From: "Bryan, Phil X." <phil.bryan@honeywell.com>
To: "'Jay Hensen'" <jlh@nrc.gov>
Date: Tue, Jan 6, 2004 8:00 AM
Subject: FW: UF6 Release - Engineering Findings

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-----Original Message-----
From: Bryan, Phil X.
Sent: Tuesday, January 06, 2004 6:56 AM
To: 'Jay Hensen (Home)'; 'Jay Hensen'
Cc: Mays, Darren
Subject: UF6 Release - Engineering Findings

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Nuclear Services Manager
MTW
618/524-6245

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UF6 Release

Engineering Findings

Metropolis Plant
December 22, 2003

UF6 Offsite Release 12/22/2003

Investigation Team: Phil Bryan, R.A. Smith (Morristown Office), Tracey Minor (Geismar Plant)

Investigation Primary Objective: Determine the facts around the incident. Coordinate with NRC investigation team and TOPS investigation team to collaborate information.

Deliverables from investigation:

- **Review timeline of event and support with process data.**
- **Develop release quantity.**
- **Develop and implement corrective actions (Still in Process).**

Highlights of Event

- Operator preparing Fluorination system to run dual trains.
- Blanks at GF2 switched without incident.
- Second Fluorination scrubbing train (B side) had to be unlocked and put on-line in order to run two trains. This involved shutting off primary source of vacuum on system (Nash vacuum pumps).
- Operator did not open valves to secondary vacuum source (Ash Dust Collector) and close system valve to isolate cold traps.
- System was blocked in with Fluorinator Bed fluidizing air and Distillation impurity stream (UF6) entering system. There was no outlet for inputs therefore the system developed pressure.
- Leak developed at C Fluorinator minus control valve stem seal.
- Shortly after the pressure developed, the leak was noticed and an entry team proceeded to systematically open the system to secondary vacuum source. This created a sudden release of pressure to the Ash Dust collector and ultimately a release from its stack to the atmosphere.
- Entry teams proceeded to restart the primary vacuum source but effort was complicated by seal liquor re-circulation pump coupling failure.

Assuming Worst Case, Pressure Rise 7.2 psig and Loss Quantity of 6.9 lb

Highlights of Event

1. **Process Pre-Incident - Fluidizing Reactors**

   Valve State

   A - Open
   B - Closed
   C - Open
   D - Open
   E - Open
   F - Open

2. **Process When System Building Pressure**

   Valve State

   A - Open
   B - Closed
   C - Open
   D - Open
   E - Closed
   F - Closed

3. **Process at Time of Loss**

   Valve State

   A - Closed
   B - Open
   C - Open
   D - Open
   E - Closed
   F - Closed

4. **Process When Loss Mitigated**

   Valve State

   A - Closed
   B - Closed
   C - Open
   D - Open
   E - Open
   F - Open

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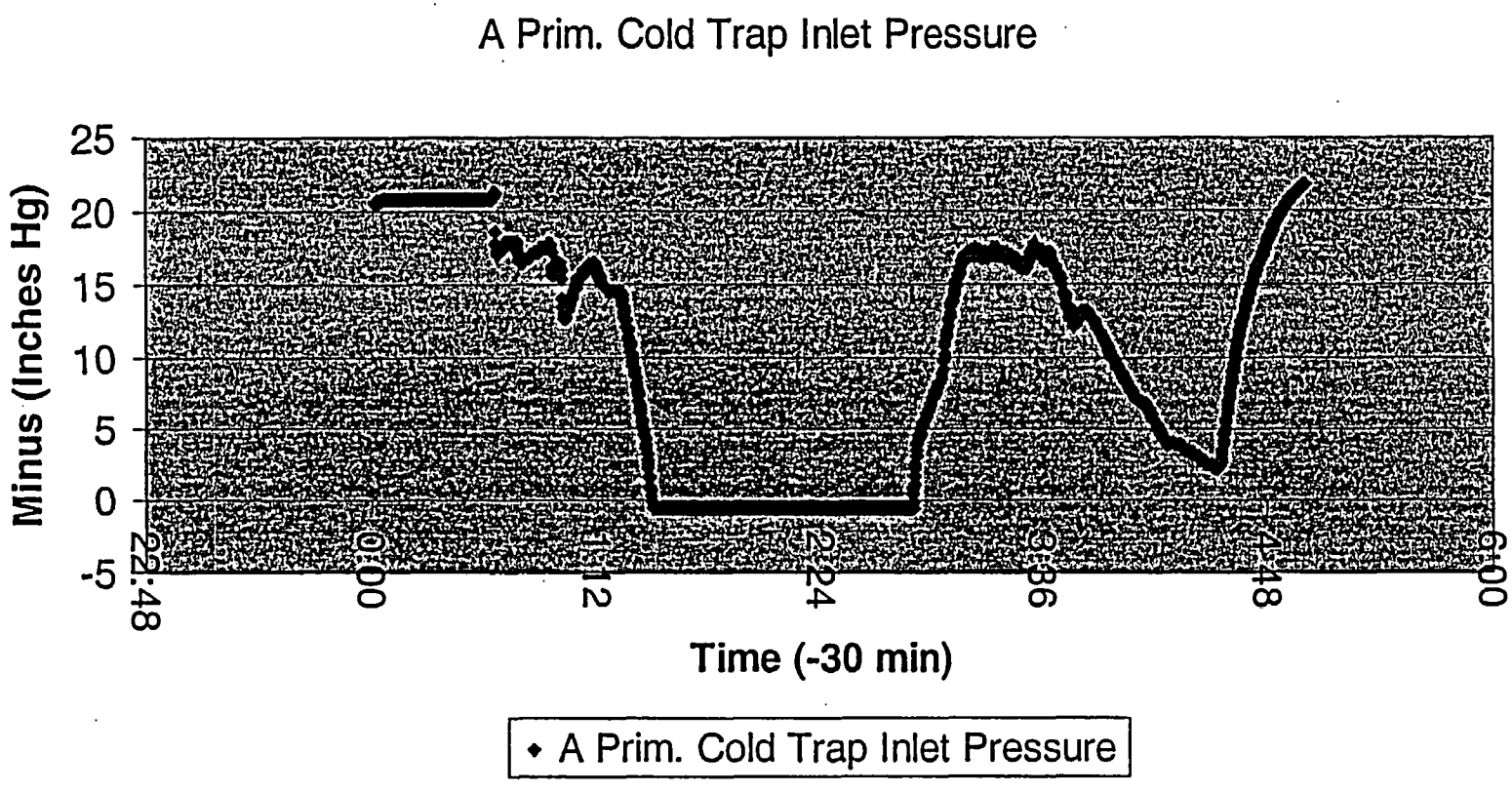
Event Time Line

Time	Process Data (Data Logger)	Process Data PR401	A Windbox pressure	Op Log
2325			pressure to <25" H2O	F2 off to switch blanks
2330				Purge on
2400				Purge off
0020				Valved A &C to dust collector
0035				Shutdown scrubbing to install blanks between A and B
0106	Cold Trap Inlet -21" Hg, begins to swing			
0107		pressure begins to swing		
0135			pressure spike, then down	
0143		pressure begins sharp rise		
0150	Cold trap inlet -15" Hg, begins sharp rise			
0155			pressure to >25" H2O	
0158		Cold trap max off scale		
0200	Cold Trap inlet goes + off scale			
?				Leak noted
0215				
0215				
0215				
0215				
0228				
0228				
0240				
0240				
0250			pressure back down to +12" H2O	
0253				
0305				
0315				
0315				
0323	Cold trap inlet begins to decrease			
0328		pressure begins to drop		
0343		pressure stabilizes		
0345				
0345				
0348	Cold Trap inlet back to -17" Hg			
0350				
0403		pressure begins to rise		
0405	Cold trap pressure begins increase			
0502		pressure maxes, begins decrease		
0502	Cold Trap pressure maxes at -3" begins decrease			

Information Gathered only - not verified

System Pressure



Pressure Rise

Estimates of pressure rise and venting

Note: Calcuations assume all vapor volumes are air (Worst Case)

Fluidizng air in: 70 SCM Both Fluorinators being Fluidized

Duration
2:15 Off
1:40 Start of pressure rise
0:35 Time air going in

35 minutes

Total air added: 2450 ft3 171.5 lb

System Volume:

Vessel	Diameter	Length	Vol. Ea	vapor space	Total vol.,ft3
2 Fluorinators			215	0.8	344
3 Filters	3	7.8	215	0.9	580.5
6 PCT			207	0.9	1117.8
5 SCT			77	0.9	346.5
4 TCT			77	0.9	277.2
1 Piping (assume)	0.33	500.00	43.52		43.52

B Filters tied into C Fluorinator

Less solid UF6 in cold traps 84883 lb = 261.60 ft3

Total **2447.93 ft3**

Pressure	Start of rise	7.4 psia	Dens=	0.035747258	87.51 lb air
	End of rise				259.01 lb air
					0.11 lb/ft3
				P=	1132.39 mm Hg abs
				P= [redacted]	psig estimated final pressure

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Loss Quantity Estimate

Estimate of Loss

Assume	0.05 % UF6 in vapor		Based on System volumes and partial pressures of gases in each component of the system (Fluorinator Side and Cold Trap Side)
avg MW	45.15		
Pre-vent pressure	7.2 psig		
Vapor density	0.170591 lb/ft3		
Vapor weight	417.5931 lb		before vent to dust collectors
Vent down to 14.7 psia	280.3022 lb		after vent to dust collectors
Loss through dust collector (max)	**137.2909 lb**		assume all went through dust collector

Estimate % UF6 in vapor

Assume UF6 saturated vapor in cold traps mixes with air in rest of system

UF6 vapor in cold traps	T	0 F	-17.7777778 C
	UF6 VP	5 mm	
	UF6 MW	352	
	UF6 density	0.006904 lb/ft3	
volume of cold traps	1479.903 ft3		
weight of UF6 vapor in cold traps	10.21658 lb UF6		

weight of air in system

volume of system	2447.927 ft3	
density of air in rest of system at	18.3 psia	(avg. pressure during release through dust collector)
	0.091559 lb/ft3	
Weight of air	224.1303 lb	

Estimated UF6 concentration is 4.36% by weight *Checks with 5% assumption*

Estimated UF6 loss through dust collector 6.9 lb

Preliminary Equipment Findings

- No.1 and No.2 Ash Dust Collector Internal Inspections
  - Bags in tact. To be changed prior to re-start.
  - Presence of residue indicates UF6 traveled to baghouse.
  - HP samples inconclusive due to potential plugging.
- Spar Hopper
  - No evidence of UF6 presence.
- C Minus Control Valve
  - Primary seal (bellows) failed.

Outside Resources to Facilitate Re-Start

UF6 Incident Engineering Analysis
- Tracy Mills
- Bob Smith

Systems for Root Cause Analysis
- William Corcoran

Systems for Handling Corrective Actions

Corrective Action Effectiveness Review
- Hugh Thompson
- Jim Milhoan

UF6 Release Point Data Calculations
- Dr. Mills

Systems of Process Hazard Safety
- Bill Hague & Team

Systems for Training and Procedures
- Jerry Watell

Systems for Mechanical Integrity
- Resource Needed

Systems for Preventive Maintenance
- Resource Needed

Corrective Action Management Review
- Alan Roy
- Russ Morehead
- Chuck Schafer