as a permanent measure.

The investigation also identified contributing material condition and design issues resulting in trapped UF6 in the utility interface piping. Management action items have been assigned to address these issues.

During the work and response to the event two inappropriate action issues involving mixed levels of PPE for personnel in the area and unnecessary personal risk taken by personnel in response to the event. Management actions have been assigned addressing these issues.

UF6 Leak 04/04/2006  
Summary of Events

April 4th, 2006 at approximately 12:35 PM a UF6 leak occurred at Honeywell-Metropolis Works Plant. The leak was from the opening created by removing a pressure indicator (PI) from a utility line connected to the distillation units process piping. The location was in the Feed Materials Building, 1st floor, distillation side. It appears that liquid UF6 had entered the fluidizing air utility line and had solidified or froze out.

Work was begun the morning of April 4th to isolate the bypass valve of the automatic control valve (located in the 1st floor hot box) of process pipe #2 (PP-2). The valve was to be removed by maintenance mechanics because the collar was broken, thus inoperable. A Special Work Permit, DIST-00704, was properly executed to ensure the system was at zero energy. Operator 1, distillation assistant, closed and locked the inboard and outboard valves of the three UF6 still feed tanks (3rd floor) that feed UF6 into the PP-2 and the inboard and outboard valves of the dump tank located on the 2nd floor. Operator 2, distillation operator, and Operator 3, assistant, proceeded to the basement to close and lock the inboard and outboard valves of the UF6 vaporizer fed from PP-2. The automatic control valve (FRC 404) in the hotbox was left open (manually). Operator 2 then opened the PP-3 chain valve on the 1st floor to evacuate UF6 between the vaporizer and low boiler column and also opened the PP-6 Alloyco valve in the 1st floor hot box to evacuate the PP-2 from the still feed tanks to the vaporizer. The PP-6 is the vacuum source to the inlet of the primary cold trap and has approximately 15-20 Hg. vacuum and is listed on the isolation device listing (IDL) as open as required. Isolating UF6 in the process vessels and not in the transfer piping places the unit in a reflux mode. While the control room has pressure indicators at four points on the PP-6 the only physical pressure indicator on the 1st floor that may be used to confirm vacuum is located on the utility purge line connected to the PP-2.

The utility line is a fluidizing air supply line used by the distillation operators to introduce air, approximately 80-90 psig., into the PP-2 line to purge restrictions that occasionally occur at the outlet of one of the three still feed tanks on the 3rd floor. The fluidizing air is supplied by the plant powerhouse and moisture content is analyzed to ensure the air is properly dried. Keeping the air in specification is extremely important because moist air can cause the formation of UO<sub>2</sub>F<sub>2</sub> and create restrictions in the UF6 process. The prior day, April 3rd, the utility system was manipulated to introduce pressurized air at the #1 still feed tank because of vaporizer feed problems. The fluidizing air utility header is configured with two check valves and two ball valves in series to the PI, and an Alloyco block valve on the outlet of the PI near the tee of the PP-2. The length of the line from the Alloyco valve to the air valves is approximately 18 inches.

Prior to donning personal protective equipment maintenance personnel questioned the PI that was reading approximately 80 psig. and initiated a STAR (Stop, Think, Act, Review) The pressure on the PI was not unusual as the distillation operators leave pressure on the utility line after purging the still feed tanks.

The distillation operators proceeded to ensure the PP-2 had vacuum by using the utility line PI as confirmation. Operator 2 stated Operator 3 pressured the fluidizing air purge line to approximately 90 psig. then opened the outboard Alloyco but did not see any pressure drop on the PI. Operator 3 shut off the air while leaving the Alloyco open and the pressure slowly decreased to approximately 78 psig. and stopped. Operator 3 manipulated the valves three to four times but achieved the same results. The common theme regarding this exercise of cycling the valves was that the operators would open the fluidizing air valves with the Alloyco outlet valve open and the PI would increase to approximately 90 psig. then slowly decrease and rest at approximately 78 psig. At this time the operators believe that the PI is faulty and/or there is a blockage at the Alloyco valve. Operations contacted the instrument department to install a new PI. When the instrument technician arrived on site he questioned removing the PI and also initiated a STAR and contacted his supervisor. The instrument supervisor went to the area and

also witnessed the utility line being pressured to approximately 90 psig. then resting at approximately 78 psig. The instrument supervisor refused to change the PI.

At this time operations personnel are convinced that the Alloyco valve on the outlet of the fluidizing air purge line has a restriction, probably UO<sub>2</sub>F<sub>2</sub>, which is not allowing pressure in the utility line to relieve into the PP-2. The operators retrieved tools to vibrate around the alloyco valve with the intention of dislodging the apparent blockage. The line was vibrated at the Alloyco valve and at the PI. During this time the operators notice the PI acting erratically and notice the needle rotate clockwise to approximately zero. A decision was made to remove the PI and install another that was calibrated. After a pre-job brief and donning PPE, Operator 1 and Operator 3 proceeded to unscrew the PI.

Operator 1 stood on a four foot ladder to unscrew the PI while Operator 3 held a vacuum hose at the site in the event there was material in the line. Operator 2 stood back, with new PI in hand, with supervisor Supervisor 1. Operator 1 was instructed to unscrew the PI slowly, ½ turn increments, then rock back and forth and watch for any signs of pressure and leaks. In the event there was some material escaping she would rotate the PI clockwise until there was no sign of further leaking. Operator 2 stated that some smoke was noticed which was easily captured by the vacuum hose as Operator 1 slowly turned the PI clockwise and counterclockwise.

Operator 1 continued to unscrew the PI and rock it back and forth. At the point the PI was almost unscrewed completely Operator 2 approached and notified her that the PI was probably on its last thread. At that moment there was a loud sound and the PI came out of Operator 1s hands and the area became instantly cloudy. The operators stated that material seen escaping looked like streamers giving the indication that there was solidified UF<sub>6</sub> in the line under considerable pressure.

Supervisor 1 and Operator 2 exited the North distillation door. Operator 1, now off of the ladder searched momentarily for the PI that came out of her hand but could not find it, she exited the North door. At this time she notices that Operator 3 is not behind her. Operator 1 re-enters the area to search for Operator 3. Operator 1 finds Operator 3 still mitigating. Operator 1 finds the new PI and installs it but the face is toward the wall. She and Operator 3 exit the South distillation door to go through decontamination.

UF6 Release 04/04/06  
Timeline of Events  
(All times are approximate)

07:30-Maintenance staged Alloyco valve at 1st floor distillation for replacement of the Alloyco valve that is the bypass of the PP-2 control valve.

08:57-unit was placed on recycle.

09:57-unit on total reflux. The PP-6 vacuum source on PP-2 was cycled open.

10:30-11:00-Maintenance supervisor, Supervisor 2, reviews and walks down special work permit #DIST-00704 with Operations supervisor Supervisor 1. Supervisor 2 notices PI on fluidizing air line that tees in with the PP-2 is reading approximately 80 psi.

11:00-Valve to be changed out, WIC-404 PP-2 bypass valve is opened.

11:00-Maintenance supervisor implements STAR due to gauge on fluidizing air line is approximately 80 psi.

11:10-Operator 3, Operator, cycled valves on fluidizing air line 2-3 times. Both fluidizing air valves were opened then the Alloyco outlet valve was opened. Each time the PI would increase to 90 psi then slowly rest back to 78 psi.

11:30- Operations contacts instrument department to change out PI. Instrument mechanic implements STAR and notifies supervisor.

11:35-11:45- Instrument Mechanic Supervisor 1, Instrument supervisor, arrives at site and cycles valves several times. Pressure again increases from approximately 78 psi. to approximately 90 psi. and slowly decreases to approximately 78 psi. Notifies operations that instrument personnel will not replace the PI.

11:50-Operations retrieves pneumatic gun to massage line to displace suspected blockage.

12:00-During the search for an air hose to use pneumatic gun the fluidizing air PI reading had decreased to approximately 30 psi.

12:25-Used pneumatic gun to massage line at alloyco valve and at line near PI. PI fails as needle turns clockwise to zero.

12:30-Operations closes 1 Alloyco valve.

12:35-Operator 1, Distillation Assistant, removes the PI and Operator 3, Distillation Assistant (training), manipulates vacuum hose in the event of release of material. UF6 is leaked at the PI nozzle sight which overcomes vacuum hose.

12:35-Operations supervisor exits via North door and takes up position at South Distillation door to fulfill emergency response team officer duties as Incident Commander. The emergency response plan is initiated, a Plant Emergency is declared. Distillation Operator, Operator 2 exits North door and reports to control room to don PPE for mitigation.

12:35-Operator 1 leaves area traveling toward North door but notices Operator 3 is not following. Operator 1 walks back to leak point and Operator 3 is still attempting to mitigate leak. Operator 1 notices new gauge Operator 2 had in hand prior to exiting area, retrieves and installs, stopping the UF6 leak. Operator 3 and Operator 1 exit via South distillation door.

12:37-Plant announcement of UF6 release and to evacuate the Feed Materials Building.

13:14-1st entry team enters area from control room to tighten PI.

13:17-1st entry team exits area via South distillation door.

13:47-2nd entry team enters area to assess.

14:02-All Clear is announced.

#### ORIGINAL JOB DESCRIPTION

Change out bypass valve for Distillation UF6 control valve on PP-2  
STAR approach activated (Maintenance)  
Perceived pressure on utility line PI that connects to the PP-2 process line.

#### PRODUCTION RESOLUTION OF STAR (Stop, Think, Act, Review)

- Determine why indicator shows pressure.
- Purged through Alloyco valve, opening fluidizing air supply valves while leaving Alloyco valve in open position.
- Process repeated twothree times. PI responded to purge by pressure increase to 90 but resting to 78 when fluidizing air valves closed.
- Production suspected restriction in the line but restriction not a hard restriction (blockage).
- Suspected line being open through the Alloyco valve but felt that the gauge was not showing actual pressure. Supervisor felt the PP2 line at the tee and line and it was warm to the touch.
- A decision was made to massage the line to remove restriction. During process of massaging line operator noticed that the line at the gauge was cold. As they massaged past the gauge the internal mechanism in the PI became uncoupled due to vibration, rendering the gauge inoperable.
- Due to response of the PI it was suspected that the line had vacuum on it but a mechanical problem was preventing the gauge showing vacuum.
- A thorough pre job brief was held with the supervisor and operators on the job.
- Production cautiously changed out gauge by closing Alloyco valve and closing fluidizing valves and slowly removing gauge.
- While gauge almost completely removed material in the nipple broke loose releasing the contents of fluidizing air and solid UF6 between the Alloyco valve and the fluidizing supply valves.

Cautious approach was taken to remove and replace the gauge.

- The Alloyco valve was closed.
- The air supply valves were closed
- Exposed system minimized
- Gauge was slowly turned while wiggling
- At each ½ turn operator looked for signs of material
- Pre job brief instructed that if material was observed exiting to screw gauge back.

## POST ANALYSIS OF INCIDENT

- Solid UF6 was in the line at the Alloyco valve.
- UF6 may have been introduced into the Alloyco valve region the day prior while trying to get vaporizer line (PP-2) to feed. UF6 was solidified in the air line due to the cold temperature of the line.
- Solid UF6 had formed a plug at the base of the PI neck. Air pressure forced the plug out after the gauge was removed releasing solid UF6 and air.

## PPE USED

Changing out PI can be viewed similar to changing out PI at the fill stations.

- When PIs are changed at fill spot we have double blocks between liquid UF6 and a vacuum source. Prescribed PPE for this task is ½ face respirator combo cartridge and leather palm gloves, per safety handbook.
- Changing out PIs in this situation we have double block between UF6 and a minus source. If this is viewed the same then the PPE should be the same.

The prescribed safety gear is a minimum. Workers have option to upgrade PPE at their own discretion.

One operator already had prescribed safety gear to assist maintenance in changing out the bypass valve. Due to convenience this same gear was used to work on the PI. The other operator had on the minimum PPE.

## Human Factors Points That Could Have Made A Difference

Trust Your Instrumentation (Gauge Pressure) (Basic Conduct of Ops)  
Inform management after STAR has been enacted to review the situation  
Operations is not the last resort CALL IN HELP (HSE/HP, Engineering)  
Minor UF6 Smoke in Air Line (Ask Why, Re-Assess Hazards)  
Recognize New Information- STOP  
Review the separation between process and utility lines.  
Review the need for a procedure if the task has safety significance and it is performed infrequently.  
PPE: ½ Face- Flee, Full Face- Investigate, SCBA Mitigate  
Watch that all close participants have appropriate PPE. Prepare for the worst case.  
Always protect #1 so not to become a fatality.  
Dont over apply buddy system:

If you have the appropriate PPE, try to correct an issue once (2-3 Minutes) then exit and allow the ERT to perform mitigation of the hazard in full PPE.

### III. SOLUTIONS

CAUSES	CORRECTIVE ACTIONS	NAME	DUE DATE
Prevent backflow of UF6	Contributing Cause- Revise this specific procedure to minimize backflow of UF6 at the pressure indicator.	Ron Erickson	7/31/2006
Prevent backflow of UF6	Contributing Cause- evaluate utility pressure to ensure that utility pressure is greater than process pressure at direct interface points. Evaluate the need to modify operator rounds or procedures.	Martin Millman	8/31/2006
fluidizing air not spec.	Contributing Cause- switch from fluidizing air to nitrogen at interface points.	Wally DeLand	8/31/2006
Line exists (Could trap UF6, utility)	Contributing Cause- evaluate proper valve installation/alignment that prevents trapping UF6 in utility lines at interface points	Ron Erickson	6/30/2006
Method to check validity ineffective	Contributing Cause- evaluate installing isolation valves close to the PI ie, Hoke valve.	Martin Millman	9/30/2006
Consultation with mgt. not thought needed	Root Cause-train operations and maintenance to effectively use STAR, and stop work when unexpected conditions occur. Supervision and engineering to be trained by May 15, 2006. Balance of plant population by June 21, 2006.	Ron Erickson	6/21/2006
Thought to be working on utility line	Root Cause-develop and implement guidance to address working at utility interface.	Darren Mays	7/31/2006
Full face and leather gloves	Contributing Cause- determine actions that may be taken with PPE	Darren Mays	8/31/2006



	worn to ensure personnel have appropriate protection for potential hazards, emergency response, and mitigation.		
No torquing standards	Contributing Cause-evaluate installing different valve type, maybe soft seat.	Martin Millman	8/31/2006
UF6 present	Contributing Cause-relocate this specific PI outside of the process boundary	Martin Millman	9/15/2006
Tracing not operable	Contributing Cause - install an indicator on electrical heat tracing at this location.	Wally DeLand	8/31/2006
Tracing not operable	Contributing Cause-add to operator checklist.	Ron Erickson	9/15/2006
Tracing not operable	Contributing Cause-evaluate installing indicators on other process heat tracing.	Martin Millman	12/15/2006
Thought defective PI	Root Cause- document and train in small groups by senior management personnel (operations and maintenance) on believing instrumentation and basic conduct of operations. Supervision and engineering to be trained by May 15, 2006. Balance of plant population by June 21, 2006.	Ron Erickson	6/21/2006

#### IV. INVESTIGATION TEAM MEMBERS:

Barry Stephenson  
Gary Timmons  
Don Heine  
Dale Story  
Ernest Robinson

#### Notes:

1. This chart is a draft and has not been checked for compliance to the rules.
2. Fluidizing means dry fluidizing air
3. Deleted

4. Some cause phrases contain conjunctions and may not be clear, feel free to question them.

**References:**

1. Pressure from the fluidizing air purge line caused the operator to drop the gauge.
2. Assumption based on operator's statements. The operator's were continually trying to blow through the alloyco outlet valve by pressuring up with fluidizing air.
3. Statements by operator and supervisor viewing the release of material.
4. Although this is not a specific cause of the UF6 leak and should be a separate Primary Effect by the Apollo standard it is captured in this cause and effect tree rather than a separate tree.
5. Unsupported via statement







































