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OCT 0 4 2012

Mr. Mark J. Duff, Paducah Project Manager
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PPPO-02-1597347-12

RECEIVED
OCT 0 9 2012
Per C. Chamb

Dear Mr. Duff:

CONTRACT DE-AC30-10CC40020: EVALUATION OF LATA ENVIRONMENTAL SERVICES OF KENTUCKY, LLC'S RESPONSE TO DISCOVERY OF ELEVATED LEVELS OF PLUTONIUM IN THE C-410/420 DECONTAMINATION AND DECOMMISSIONING COMPLEX

The U.S. Department of Energy (DOE) has performed an evaluation of LATA Environmental Services of Kentucky, LLC response to discovery of elevated levels of plutonium in the C-410/420 Decontamination and Decommissioning complex. Although LATA Kentucky's responses were adequate, DOE has noted some areas for further improvement. Please submit a corrective action plan within 30 days of receiving this letter.

If you have any questions or require additional information, please contact Donald Dihel at (270) 441-6824.

Sincerely,

William Creech
Contracting Officer
Portsmouth/Paducah Project Office

Enclosure:
Paducah Oversight Report

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Portsmouth/Paducah Project Office
Office of Environmental Management

Paducah Oversight Report:

Evaluation of LATA Kentucky's Response to Discovery of Elevated Levels of Plutonium in the C-410/420 D&D Complex

July 2012

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CONCURRENCES AND APPROVALS

Evaluation of LATA Kentucky's Response to Discovery of Elevated Levels of Plutonium in the C-410/420 D&D Complex

CONCURRENCES:

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APPROVAL:

/Tom Hines 9-17-2012

Tom Hines, Portsmouth/Paducah Project Office
Nuclear Safety Oversight Lead — Date

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Acronyms

µL	micro liter
AIHA	American Industrial Hygiene Association
ALS	Australian Laboratory Services
APF	Assigned Protection Factor
Am	Americium
BCS	Boundary Control Station
BZ	Breathing Zone
CAAS	criticality accident alarm system
D&D	Decontamination and Decommissioning
DAA	DSA Applicability Area
DAC	Derived Air Concentration
DOE	U.S. Department of Energy
DOECAP	Department of Energy Consolidated Audit Program
DOELAP	Department of Energy Laboratory Accreditation Program
dpm	decays per minute
DSA	Documented Safety Analysis
F_2	Fluorine
FFAPR	Full Face Air Purifying Respirator
FLS	Front-Line Supervisor
FR	Facility Representative
HF	hydrogen fluoride
HVAC	heating, ventilation, and air conditioning
IH	Industrial Hygiene
IS	Industrial Safety
LATA Kentucky	LATA Environmental Services of Kentucky, LLC
MDA	Minimum Detectable Activity
mg/g	milligrams per gram
MSA	Mine Safety Appliances
NIOSH	National Institute for Occupational Safety and Health
Np	Neptunium
NRC	Nuclear Regulatory Commission
OMP	Occupational Medical Provider
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
PAPR	Powered Air Purifying Respirator
pCi	picocuries
PCP	Primary Care Physician
PEL	Permissible Exposure Limit
PGDP	Paducah Gaseous Diffusion Plant
ppb	parts per billion
PPE	Personal Protective Equipment
ppm	parts per million
PPPO	Portsmouth/Paducah Project Office
Pu	Plutonium

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RADCON	Radiological Control
RCT	Radiological Control Technician
REL	Recommended Exposure Limit
SCO	Surface Contaminated Object
SDO	Scheduled Day Off
SOP	Standard Operating Procedure
STEL	Short term exposure limit
TRU	transuranic
TWA	Time Weighted Average
U	Uranium
UF_6	Uranium Hexafluoride
USEC	United States Enrichment Corporation
USW	United Steel Worker

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Executive Summary

The purpose of this report is to evaluate LATA Environmental Services of Kentucky, LLC (LATA Kentucky) response to the discovery of elevated levels of Plutonium (Pu) in the C-410/420 Complex Decontamination and Decommissioning (D&D) Project during the months of January and February 2012. In addition, the report also assesses LATA Kentucky's evaluation of the level of correlation (if any) between; (1) a change in condition, elevated levels of Pu, discovered during uranium hexafluoride (UF_6) piping stabilization activities and (2) the onset of an employee illness. The Nuclear Safety Oversight Lead requested that a U.S. Department of Energy (DOE) oversight report be developed to document the evaluation. The evaluation was performed in accordance with DOE Order 226.1B, *Implementation of Department of Energy Oversight Policy*. As part of the evaluation, the Portsmouth/Paducah Project Office has compiled and considered background information pertaining to the work site and work-site conditions including air and surface monitoring results. The evaluation also considered the job duties of the employee and work controls implemented as well as basic information regarding medical treatment of the employee and all associated LATA Kentucky case management protocols.

The DOE investigative review team reached the following conclusions.

My report and Tony Record's witness statement explain the circumstances

entucky's response to the elevated transuranic activity in 4 inch UF_6 piping was , although areas for improvement were noted. (The principle element in the transuranic l all transuranics are included when referring to Pu, as appropriate). The worker crews wore Personal Protective Equipment (PPE) that provided protection from the Pu, and the implementation of a Suspend Work was appropriate.

The worker (that experienced an illness) did not follow LATA Kentucky procedures by exiting the work area when he suspected a respirator failure. LATA Kentucky's response to the notification by the worker was appropriate and consistent with LATA Kentucky procedures. The Occupational Medical Provider determination that the worker's illness was not due to occupational exposure was based on professional judgment of test results and knowledge of the working conditions. The LATA Kentucky response and actions associated with the employee illness was also adequate, although areas for improvement were noted.

My Dr diagnosed me with Chemical Pneumonitis

LATA Kentucky's determination that the elevated Pu contamination and the determination that the worker illness was not related is consistent with the information gathered by the DOE investigative review team. The LATA Kentucky conclusion that there is not a correlation between the two events is supported by the results of this investigation, although areas for improvement were noted.

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1.0 INTRODUCTION

The U.S. Department of Energy (DOE) owns the Paducah Gaseous Diffusion Plant (PGDP), located near Paducah, Kentucky. Within the PGDP is a group of DOE non-leased facilities, equipment, and associated infrastructure that were collectively used in the past to produce uranium hexafluoride (UF_6) as feed material for the cascades. The UF_6 production facilities are referred to, collectively, as the "C-410 Decontamination and Decommissioning (D&D) Project Facility" or as the "Facility." This group of facilities has not produced UF_6 since they were permanently shut down in June 1977. The Facility is undergoing D&D by the Environmental Remediation Contractor, LATA Environmental Services of Kentucky, LLC (LATA Kentucky), under contract to DOE. LATA Kentucky has held this contract since July 2010.

On January 5, 2012, a 4 inch UF_6 header was cut in C-410 and a section was removed. The removed section was dipped in UF_6 neutralization solution. On January 19, 2012, swipe samples collected on this section of piping for waste characterization indicated elevated readings of what was on February 3, 2012 determined to be plutonium (Pu) contamination. Work was "redirected" by LATA Kentucky on January 19, 2012, for this activity due to the identified change in conditions. Other UF_6 piping, not directly connected to this system, continued to be cut and removed.

On February 13, 2012, LATA Kentucky determined that work could be safely performed and authorized work on the UF_6 piping system. However, on the next day, February 14, 2012, a Formal Suspend Work[1] was instituted to cease cutting UF_6 piping systems (i.e. cold traps) including and/or linked to the two aforementioned 4 inch diameter headers, which had been determined to contain a higher concentration of Pu contamination. (Several actions were developed by LATA Kentucky to resume this work activity and are detailed in Section 3.2.)

On February 14, 2012, a LATA Kentucky Front-Line Supervisor (FLS) assigned to the C-410/420 Complex, reported symptoms of a respiratory illness. The employee had seen his primary care physician (PCP) the previous day. It was then that his physician posed the question regarding the possible association of his symptoms with an exposure at work. The employee recalled an issue with his respirator the week before, February 8, 2012, which was not reported at that time to his supervisor.

Later, on February 22, 2012, the employee's illness had progressed resulting his his admission to a local hospital.

See Attachment A for combined timeline of events.

2.0 PURPOSE/SCOPE

The purpose of this report is to determine if:

1. the LATA Kentucky response to the elevated Pu levels was sufficient and appropriate,

[1] A formal suspension of work is LATA Kentucky protocol for a questionable condition or practice identified by any worker that cannot be corrected in a timely manner and the extent of condition may impact other work groups.

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2. the LATA Kentucky response to the LATA Kentucky employee illness was sufficient and appropriate, and if
3. the LATA Kentucky decision that no correlation exists between the employee illness and the elevated levels of Pu in the C-410 Complex was accurate.

3.0 SEQUENCE OF EVENTS

3.1 C-410/C-420 Operational History

Operation of the C-410 Complex stopped in the mid-1970s. The Facility was inactive as a process facility after 1977 with the exception of limited fluorine (F_2) production that continued until 1994. After the Facility was shut down in 1977, it was used for a variety of additional purposes, including office space, electrical shops, training facilities, component rebuild facilities, laboratory facilities, a computer maintenance shop, and storage of material from other areas of the PGDP and/or the DOE Complex. Limited deactivation activities were started in the Facility in 2000. The Facility has moved from a transitional Surveillance & Maintenance (S&M) life cycle phase into a combined deactivation and D&D phase. Considering the area over which the facilities are spread and the complexity of the deactivation and D&D work to be performed, a physical area was defined that collectively encompasses the facilities, as well as, additional surrounding land that will be necessary to conduct D&D activities. That area has been identified as the Documented Safety Analysis (DSA) Applicability Area (DAA). For the C-410 D&D Project DSA, the project boundary is the perimeter of the DAA. The dominant structure within the DAA perimeter is the single contiguous building that consists of the C-410 Feed Plant, the C-411 Cell Maintenance Building, and the C-420 Green Salt Plant and is known as the C-410 Complex. The C-410 Complex was the main facility used in the production of UF_6 at PGDP. The Facility has a nuclear hazard categorization of Hazard Category 2 and hazard classification of "High" for non-nuclear hazards.

During C-410 D&D Facility process operations, the uranium (U) feed material used in UF_6 production contained less than 1 weight% assay ^{235}U, per FDD-RM-C410-0001R0, *Facility Description Document for the C-410 Complex* and the *Hazard Analysis for the C-410 Complex*, CAN-C41000-A001, Rev 1. Also during process operations, an inventory of ^{239}Pu was introduced into the C-410 Complex through the processing of recycled reactor fuel from the reactor tails program. The reactor tails program ran from 1955-1977. Based on mass balance accounting, it has been estimated that up to 160 grams of ^{239}Pu remains as holdup in C-410 Complex process piping and equipment. Along with Pu, elements such as Technetium, Neptunium, Americium, and Cesium are expected to be present at low levels. Since approximately the year 2000 the building has been posted as containing transuranic or "TRU" materials.

3.2 Discovery and Response to Elevated Plutonium (Pu) Contamination Concentrations

On March 28, 2011 (previous year), LATA Kentucky implemented work control package 08-FD-P053 for the removal of UF_6 piping in C-410. The work release associated with this work package is 11WR-DD-133. The work scope involves installing "hot taps," using a chemical trap

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to remove gaseous UF_6 and HF, cutting piping into manageable lengths for stabilization and waste disposition, "dipping" the piping into calcium carbonate, and packaging the piping for waste disposal. Radiological and air monitoring is required by the Radiological Work Permit (RWP), PAD-FD-29336, Rev 1, for this work activity. (See Attachment B for building layout.)

During the month of January 2012, LATA Kentucky was in the process of cold trap isolation under work control package 08-FD-P053. The approach to cold trap isolation had been to start with piping that contained lesser amounts of contamination, then moving to the more heavily contaminated piping. The identification of the piping with lesser amounts of contamination was based on process knowledge, current conditions, and historical sampling data. The contamination in the piping includes varying levels of UF_6, Hydrogen Fluoride (HF), Uranium Fluorides, Uranium Oxi-Fluorides, Technetium-99 (^{99}Tc), and TRU. There were 19 cold traps within the C-410/420 complex. The UF_6 piping sampling data collected prior to January 19, 2012, indicated a higher ratio of U content compared to other TRU. This was evidenced by the fact that the gross beta activity was systematically significantly higher than the gross alpha activity.

Note: A cold trap is a device that condenses gaseous UF_6 into a solid.

On Thursday[2], January 19, 2012, following dipping of piping that originated from cold trap (6 traps total) isolation activities on the mezzanine level in Zones 23 and 24, a designated TRU area, surface contamination smears on the interior surfaces of two, 4 inch diameter UF_6 piping lines, indicated a gross alpha activity that was much greater than the beta and gamma activity. These sections of pipe had been cut on Thursday, January 5, 2012, and had originally been situated in a heated housing located in Zones 23 and 24. This sampling result was after the piping had been "dipped" in calcium carbonate solution in Zone 25, but before the piping was placed in a waste package (See Table 1). Staging piping in this manner, to be neutralized at a later date, was consistent with work controls stipulated for UF_6 stabilization in place at that time. LATA Kentucky recognized the differing radiological ratios taken from the piping as a changed condition and "paused" the work. A hold (or redirecting work to other areas) was placed on the cutting of all 4 inch diameter lines inside the heated housing in Zone 23, pending isotopic results[3]. Although work was not continued on the 4 inch line in Zone 23, other UF_6 piping was being isolated, removed, and processed for disposal in other zones, primarily Zone 33.

Two swipes (C410HP12-01 and C410HP12-02) were collected on Thursday, January 26, 2012 (the third business day after January 19, 2012) and received by USEC laboratory on Monday, January 30, 2012 (the next business day for LATA Kentucky). Swipes C410HP12-01 and C410HP12-02 were from the piping that showed the elevated alpha to beta activity after it had been dipped. Results were reported on Friday, February 3, 2012 and the results are reported in Table 1.

[2] LATA Kentucky was working a compressed work schedule. Most field workers were working ten hour days, Monday through Thursday. As needed, some workers worked overtime on Fridays.

[3] LATA Kentucky believed the alpha contamination was from Thorium. The work control practices (engineering controls including the chem. traps and NAMs, administrative controls including ongoing surveying and radiological controls with Limiting conditions, and PPE) were adequate to protect workers.

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The elevated Pu swipes prompted LATA Kentucky to perform further investigation. A swipe (C410HP12-03) from inside the pipe was collected on Monday, February 6, 2012 (the first business day after receiving the dipping swipe results) and received by USEC laboratory on the same day. Swipe C410HP12-3 was collected from piping that was the same section of the piping system that the piping for swipes C410HP12-01 and C410HP12-02 had been cut, but this section of piping had not been removed and dipped yet. Results were reported on Monday, February 13, 2012 (fourth business day for LATA Kentucky since swipes were taken) and the results are reported in Table 1.

Table 1 4 inch UF_6 Piping Monitoring Results

Isotope	Sample C410HP12-01; after dipping/neutralizing in solution (pCi/swipe)	Sample C410HP12-02; after dipping/neutralizing in solution (pCi/swipe)	Sample C410HP12-03; taken directly from existing piping (pCi/swipe)
$^{239/240}Pu$	165,000	277,000	805,000
^{238}Pu	4,300	12,400	17,300
^{237}Np	2,400	1,120	1,380
^{241}Am	30,400	61,800	103,000
^{99}Tc	49,500	51,300	26,800
^{228}Th	5.44	5.82	14.4
^{230}Th	95.5	132	7,100
^{232}Th	1.37	.684	10.9
^{234}U	4,490	519	1,370
^{235}U	268	28.5	69.4
^{238}U	4,730	524	1,430

On Monday, February 13, 2012 (thirteen business days after discovery of the unexpected high beta to alpha ratio), the results of the review that was conducted by LATA Kentucky Radiological Control (RADCON) was given to the C-410 workers as part of their daily pre-job briefing. The email issued by the Project Health Physicist that was read to the C-410 work crews contained the following statement:

> "February 10, 2012, RADCON has evaluated the hold that has been placed on cutting of all 4" lines and based on our current and historical surveys believe the high relative concentration of TRU material found in the two 4" lines inside the heated housed in Zone 23 is our only known source of high TRU material being worked.
>
> Surveys have been performed on the 2" line located in the same heated housing, chemical traps during media changed use to pull on lines, stove piping Zone 22, HVAC in Zone 22, and other various material without seeing the activity levels as identified in the two 4" lines.

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> Based on the chemical traps providing a very good engineering control and the need to gather additional information in other lines/systems, RADCON would like to restrict cutting of 4" piping to those currently identified in Zone 23 (from UF_6 filters to the 6 cold traps in Zone 23/24) and allow for other 4"lines to be cut.
>
> RADCON must be present during cutting to collect swipes and evaluate the material in these systems. If Alpha to Beta ratio is greater that 1:1 work will be suspended until the additional controls are put in place to continue cutting. These systems will be identified as TRU systems and worked under a different RWP requiring a different DAC[4] value, different bioassay protocol, 1:1 BZ[5] pump ratio, and possible use of an air-line."

Based on the memo, LATA Kentucky authorized work to restart on the UF_6 piping on February 13, 2012. LATA Kentucky continued the evaluation of the impact of elevated Pu levels, especially their ability to respond to a personnel internal contamination incident. It was determined by LATA Kentucky that sufficient facilities, equipment, and training were not in place should an internal contamination incident occur. LATA Kentucky's continued to walk down of the piping and discovered piping had already been removed that was expected to contain high levels of Pu, but didn't show Pu contamination. Therefore on February 14, 2012 (fourteen business days after discovery of the unexpected high beta to alpha ratio), LATA Kentucky issued a "Formal Suspension of Work[6]" for cutting and dipping of UF_6 piping and systems (i.e. cold traps) tied to the two, 4 inch diameter headers previously determined to contain significant concentrations of Pu in Zones 23 and 24.

The Suspension of Work was issued to review and ensure that mitigation controls were adequate including as the necessary emergency response protocols should there be a Pu personnel contamination incident. The required conditions for removal of the Suspension of Work were identified by LATA Kentucky. The conditions are listed below.

1. "Specifically identify with visible markers and delineate piping into two bins: Bin #1 includes those which are connected to the two 4 inch headers or for which no data regarding potential Pu content is available; and Bin #2 includes those pipes which are separated from the two 4 inch headers and data exists (through swipe sampling of inside of piping) that indicate equivalent levels of alpha and beta contamination, and therefore are not a Pu concern. Note: Piping for which there is no data regarding contamination levels of Pu inside the piping are being placed into Bin 1. (Note - not all binning and marking of piping is required before restart. No un-binned or unmarked UF_6 piping will be cut.)
2. Brief workforce on Pu issue and results of walk-down.
3. Resume cutting on piping in Bin 2 above. (Note – Walk-downs and categorizing piping into bins will be an iterative process. Pipes may be released for cutting by placing into

[4] Derived Air Concentration
[5] Breathing Zone
[6] A formal suspension of work is LATA Kentucky protocol for a questionable condition or practice identified by any worker that cannot be corrected in a timely manner and the extent of condition may impact other work groups.

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Bin 2 [with concurrence from Radiation Protection Manager or Project Health Physicist/Radiological Engineer] before all walk-downs are completed.)

4. If radiological survey levels observed during pipe or equipment cutting operations exceed established thresholds, cutting operations on this pipe or equipment will be suspended, it will placed into safe configuration, and reclassified as Bin 1.
5. Procure specific instrumentation, decontamination process and materials, and readily available medical treatment capabilities to respond to an exposure to Pu.
6. Update and/or revise protocols for response to an exposure to Pu.
7. Issue new RWP with revised bioassay and personnel monitoring requirements for cutting piping from Bin 1.
8. Install continuous air monitor in Boundary Control Station (BCS) utilized for Bin 1 operations personnel.
9. Brief workforce on new RWP and Controls for cutting Bin 1 piping.
10. Resume cutting Bin 1 piping.
11. If established thresholds are exceeded during in process monitoring, when accessing chemical traps, vacuums, and negative air machines, then operations will be suspended, systems placed in a safe configuration, and additional radiological controls implemented."

During the meeting with C-410 workers on Thursday, February 23, 2012, to discuss the following employee issues, LATA Kentucky committed to analyzing all C-410 worker's monthly bioassay samples for plutonium. The bioassay results did not indicate any analytical result that was above the action level.

On Wednesday, March 7, 2012, LATA Kentucky met with the United Steel Worker (USW) leadership to discuss the restart of UF_6 stabilization work activities. The eleven Stop Work corrective actions had been completed and the work stoppage was lifted on Monday, March 12, 2012.

3.3 Employee Illness

On February 13, 2012, an employee came to work with a "persistent cough." The employee, a C-410/420 FLS, left work early to seek treatment by his PCP.

On February 14, 2012, the employee reported an illness and requested that LATA Kentucky investigate the likelihood of his illness being associated with any radiological or chemical uptake acquired in his assigned workspace with the facility, Zone 22[7]. The employee stated symptoms began on February 11, 2012 and had progressively worsened through February 14, 2012. On the morning of February 14, 2012, the employee was taken to seek medical evaluation through the LATA Kentucky Occupational Medical Provider (OMP).

[7] In an email from the employee to his supervisor on February 14, 2012, the employee stated that his PCP had "diagnosed me with potential exposure pending bloodwork results." The employee continues to state this "could be unrelated to work, but I need your help and guidance if this is an exposure."

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F2 has a half life of 6 hours how can this even be considered?

eporting the medical concern, the employee also notified his supervisor he'd recalled a problem with his respirator on February 8, 2012, that he had not previously reported. In an email, he stated that while utilizing his Full Face Air Purifying Respirator (FFAPR) with a Mine Safety Appliances (MSA) HF/CL/P100 cartridge, it seemed "uncharacteristically easy to breathe out" and he had a "strong metal taste" in his mouth.

Upon notification to his supervisor (on February 14th), Industrial Safety (IS) and RADCON were contacted. Due to the comment of a "metallic taste," a spot bioassay sample (employee urine sample) was ordered for Fluorides and U analysis[8]. A full 24-hour bioassay sample was also requested. The spot bioassay was collected on February 14, 2012. On February 15, 2012, the fluoride results indicated 1.4 mg/g Creatinine, with a limit of 10 mg/g Creatinine for F_2, and 0.50 µg/L U[9]. The U levels are considered normal and are less than the decision level of 0.1dpm/day[10], which would have required an isotopic analysis. The employee and the employee's supervisor were apprised of the results on February 16, 2012.

We work by email, for records reasons

The 24-hour bioassay was never completed due to the worker not submitting a sample despite several phone request from LATA Kentucky's Rad Con Management. A routine monthly bioassay was found on the employee's desk (on February 23, 2012) that had been requested on February 6, 2012. The sample was not representative of a complete 24 hour period nor was Chain-of-Custody of the sample preserved since the sample was left on the employee's desk for over 2 weeks. The employee has not provided information on the times the sample was collected.

Yet it is cited?

In addition to the spot bioassay, the employee was sent for an evaluation by the OMP. The OMP contacted the employee's PCP and obtained the results of the lab analysis, which had been initiated the previous day. The OMP also ordered chest x-rays. Per the email sent by the employee to his supervisor and the DOE interview with the OMP, the OMP diagnosed the employee with a personal illness. The employee was placed on respirator restriction at that time and was scheduled for follow-up x-rays on February 22, 2012, to determine if the respirator restriction could be lifted. The employee did not return to work, but remained on sick leave.

This was a HIPAA violation, yet I had to hire legal counsel to get sample results from the LATA

On February 14, 2012, an email message from the employee to his supervisor stated that on February 8, 2012, the employee had asked a fellow employee to check his respirator during work activities inside the airborne contamination area of C-410/420. Per interview records conducted by LATA Kentucky, a USW operator, assigned to the employee's work crew, was asked by the employee to check his respirator. The operator did not see anything wrong with the respirator. A Radiological Control Technician (RCT) stopped the employee to apprise him that work in Zone 23 was being suspended. Per the RCT's statement, the employee also told the RCT that his respirator was not working correctly. The RCT told the employee "If you (the employee) don't feel like your respiratory protection is working like it should, then you need to exit the building now and let the RCT's at the BCS know so they can get you to the right people." The RCT notified by radio the Boundary Control Station (BCS) Rad Con Supervisor to tell him someone

[8] F_2 is rapidly absorbed from the gastrointestinal tract, with a half-life of about 6 hours[8]. The biological half-life for U is 15 days.
[9] LATA Kentucky does not convert µg/L U into a dose.
[10] Limit is based on the entire 24 void being less than 0.1 dpm.

I have no recollection of an RCT being involved

Case in Point

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because no call was made

was coming out with a respirator issue. However, per the employee's email and a statement from the G-crew FLS, he remained inside the airborne radioactive area (ARA) and walked down remaining work areas with the G-crew FLS. That walk-down started at the base of the south stairwell in C-420 and continued through zones 25, 31, 35, 34, 33, 27, 28, and 26[11]. It was reported that this tour took approximately 10 minutes to complete. The employee successfully monitored out of the work zone through a half-body monitor at the C-410/420 BCS. The monitors will indicate an all clear if readings are less than decontamination levels which are specified in 10 CFR 835, *Occupation Radiation Protection, Appendix D*, for total contamination; less than 500 dpm alpha and less than 5000 dpm beta. Attachment B of this report outlines the basic tour path. There is no record of anyone at the BCS being aware of the employee having mentioned a problem with his respirator or receiving a communication from the RCT. However, interviews with the RCT Supervisor indicated the radio message was received at the BCS, but the RadCon personnel at the BCS forgot about the message during the daily egress of workers from the Facility.

None of these symptoms were displayed

LATA Kentucky's procedure, PAD-IH-5151, *Issue, Control, and Use of Respiratory Equipment*, states "IF while using RPE[12] and a situation where the respirator is malfunctioning, if experiencing symptoms such as dizziness, shortness of breath, nausea, or lightheadedness, THEN immediately exit the RPE use area and notify Front Line Supervisor and IS/Hygiene." The employee was respirator trained and qualified. Records indicate the employee had rad the procedure.

According to the RWP sign in sheet, the employee was in the air-borne contamination area, or work area covered by the RWP, on February 8, 2012 for a total of one hour fifteen minutes. That time-span was spent in the afternoon from 1300 hours to 1415 hours. However, a radio communication from the employee to a member of his crew was placed from inside the BCS at 1308. So, the time listed on the sign in/out sheet is greater than the time that employee was actually in the airborne contamination area.

The respirator was located before transfer to the Respirator Cleaning Facility and was monitored by the RCT's on February 14, 2012. The inside surfaces of the respirator were determined to be uncontaminated. The respirator was inspected by the Industrial Hygiene (IH) Manager and no visible defects were found. Since there was no tracking number assigned to the respirator cartridge, the respirator cartridge could not be located for inspection.

Note: During the doffing procedure, the cartridge is removed from the respirator and disposed into a general trash bag. The cartridge has no tracking number to allow for recovery of the cartridge after it has been separated from the respirator. The respirator however, has a unique identification number that allows for tracking the respirator from cleaning to issue to return to the cleaning facility.

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[11] The piping with high levels of plutonium were located under the mezzanine of Zone 23/24, and the cut pipe was in the dipping area in Zone 25. The dipping area is in an exclusion area segregated from the balance of Zone 25, and should not have been entered by the employee during a tour as described here.

[12] Radiation Protection Equipment

Who toured the 25 Exclusion zone? I didn't, the only time we would enter the 25 exclusion zone would be to gain access to zone 22 with Darren's pre-approval because we were in HFP100 canisters

I have the email that was sent and every email that I sent and received, I was the one that said it was personal to prevent further harassment and unwanted attention

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The employee did not work all his assigned regular work hours on both February 14 and 15, 2012, and his first full day off from work was February 16, 2012. Documentation requesting Short-Term Disability (STD) was sent on February 15, 2012. STD was initiated based on direction from the employee's PCP, or treating physician.

On February 14, 2012, the Manager of Projects "reiterated with the employee's supervisor to reinforce with the employee that the employee is to stop work if there is any doubt about the proper functioning of respiratory protection equipment."

3.4 LATA Kentucky Response to Employee Hospitalization and Allegation of Plutonium Exposure

On February 21, 2012, the employee notified his supervisor that he was to see his personal physician the following day to determine whether he would then be cleared to return to work or hospitalized and reported that his illness was currently termed as a non-work related. This coincides with the LATA Kentucky "Case Management, OSHA Record Keeping Decision" from February 14, 2012 as non-work related.

On February 22, 2012, the employee emailed his supervisor to let him know that he was being admitted to a local hospital. The LATA Kentucky OMP had been in contact with the employee's PCP. The OMP concluded that the symptoms the employee was experiencing were not consistent with a Pu exposure. On February 23, 2012, LATA RADCON made a request to the OMP, who consulted with the PCP, to request a 24 hour bioassay sample[13]. As a result of this request this sample (Bioassay #2) was collected at the hospital, logged in to LATA Kentucky tracking system and hand delivered to Oak Ridge National Laboratory (ORNL), with Chain-Of Custody maintained during the entire handling time. Bioassay #2 was analyzed for ^{241}Am, ^{238}Pu, and $^{239/240}$Pu. On February 27, 2012, ORNL reported all results below the Minimum Detectable Activity (MDA) and/or Action Limit. Bioassay #1 was also hand delivered to ORNL (note: the chain of custody was not complete for Bioassay #1) and was analyzed for ^{234}U, ^{238}U, and Technetium-99.

On February 23, 2012, LATA Kentucky and USW leadership held a meeting with D&D personnel to discuss rumors of Pu exposure and hospitalization of a fellow worker. LATA Kentucky stated that they had concluded their investigation into the matter by reviewing the OMP testing and diagnosis, reviewing radiological contamination monitoring results, reviewing airborne sampling results, and bioassay results to that date. The meeting was also utilized to address a rumor that several workers had similar symptoms, none of which had been reported to LATA Kentucky at that time. The workers present at the meeting did not substantiate the rumor with only one worker claiming to have similar symptoms.

The employee emailed his supervisor on February 24, 2012, to inform of his upcoming release from the hospital. However, he stated, he'd been informed by his physician that he could potentially be on STD for up to an additional 90 days.

- Ricky Denfip and Don Lents are briefing on AHAs.
- David Langston left at 0800 sick
- Pearl Brown called in sick
- Tony Record is sick (but staying till it gets worse)
- I'm sick (we'll see what happens)

Copied from my Supervisor's daily report 2-13-12

[13] The effective half-life[13] for Pu is approximately 6930 days.

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On February 26, 2012, the LATA Kentucky case manager received an email from the OMP stating that the results from the heavy metals lab work drawn while employee resided in the hospital, were negative and were below detectable limits.

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4.0 WORKING ENVIRONMENT FOR WEEK OF FEBRUARY 6, 2012

4.1 Radiation Work Permits

RWP PAD-FD-29385 covers removing heating, ventilation and air conditioning (HVAC) ductwork and UF_6 piping. The RWP became effective on March 25, 2011. The RWP required routine bioassay samples for Isotopic U (^{235}U and ^{238}U). The Note section states "Respirator and Personal Protective Equipment (PPE) requirements may change due to IH concerns. Follow the requirements listed on the C-410/420 System Hazard PPE and Monitoring Chart." The Hold-points listed are "Contact RCT prior to entering area in order to be briefed on the radiological Work permit and current conditions."

A C-410/420 IH staff member reported the PPE (personal protective equipment) requirements for working on Zone 22 HVAC duct removal on February 8, 2012, which held yellow and green salt/hold-up material, to be Level C. This was also reported to the Portsmouth/Paducah Project Office (PPPO) representative on February 14, 2012, during an interview, was outlined in the RWP, and was included in a statement from the employee. His PPE for Level C included: double Tyvek anti-contamination coveralls, a full-face respirator with HF/CL/P-100 cartridge, inner surgeon's gloves, leather gloves, tear away shoe covers, and rubber booties.

The RWP also requires "General Area Low Volume Air sampler of the work area for *Contamination, High Contamination,* and *Airborne Radioactivity Area's.*" However, "Note: 2. For General Area and Boundary air samples. A lapel BZ air sampler may be used in areas for lack of power or a high volume air sampler for short duration jobs." In this case, BZ air sampler was used. (See section 4.3 for results)

4.2 Work Being Conducted In C-410/C-420 On Week Of February 6, 2012

The following is a description of the work being performed in C-410/420 during the week of February 6, 2012. The work of each team inside C-410/420 to ensure a comprehensive understanding of all work that was being performed in the building.

FLS "A" was working Zone 22. FLS F was performing work under Work Releases 12WR-DD-011(C-410 HVAC Duct and Gasket Removal), EW12-DD-005 (Operation of Mobile Equipment), EW12-DD-006 (Operation of Mobile Equipment), and EW12-DD-007 (Minor maintenance activities). On February 6, 2012, the crew was splitting open HVAC piping using a reciprocating saw in preparation for packaging the removed materials as waste. On February 7, 2012, the crew was working in Zone 22, 2nd level removing HVAC duct work. On February 8, 2012, the crew moved to the 3rd level of the mezzanine, but encountered contamination limits close to the limits of RWP 29385. There was no entry on the Work Control Status Log for February 9, 2012. On February 10, 2012, the crew was cutting HVAC piping, but was stopped

COPY

when another work crew that was removing UF_6 piping in Zone 23 discovered elevated HF readings.

FLS "B" was working in Zone 31, 27, 28 and into 26 on February 6, 2012. His crew was cutting holes in ductwork throughout C-410, vacuuming residual materials from the ducts as necessary, and spraying the interior surfaces with a fixative. On February 8, note was made to leave vent covers in pace in Zone 50 locker room to prevent asbestos from becoming friable. The crew was spraying with both ABC Fixative and CC Wet Fixative. On February 7, the crew changed location to Zone 48. The crew started cutting holes and spraying fixative again on February 8, 2012. On February 9, 2012, they were performing the same work in Zone 47 and 50. On February 10, 2012, the crew cutting access holes in HVAC ductwork in Zone 33 and 38. FLS G was performing work under Work Releases 12WR-DD-011 C-410 HVAC Duct and Gasket Removal), EW12-DD-005 (Operation of Mobile Equipment), EW12-DD-006 (Operation of Mobile Equipment), and EW12-DD-007 (Minor maintenance activities).

FLS "C" /FLS "D" were working 11WR-DD-133 (Removal of UF_6 Piping in C-410 Complex). On February 6, 2012, the FLS D crew focused on down-sizing piping, and preparing it for transport to the dipping station. FLS D crew hot tapped 3" diameter UF_6 piping in Zone 33 and removed the piping on February 6 through February 8, 2012. FLS D crews hot tapped and removed UF_6 piping in Zone 26 mezzanine.

FLS 'E" crew was working on work release numbers 12WR-DD-003 (Perform CAAS Sentry Duties in and around C-410 Complex), 12WR-DD-013 (Waste Packaging in D&D Facilities), EW12-DD-005 (Certification of the C-410 Elevator), EW12-DD-006 (Operation of mobile Equipment), EW12-DD-007 (Minor maintenance activities), and 12WR-DD-001 (Daily Routine Activities). For the week, FLS A's crew basic duties were performing cleaning activities, restocking the BCS, and performing criticality accident alarm system (CAAS) Sentry Duty.

FLS "F" was working in Zone 25 staging UF_6 piping to be packaged, decontaminated waste packages for transportation out of C-410, and packaging waste. FLS B was working on work release numbers 12WR-DD-003 (Perform CAAS Sentry Duties in and around C-410 Complex), 12WR-DD-013 (Waste Packaging in D&D Facilities), EW12-DD-005 (Certification of the C-410 Elevator), EW12-DD-006 (Operation of mobile Equipment), EW12-DD-007 (Minor maintenance activities), 12WR-DD-001 (Daily Routine Activities), EW12-DD-09 (Cleanup of PCB Spills), and 12WR-DD-013 (Waste Packaging in D&D Facilities). On February 9 and 10, 2012, the crew was working 11WR-DD-128 (Abate asbestos in the C-410 Complex) and 12WR-DD-001 (Daily Routine Activities).

FLS "G" was working in Zone 24. On February 6, 2012, FLS E's crew pulled down a 4 inch diameter line and took off the end cap in order to collect a sample. Most workers, including FLS E, did not have respirators available to make an entry into the work area, so the crew members who had respirators performed cleanup duties. On February 7, 2012, the crew installed blanks on three 2 inch diameter lines. They installed three Hot Taps on "last" three 2 inch diameter drain lines for Cold Traps 507 C, B, and A. The afternoon "jump"; took three HF samples of the atmosphere inside the 2 inch line and all the sample results were over 100 parts per million (ppm). On the morning of February 8, the work crew installed a tent over the dipping station to

So the crew was pulling on an F2 line with the wrong mix in the chem trap?

COPY

capture any fugitive fumes from the dipping station, cut 40 feet of 2 inch diameter drain line under the cold traps. In the afternoon, IH had a positive indication, or a "hit," in a 2 inch diameter line of Fluorine. This was a change in conditions that is anticipated and planned for in the work package, and in accordance with work control. Work ceased and the crew came out. When FLS E asked his crew if anyone had smelled anything, the responses were "no." On February 9, 2012, the crew sampled the drain line and had a positive indication of 2 ppm fluorine. Therefore, in accordance with work controls, the crew changed the media in the Chemical Traps (to include tri-mix in the first tube for each) and found an oil leak on the south Chemical Trap. FLS E was working Work Releases 11WR-DD-133 (Removal of UF_6 Piping in C-410 Complex), 12WR-DD-001 (Daily Routine Activities), and 11WR-DD-137 (Removal of Wall Section and Building Modification in C-410 Complex).

All work release numbers are included in the Plan of the Day which authorizes the work to be performed.

4.3 Air Monitoring Results

To determine appropriate PPE levels and respirator protection requirements, routine air monitoring was conducted. See Attachment C for the air monitoring conducted by LATA Kentucky during the period reviewed by the oversight review team.

4.4 Dust Collection System Analysis

Sample of material in the Dust Collection System (also called the HVAC system) in Zone 22 and 26 were collected and analyzed. LATA Kentucky evaluated the results to determine if the PPE and air monitoring were adequate for protecting the workers. The results are in Table 2 below.

4.5 Radiological Smear Monitoring Results

To determine appropriate PPE levels and respirator protection requirements, routine radiological monitoring is conducted. See Attachment D for the monitoring conducted by LATA Kentucky during the period reviewed by the oversight review team.

4.6 Other personnel sick the weeks of February 6, 2012 and February 13, 2012

Table 3 is a review of the Pre-job-Briefing and Work Feedback sheets for the weeks of February 6, 2012, and February 13, 2012 to determine who was absent during the time period. Work assignments were tracked for all workers signed onto one of these sheets. Based on this data, LATA Kentucky concluded there was no common trend indicating an exposure event.

- Ricky Denfip and Don Lents are briefing on AHAs.
- David Langston left at 0800 sick
- Pearl Brown called in sick
- Tony Record is sick (but staying till it gets worse)
- I'm sick (we'll see what happens)

Copied from my Supervisor's daily report 2-13-12

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Table 2 Bulk Sampling Results from Material Removed from Dust Collection Duct Work

Zone	22		26
Date	2/23/2012		2/28/2012
Sample ID	022312-004	022312-005	022812-017
Agent	Result	Result	Result
Aluminum	1270 mg/kg	521 mg/kg	168 mg/kg
Antimony	11.1 mg/kg	9.59 mg/kg	9.68 mg/kg
Arsenic	20.7 mg/kg	19.2 mg/kg	19.4 mg/kg
Barium	21.9 mg/kg	5.16 mg/kg	3.07 mg/kg
Beryllium	0.493 mg/kg	0.48 mg/kg	0.484 mg/kg
Boron	255 mg/kg	193 mg/kg	190 mg/kg
Cadmium	70.4 mg/kg	45.6 mg/kg	31 mg/kg
Calcium	1520 mg/kg	672 mg/kg	191 mg/kg
Chromium	57.9 mg/kg	55.4 mg/kg	79.3 mg/kg
Cobalt	15.5 mg/kg	2.95 mg/kg	10.9 mg/kg
Copper	218 mg/kg	67.5 mg/kg	12,800 mg/kg
Iron	54,100 mg/kg	19,900 mg/kg	12,800 mg/kg
Lead	354 mg/kg	56.1 mg/kg	79.5 mg/kg
Lithium	4.93 mg/kg	4.8 mg/kg	4.84 mg/kg
Magnesium	187 mg/kg	96.1 mg/kg	43.7 mg/kg
Manganese	226 mg/kg	80.9 mg/kg	113 mg/kg
Molybdenum	7.08 mg/kg	2.4 mg/kg	2.42 mg/kg
Nickel	111 mg/kg	106 mg/kg	96.8 mg/kg
Potassium	286 mg/kg	150 mg/kg	96.8 mg/kg
Selenium	19.7 mg/kg	19.2 mg/kg	19.4 mg/kg
Silicon	5160 mg/kg	6450 mg/kg	4250 mg/kg
Silver	2.47 mg/kg	2.4 mg/kg	2.42 mg/kg
Sodium		280 mg/kg	338 mg/kg
Strontium	4.98 mg/kg	2.57 mg/kg	2.42 mg/kg
Tin	384 mg/kg	95.9 mg/kg	96.8 mg/kg
Titanium	93.9 mg/kg	29.2 mg/kg	14 mg/kg
Uranium	520,000 mg/kg	572,000 mg/kg	587,000 mg/kg
Vanadium	5.03 mg/kg	2.4 mg/kg	2.42 mg/kg
Zinc	38,900 mg/kg	14,800 mg/kg	32,900 mg/kg

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Table 3 Daily Attendances for HVAC Workers

Employee	2/6/12	2/7/12	2/8/12	2/9/12	2/10/12 (Overtime)	2/13/12	2/14/12	2/15/12	2/16/12
	FLS A Crew[14]								
Worker A1	Present	Present	Present	Present	Present	PTO[15]	Present	Present	Present
Worker A2	Present	Present	Present	Present	Present	Present	Present	Present	Present
Worker A3	Present	Present	Present	Present	Sick	Review AHA	No Data	Present	With FLS B
Worker A4	PTO	Present	Present	Present	Present	Review AHA	No Data	Present	With FLS B
Worker A5	Present	Present		Present	Present	Present		With FLS B	With FLS B
Worker A6	Present	Present	Present	Present	No Data	Present	Present/PTO[4] P.M.	No Data	With FLS B
Worker A7	Present	Present	Present	Present	Present	PTO[4]	PTO[4]	With FLS B	With FLS B
Worker A8	Present	Present	Present	Present	Present	Present	Present	No Data	No Data
Worker A9	No Data	No Data	Present	Present	Present	Present	Present	Present	PTO[4]
Worker A10	Present	Present	Present		SDO[16]	½ day PTO[4]	½ day PTO[4]	PTO[4]	Present
Worker A11	PTO[4]	Present	Present	Present	SDO[5]	STD[17]	STD[6]	STD[6]	STD[6]
Worker A12	With FLS B	Present	Present	Present	Present	Present	Present	Present	Present
Worker A13	Present	Present	Present	Present	Present	Present	Present	Present	Present
	FLS B Crew								
Worker B1	Present	With FLS A	Present	Present	Present	Present	Present	Present	Present
Worker b2	Present	Present	Present	Present	Present	Present	Present	Present	Present
Worker B3	Present	Present	Present	Present	Present	Present	Present	Present	Present
Worker B4	Present	Present	Present	Present	Present	Training	Present	Present	Present
Worker B5	Present	Present	Present	Present	Present	Present	Present	Present	Present
Worker B6	Present	Present	Present	Present	Present	Present	Present	Present	Present
Worker B7	Present	Present	Present	Present	Present	Present	Present	Present	Present
Worker B8	Present	Present	Present	Present	Present	Present	Present	Present	Present

[14] FLS was sick starting 2/13/12.
[15] Personal Time Off
[16] Scheduled Day Off
[17] Short Term Disability, not related to any occupational injury or illness

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Worker B9	PTO[4]	Present	Present	Present	Present	Present	Present	Present	Present
Worker B10	No Data	No Data	No Data	No Data	No Data	No Data	Present	Present	Present
Worker B11	Present	Present	Present	Present	Present	Present	Present	Present	No Data
Worker B12	Present	Present	Present	Present	Present	Present	Present	Present	No Data
Worker B13	Present	Present	Present	Present	Present	Present	Present	Present	Present

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Table 4 Daily Attendance for UF_6 Workers

Employee	2/6/12	2/7/12	2/8/12	2/9/12	2/10/12 (Overtime)	2/13/12	2/14/12	2/15/12	2/16/12
	FLS C and FLS D Crews								
Worker C/D1	Present	No Data	Present	Present	SDO[18]	Present	Present	Present	Present
Worker C/D2	Present	Present	Present	Present	Present	Present	Present	Present	Present
Worker C/D3	Present	Present	Present	Present	Present	Present	Present	Present	Present
Worker C/D4	Present	Present	Present	Present	Present	Training	Training	Present	Present
Worker C/D5	Present	Present	Present	Present	SDO[7]	Present	Present	Present	Present
Worker C/D6	Present	Present	Present	Present	SDO[7]	Present	Present/PTO[19] p.m.	Present	Present
Worker C/D7	Present	No data	Present	Present	Present	PTO[8]	Present	Present	Present
Worker C/D8	Present	Present	Present	Present	Present	Present	Bereavement	Bereavement	Present
Worker C/D9	Present	Present	Present	Present	Present	Present	Present	Present	Present
Worker C/D10	Present	Present	Present	Present	Present	Present	Present	Present	Present
Worker C/D11	Present	Present	Present	Present	Present	Present	Present	Present	Present
Worker C/D12	Present	Present	Present	Present	Present	Present	Present	Present	Present
Worker C/D13	Present	Present	Present	Present	Present	Present	Present	Present	Present
Worker C/D14	Present	Present	Present	Present	Present	PTO[8]	Present	Present	Present
Worker C/D15	Present	Present	Present	Present	Present	Present	Present	Present	Present
Worker C/D16	Present	Present	Present	No Data	Present	Present	Present	Present	Present
Worker C/D17	No Data	Present	Present	Present	No Data	No Data	No Data	No Data	No Data
Worker C/D18	Present	Present	Present	Present	Present	Present	Present	Present	Present
Worker C/D19	Present	Present	Present	Present	Present	Present	Present	Present	Present
Worker C/D20	Present	Present	Present	Present	Present	Present	Present	Present	Present
Worker C/D21	Present	Present	Present	Present	Present	Present	Present	Present	Present
Worker C/D22	No Data	No Data	Present	Present	Present	Present	Present	Present	Present

[18] Scheduled Day Off
[19] Personal Time Off

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4.7 Similar Occurrence

On February 27, 2012, SNR-LK-2012-007 was issued. Per the Safety Notification Report, a RCT was working on HVAC system when he took a smear of the duct work when noticed a metallic taste in his mouth. As he was exiting the area and heading back to the BCS, the taste became very strong. He then notified IH and his Supervisor. Spot bioassays were collected for the entire work crew. The spot bioassay results were analyzed by United States Enrichment Corporation (USEC) for fluorine and U. USEC reported the results on February 29, 2012. All results were found to be below action limits.

Respirators and filters were collected and held for further examination. Examination of the respirators and cartridges showed no deficiencies or defects. A radiological monitoring of the inside of the respirator showed no detectable contamination.

Workers gave witness statements. One witness statement states that the worker was cutting duct work in Zone 26 and smelled an odor. All other witnesses stated they did not smell anything at that time. But one witness stated he often gets a metallic taste when cutting along with a "different odor."

Air samples that workers were wearing were shipped off for analysis. The results are tabulated in Table 5. None of the sample exceed the assigned limits.

Table 5 Air Monitoring Results

Date	Sample ID	Zone	Uranium in mg/m^3 (% of limit)	Zinc in mg/m^3 (% of limit)	Lead in mg/m^3 (% of limit)
2/27/2012	022712-013	26	37.6 (26.8%)	0.0329 (2.4%)	1.84 (4.6%)
2/27/2012	022712-016	22	54.47 (39.1%)	0.0310 (2.2%)	1.12 (2.8%)

An IH tech went back to the area where they were working and took HF samples. No levels were detected.

Table 6 HF Monitoring Results

Date	Zone	Number of HF samples collected	Number of samples above detection limit (0.5 ppm)
2/27/12	26, 38	18	0

LATA Kentucky Management discontinued work activities on the HVAC system until the additional investigative sample results were analyzed and evaluated. In addition to bulk, personal air, and biological samples, a sample was collected using an evacuated cylinder

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(Summa canister) to determine if there was a source of vapors from somewhere else in the building. The Summa Canister, which is designed to collect grab air samples, was analyzed for volatile and semi-volatile organic compounds. No chemical agents tested met any NIOSH or OSHA limit. Detailed results are in Attachment E.

5.0 OVERSIGHT REVIEW RESULTS

Was the LATA Kentucky response to the elevated plutonium levels sufficient and appropriate?

LATA Kentucky's response to the change in radiological conditions was adequate, but areas for improvement were identified. Once the change of conditions was identified in the 4 inch heated housing piping, this work was informally ceased per PAD-WC-0018, R1FC1, *Work Planning and Control Program*. LATA Kentucky's management reviewed the LATA Kentucky procedure for Stop Work and concluded that work could still be safely performed in other areas, but did not want to work the piping with the high alpha to beta ratio until there was a better understand of the situation.

On February 10, 2012, LATA Kentucky still felt they had adequate controls (engineering controls including the chemical traps and NAMs, administrative controls including ongoing surveying and radiological controls, and PPE) and that if an internal contamination event occurred, the employee could still be treated with the six hours. Therefore work was authorized to restart on the affected UF_6 piping. LATA Kentucky continued to walk down of the piping and discovered piping had already been removed that was expected to contain high levels of Pu, but didn't show Pu contamination and areas where Pu was not expected, did have Pu contamination..

In addition to the continued walkdown of the piping systems, LATA Kentucky re-evaluated its emergency response capabilities. To meet the six hours guidance, the contaminated employee would have had to be driven to Oak Ridge for treatment (a five hour drive). Although this was acceptable, it did not account for possible delays in transportation (such as traffic and/or weather.) Therefore on February 14, 2012, to error on the side of caution and due to inconsistent location of the Pu contamination, LATA Kentucky issued a Suspend Work. LATA Kentucky issued a Suspend Work instead of a Stop Work because they not think the condition rose to the level of a "Stop Work" because the failures that would occur to result in an internal plutonium exposure did not make it a "reasonable expectation" of such an event.

LATA Kentucky safety basis documents indicated Pu, along with other TRU material, was to be expected in the ash receivers, filters, and reactor towers. These system components have been slated for stabilization for several years. It would have been prudent for LATA Kentucky to have been more prepared for the eventuality of encountering the condition. Prior to the discovery of Pu, Radiological Worker training included what could be described as "awareness" level TRU characteristics and controls. TRU limits had been used for material removal/posting and establishing air sampling limits. Therefore, C-410/420 personnel were aware of the potential hazard through training and work protocol(s), yet preparation for the impact on the mitigation elements of the radiation protection program related to the condition was not fully implemented.

This whole ordeal is like catching a virus, if you are around someone that has it do you run around saying you have it before you're sick? I did not report it because we thought i was just imagining it when in zone 22 just like mine and Tony Record's witness statement says, I then got sick.....not from a virus or bacteria.....

COPY

See witness statements and email

...ded a 30-45 day work stoppage for a majority of UF_6

LATA Kentucky's RWPs were written to protect workers from radioactive contamination. The controls (Negative Air Machine, Chemical Traps, and PPE) protected workers from U and Pu contamination.

LATA Kentucky maintained an appropriate level of communication with USW Representatives throughout the process.

Was the LATA Kentucky response to the employee illness sufficient and appropriate?

The employee did not adequately comply with LATA Kentucky procedures. The employee did not follow the basic respiratory program requirements related to discovery of potential PPE equipment failure. His error was compounded by reporting the issue with the respirator days after the fact. The LATA Kentucky occupational medical program management handling of this incident was consistent with company protocol and procedures. The employee was taken to the LATA Kentucky OMP in a very timely manner. The lab work ordered by the OMP addressed potential chemical, heavy metal, and radiological exposure. The OMP reviewed the PCP lab analysis as well. All such lab-work came back as normal or non-detectable. The explanation of why the OMP characterized this as a "personal illness" and non-work-related was based on medical testing results, patient examination, and an understanding of the working conditions at the C-410/420 Complex.

Emergency spot-bioassay results were normal. However, the window between the potential time of exposure and the collection of the spot bioassay sample spans too great a time for the detection of fluorides due to work exposure[20]. In addition, spot bioassay samples sent to USEC cannot be used for dosimetry purposes since USEC is not a Department of Energy Laboratory Accreditation Program (DOELAP) provider. The LATA Kentucky DOELAP provider cannot provide analytical results within 24 hours of receipt, like USEC can. USEC has not been evaluated by LATA Kentucky for performing urinalysis; only for environmental sampling [through Department of Energy Consolidated Audit Program (DOECAP)]. LATA Kentucky should have utilized an approved DOE lab for any bioassay analysis for radiosotopes. Results could not be utilized as an official record, but were reported to be below detectable levels.

The followup 24-hour bioassay sample used for official dosimetry reporting was not completed within the allotted 24-hour period. An additional, full, 24-hour bioassay was ordered almost two weeks after the potential exposure while the employee was hospitalized. These results were within normal ranges as well for U and Pu.

The employee's respirator was located inspected, and monitored for radioactive contamination in the interior breathing zone. Radiological smears on the respirator were below detectable limits

[20] LATA Kentucky stated sample was collected to determine if the employee might have a fluoride exposure due to non-work related activities. LATA Kentucky stated the sample might be collected for other workers in a similar situation, but could not provide documentation to substantiate the claim.

I hate to sound like a broken record...

Rightfully so

COPY

By what Rad? So how is it possible that the exterior of some respirators pass a smear test after being in the zone with out wiping them down?

and the respirator was found to be in good working order with no visible defects. Had there been a failure of the filtering canister, the inside of the respirator would have been contaminated. During interviews several days later, the Radiation Protection Manager thought the respirator had been retrieved at the respirator laundry facility and inspected there. However, the Project Health Physicist provided the radiological survey that demonstrating LATA Kentucky personnel had surveyed and inspected the respirator onsite at the C-755 facility. This indicated that LATA Kentucky did not have a complete picture of the facts of the incident several days later. A written summary of the incident would have prevented miscommunication of the facts in this case.

LATA Kentucky reviewed monitoring data for possible exposure to HF or heavy metals concluded none were found. The only documentation of some of the data reviewed and the conclusion was in emails. LATA Kentucky collected witness statements from C-410/420 co-workers. An interview was conducted with the individual, an RCT, the employee asked to inspect his respirator. This individual stated he did not see any issues with the respirator and that he had not suspected any abnormalities in the work environment the day in question. However, his statement that he contacted the BCS regarding a potential respirator issue could not be confirmed by a review of the radio record obtained. This discrepancy was not identified nor investigated by LATA Kentucky. Positive communication between workers is a key component of Conduct of Operations.

I asked Tony Record an operator to inspect it, no an RCT

LATA Kentucky also collected a grab sample (summa canister) from C-410 on February 28, 2012, following the second report of a metallic taste. Documentation as to why this sample was collected was not available during this investigation. LATA Kentucky response to this report stated that LATA Kentucky thought some outside influence could be contributing to the work conditions. LATA Kentucky felt the material in the ventilation ductwork was well documented. This sample was sent to Australian Laboratory Services (ALS) Environmental of Salt Lake City. ALS is an AIHA certified in Industrial Hygiene in NIOSH Method 7300 Mod.

DOE-PPPO representatives met with the LATA Kentucky OMP physician to review all relevant (non-Health Insurance Portability and Accountability Act) details associated with the case. The OMP protocol for determination of a lack of exposure to either chemical or radiological constituents was sufficient and as timely as allowed given the late report by the employee. The decision to restrict the worker from using a respirator was appropriate and justified. Follow-up monitoring was also appropriate.

Was the LATA Kentucky decision that no correlation exists between the employee illness and the elevated levels of Plutonium in the C-410 Complex accurate?

The employee illness surfaced within the same time-frame as the discovery of elevated levels of Pu in an adjacent work area.

Given the lack of detectable levels of constituents in urine and blood analysis, lack of standard symptomatic characteristics associated with radiological/TRU exposure exhibited by the employee, the lack of alpha/beta ratios in the TRU range in the employee's work zone that day, the lack of contamination in the inner portion of the respirator, and the results of the OMP medical testing, the DOE-PPPO concurs with the LATA Kentucky OSHA Recordkeeping

Without one single interview with me?

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Determination of non work-relatedness. However, LATA Kentucky did not document the exact data reviewed to reach this conclusion. When asked of the potential exposure levels of the employee if the respirator had failed, LATA Kentucky stated the levels would not be at a level of concern. LATA Kentucky did not substantiate this statement with a written evaluation of exposure had the employee had a respirator failure.

Although a complete record for all C-410 personnel daily attendance could not be provided by LATA Kentucky for this report, a review of personnel attendance, airborne monitoring results, and radiological conditions at C-410 for UF_6 and HVAC removal crews showed no exposure (radiological or chemical) to a large group of personnel.

The DOE investigative review team performed a rough order of magnitude estimate of the worst case exposure of the worker as part of this report. These calculations are a rough but conservative estimate of the maximum possible internal dose; they are not definitive dose evaluations. Using calculations in Attachment F, the total dose to the worker assuming a complete failure of his respirator and being in the highest concentrated airborne activity area for the entire time he was in the area would have resulted in an estimated dose of 0.39 mrem, which is not a recordable worker exposure. Based on this calculation with the assumptions that the respirator failed, the worker was exposed at the highest airborne concentration recorded that day, and the airborne contaminant was Pu, the worker would not have received a dose that would require recording the dose in the employee's dose record and therefore, not a health risk. A more rigorous calculation utilizing current International Commission on Radiological Protection (ICRP) internal dose determination methods should be conducted to discuss estimated doses in the context of compliance with DOE Guidance documents[21], if warranted.

Using calculations in Attachment G, the DOE investigative review team performed another method for estimating the intake using the USEC Analytical Lab urinary U analysis results. This method takes the measured urinary U concentration by USEC and decay corrects (using the effective biological half-life) to the potential exposure time. Any exposure above 0.066 mrem would have been detected by the urinary U analysis.

Comparing the two results indicates that the bioassay was sensitive enough to have detected a complete failure of the respirator. Since the urinalysis result is below the estimated dose for a complete respirator failure and no detectable contamination was found in the respirator, it is unlike that the respirator had a failure that resulted in a recordable worker exposure[22].

Another possible evaluation was conducted assuming all the airborne concentration was due Pu. This evaluation assumes pure $^{239/240}Pu$ since the Effective Dose Coefficients from Inhaled Air[23] for ^{238}Pu, ^{239}Pu and ^{240}Pu are the same. The exposure time and total airborne radioactivity concentration remain the same as the U calculations above

Total Pu activity = 1.75e-4 μCi = 6.51 Bq

[21] Such as DOE-STD-1136-2000, *Guide of Good Practices for Radiological Protection in Uranium Facilities*, Table 2-5 (August, 2000)
[22] Worker internal exposures below 100 mrem are not required to be reported on the employee's annual dose report.
[23] *Derived Concentration Standard*, DOE-STD-1196-2011, Table A-2, page 148.

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Estimated dose = 6.51 Bq x 1.21e-4 Sv/Bq
= 7.88 e-4 Sv = 78.8 mrem

Although it is extremely unlikely the entire airborne alpha concentration was due to Pu, the worker with a complete failure of the respirator would not have resulted in a recordable worker exposure.

In all cases of dose reconstruction, there would not have been any exposure from a radiological analysis that would have resulted in a health concern.

As a precaution, LATA Kentucky had all January and February C-410 worker's bioassay results analyzed for U and Pu. All results from the DOELAP provider laboratory are below action limits.

6.0 CONCLUSION

This oversight report focused on the activities occurring in C-410/420 during January and February 2012. The goal of this report was to answer the following three questions:

1. Was the LATA Kentucky response to the elevated Pu levels sufficient and appropriate?
2. Was the LATA Kentucky response to the employee illness sufficient and appropriate?
3. Was the LATA Kentucky decision that no correlation exists between the employee illness and the elevated levels of Pu in the C-410 Complex accurate?

LATA Kentucky's response to the higher than expected Pu levels in 4 inch UF_6 piping was adequate, improvement were identified as part of the investigation. The work crew's PPE and other engineering controls were written to protect workers from U exposure, but also provided the required protection from the Pu. When the Suspend Work was finally implemented, it was consistent with approved procedures and was appropriate.

LATA Kentucky's response to the notification by the employee of his illness was appropriate and consistent with LATA Kentucky procedures. The OMP determined that the worker's illness was not due to occupational exposure. His determination was based on evaluation of test results and knowledge of the facility and environmental working conditions.

LATA Kentucky's determination that the elevated Pu contamination and the employee illness were not related is consistent with the conclusions of the DOE-PPPO investigative review team.

7.0 ITEMS FOR FURTHER IMPROVEMENTS

While the main questions of this Oversight Report has determined LATA Kentucky's responses met the minimum requirements, several areas for further improvement were identified by the review team, as listed below:

1. LATA Kentucky did not implement their stop work policies and procedures in an effective manner. During the discovery process, LATA Kentucky "redirected" work per LATA

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Kentucky's procedure PAD-WC-0018, R1FC1, *Work Planning and Control Program,* rather than implement the Formal Stop Work (or Suspend Work) as required by PAD-SH-2018, *STOP/SUSPEND WORK (SAFETY RELATED)* and as implied by PAD-RAD-1104, *Radiological Area Entry Control.*

With the discovery of high alpha to beta activity, LATA Kentucky "suspected" something was wrong and thereby should have initiated a "stop/suspend work." At this time, LATA Kentucky did not know what the circumstances were or what the information was telling them. The procedure PAD-SH-2018 states "Work that is suspected or proven to place workers, the public, or the environment at risk shall be stopped or suspended until it can be demonstrated that it is safe to proceed with the work." In addition, the condition exceeded the Limiting Condition for the RWP. Per PAD-RAD-1104, *Radiological Area Entry Control,* step 6.5.5 requires "**STOP** or **SUSPEND**" work immediately if a Limiting Condition is exceeded. In this case, the Limiting Conditions of RWP PAD-FD-29336 was exceeded. LATA Kentucky's procedure PAD-WC-0018, R1FC1, *Work Planning and Control Program,* step 3.3.6 states that "where no specific hazards exists, but a suspension of work is warranted" is when an "unexpected result occurs." While it was realistic to assume that the high alpha to beta ratio did not pose a health risk to workers due to the PPE workers were wearing, it did exceed the Limiting Conditions of the RWP and therefore created an unevaluated hazard. Therefore the use of work controls to establish work requirements as allowed by PAD-WC-0018 was not appropriate since there was a "specific hazard."

The use of a "redirected work" when conditions are suspect/unknown (a specific hazard) or has exceeded the Limiting Conditions of a RWP (unevaluated condition) bypasses the procedural restart requirements of a Stop Work or Suspend Work process approved in the LATA Kentucky Work Authorization Basis, using a graded approach, and DOE O 425.1B. Discussions with LATA Kentucky's middle management identified a lack of understanding restart requirements and a reluctance to issue a formal Stop Work due to the belief that a Stop or Suspend work stops all work under that work instruction.

2. LATA Kentucky delayed work due to inadequate planning. LATA was not proactive and timely in the development of programs that would be needed to support planned work activities. The potential for encountering the plutonium (Pu) was known within the project prior to the discovery during the work evolution. Work was halted and Pu identified as the isotope of concern on February 3, 2012. On February 13, 2012, work was authorized to start. However, on February 14, 2012, a formal Suspend Work was issued due to results from continued investigation of the spread of Pu contamination and the determination that LATA Kentucky was not confident of being able to properly handle a case of internal Pu contamination due to an accident.

   During the planning phase of the work activities, LATA Kentucky determined that personnel that experienced internal exposure of transuranics (including Pu) would be transported to existing facilities in Oak Ridge (approximately 5 hours away). This plan was deemed to be acceptable by LATA during the planning, since the treatment was recommended to be accomplished within 6 hours. This was confirmed by the email sent by RADCON on February 10, 2012. The decision to accept this response was influenced by the LATA

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perception that the chance of an employee being hurt and contaminated (e.g. experiencing a puncture wound while working on contaminated equipment) was low. However, during the DOE review of the event it was noted that the LATA Kentucky injuries at C-410 included 21 injuries in the preceding 24 months, 7 of which involved bleeding.

On February 14, 2012, LATA Kentucky revisited this decision and determined that the plan to transport injured personnel to Oak Ridge was not adequate. This, coupled with the fact that there was inconsistent location of the elevated Pu contamination, resulted in the Suspend Work being issued.

3. Although no worker was exposed to Pu, LATA Kentucky failed to respond appropriately to a change in facility condition. On January 19, 2012, LATA Kentucky discovered a high alpha to beta ratio in a smear taken on a piece of UF_6 piping that was being processed for disposal. At that time, LATA Kentucky responded to the discovery as if believed the initial high alpha contamination level was an "anomaly."

   LATA Kentucky received the smear analytical results on February 3, 2012 that indicated that the high alpha to beta reading were due to transuranics (mainly Pu), not Thorium. At this time, LATA Kentucky continued the work pause for the affected work area. They did not use this opportunity to initiate a formal Stop or Suspend work action until the scope of the discovery of Pu was fully understood.

   In addition, LATA Kentucky did not identify the extent of condition in a timely manner. When the "redirect" work was released on February 13, 2012, based on the RADCON email, LATA Kentucky was still performing a walkdown of the affected system.

4. LATA Kentucky management discontinued work activities on the HVAC system following a second report of a metallic taste until the additional investigative sample results were analyzed and evaluated without issuing a Suspend Work.

5. LATA Kentucky needs a system to collect bioassay samples when a worker is required to submit a sample, but is not at work. LATA Kentucky knew a bioassay sample was due from the employee, but never implemented any steps to obtain the bioassay sample other than leave phone messages. The lack of follow-up to initial 24 hour bioassay is partial due to a reliance on the spot bioassay sample results. In this case, the failure to have a valid 24 hour sample until 2 weeks after the event had minimal impact on the data, but in future cases, this may not be the case.

6. The practice of collecting samples at work needs to be discontinued because a person may not have access his collection bottles if he does not return to the site and because of the higher possibility of samples being cross-contaminated, either unintentionally or intentionally.

7. LATA Kentucky maintained communication with USW Representatives throughout the process. However, it was reported by the USW Safety and Health Representative that another, simultaneous, work stoppage occurred in the C-410/420 Complex associated with

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So the ASH Receivers that were observed off-gassing >100PPM HF, that this dust collection serviced and was near has no bearing?

the Zone 25 neutralization solution dipping station. The USW alleged "stop work" involved three issues:
(1) The operator manning the station had not been fully briefed regarding the hazards of neutralizing pipe potentially containing elevated levels of transuranics.
(2) The operator also reported that the tanks were so full not all of the pieces could be fully submerged.
(3) There was no mechanism in place to collect and filter off-gassing should it occur. Adjacent work activities were being concurrently performed that did not require the same level of respiratory protection.

A meeting was held between LATA Kentucky senior management and the USW to discuss the issue which occurred before the February 14, 2012 Suspend Work order for UF_6 piping was issued. It was confirmed through document review that as of February 8, 2012, the dipping station cover had been installed. The three issues with the dipping station were reportedly known by LATA Management and C-410/420 staff could speak to the issues and their eventual resolution. But the requirements of PAD-SH-2018 were not implemented, whether requested by the USW or not, and LATA management resolved the issues over a period longer than a shift.

LATA Kentucky and the USW need to ensure the same terminology is being used when discussing issues. Outside parties are confused when the USW claims to have called for a Stop Work, but LATA Kentucky management does not consider the issue to be a Stop Work and does not implement the requirements of PAD-SH-2018. LATA Kentucky also needs to formally capture those issues and document the resolution if it is not a Stop Work issue.

8. For the circumstance evaluated in this report, the window between the potential time of exposure and the collection of the spot bioassay sample spans too great a time for the detection of fluorides. Requesting a spot bioassay provided no useful information and is a waste of DOE funds, if performed to confirm a work related exposure. If the analysis is due to confirm a non-work related exposure (as was noted during interviews), the reason needs to be documented. Workers need to be encouraged to immediately report any potential fluoride exposure and they need to understand the consequences of not reporting the issue in a timely manner (i.e., when bioassay samples for fluorides are not useful).

9. LATA Kentucky reviewed monitoring data for possible exposure to HF and heavy metals. They concluded there was no exposure to workers, but did not document the data reviewed or the conclusion, except in emails. In the review of this material, some analytical results were not reported until after the conclusion had been reached to continue work. Additionally, no written evaluation of exposure had the employee's respirator failed was documented or provided. The only response to the question was "It is not a concern." The calculation of a number will add a framework for understanding the severity (or a lack of) to the incident.

10. LATA Kentucky should have collected a witness statement from the employee as they were being transferred to the Occupational Medical Provider (OMP) or shortly thereafter. LATA Kentucky has a history of waiting until an employee returns to a normal work schedule before collecting a witness statement. In addition, in this case, witness statements were not

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collected from BCS personnel or from the affected employee. This can result in the loss of valuable information. This is not to infer that the witness statement is more important than treating the worker. But when a worker is stable and able to discuss the incident, efforts should be made to record the worker's statement.

11. A Radiological Control Technician (RCT) and a union worker were asked by the employee to inspect the employee's respirator because the employee thought his respirator was not working properly. Both employees stated they did not see any issues with the respirator. Both employees should have reported/verified the incident had been reported upon exiting the work area.

    LATA Kentucky needs to instill into all workers that if a respirator failure is suspected, or they are experiencing any symptom of an exposure, they must exit the area immediately and report the incident to their supervisor and Industrial Hygiene (IH). If a worker suspects a fellow worker has experience a potential respirator failure, they must establish a positive means to ensure the worker, regardless of the person's position, is immediate removed from the area and examined by IH.

12. The RCT statement stated that he contacted the BCS could not be confirmed by the radio record obtained. If that communication is by radio, a checks and balance system must be implemented to ensure radio messages are heard and understood. It was later confirmed through the review team's interview that the message was received by the BCS, but forgotten during the daily exodus of personnel through the BCS. LATA Kentucky needs to improve radio communications to ensure messages are received, properly understood, and documented to prevent the loss of information. In this case, if the RCT had verify their communications were received upon leaving the work area or the BCS Rad Supervisor had identified that a worker had not checked in with a respirator issue, the issue with a worker with the suspected respirator failure would have been identified earlier.

    The RCT could have escorted the worker to the BCS, but doing so would have resulted in a temporary work pause for the RCT's assigned work crew. But the RCT thought his communication with the BCS would be handled properly. During the interviews, the RCT stated he would not hesitate to stop work if a worker's safety was in jeopardy.

13. The OMP protocol for determination of a lack of exposure to either chemical or radiological constituents was sufficient and as timely as allowed given the late report by the employee. However, the basis why the OMP determined the illness was not work-related should have been clearly communicated to the worker before being leaving the OMP office.

14. Some C-410 personnel daily attendance could not be provided by LATA Kentucky. LATA Kentucky should be able to demonstrate which employees were working in any area on any date. This is critical information for evolutions such as dose reconstruction.

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8.0 DOCUMENTS REVIEWED

1. USEC Analytical report for swipes with LATA interpretation from 4 inch piping.
2. Suspend Work for Elevated Pu levels in C-410.
3. Transuranic Materials Orientation, March 2012.
4. Radiation Work Permit PAD-FD-29385, Rev 0, (for Tours and Inspections and removing HVAC ductwork), effective 5/25/11, expires 4/24/12.
5. Email from Project Planner to PPPO Facility Representative about stop work for dipping station.
6. Work Control Status Logs – FLS 'D" crew – February 2, 2012 to February 9, 2012
7. Work Control Status Logs – FLS "E" crew – February 1, 2012 to February 10, 2012
8. Work Control Status Logs – FLS "G" crew /FLS "F" crew – February 6, 2012 to February 27, 2012
9. Work Control Status Logs – FLS 'B" crew – February 2, 2012 to February 15, 2012
10. Work Logs – FLS 'A" crew – February 6, 2012 to February 9, 2012
11. Pre-Shift Briefing & Worker Feedback –FLS 'B" crew – February 7, 2012 to February 9, 2012
12. Pre-Shift Briefing & Worker Feedback – FLS 'A" crew – February 6, 2012 to February 9, 2012
13. Pre-Shift Briefing & Worker Feedback – FLS 'C" crew /FLS 'D" crew – February 6, 2012 to February 9, 2012
14. Pre-Shift Briefing & Worker Feedback – FLS "E" crew /FLS "F" crew – February 6, 2012 to February 9, 2012
15. Pre-Shift Briefing & Worker Feedback – FLS "F" crew – February 13, 2012 (includes email from Greg Carter on cutting 4 inchUF_6 lines)
16. Pre-Shift Briefing & Worker Feedback – FLS "F" crew – February 6, 2012 to February 10, 2012
17. Pre-Shift Briefing & Worker Feedback – FLS "G" crew – February 6, 2012 to February 23, 2012
18. LATA Kentucky Case Management OSHA Record Keeping Determination
19. Personal air monitoring results, HF Air sampling results, and spot bioassay result from Industrial Hygiene Program Supervisor

20A. Radiological air monitoring results in C-410/420

20B. Radiological air monitoring results in C-410/420 for UF_6 work

21. Radiological air monitoring results in C-410/420 for HVAC work
22. Radiological surveys of C410 – January 17, 2012 to February 14, 2012
23. Witness statement - Zone 22 Vacuum System Duct Removal RCT Job Support – February 23, 2012 for Vacuum System for Zone 22
24. Witness statement - Zone 22 Vacuum System Duct Removal RCT Job Support – February 27, 2012 for Employee respirator on Feb 8, 2012
25. Witness statement –Industrial Hygiene Specialist– February 9, 2012 – UF_6 Drain line
26. Email from Industrial Hygiene Specialist – Exclusion Boundary in 23/24
27. Emails from Employee to C-410/420 Superintendent – personal illness related
28. Email from ES&H Manager to C-410/420 Superintendent – respirator restriction
29. Email from Manager of Projects to C-410/420 Superintendent – proper response to respirator failure

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30. Email from Occupational Medicine Program Manager to C-410/420 Superintendent– respirator restriction
31. Email from Project Health Physicist to C-410/420 Superintendent – spot bioassay results notification
32. Email from Radiation Protection Technician to C-410/420 Superintendent – missing monthly bioassay sample
33. Email from Project Health Physicist (D&D) to C-410/420 Superintendent – recovery of bioassay sample from worker's desk
34. Email from RCT Frontline Supervisor (C-410 Project) to C-410/420 Superintendent – bioassay chain-of-custody
35. Email from C-410 D&D Project Manager to Paducah Environmental Remediation Project Manager - impression on Roxy presentation
36. Email from HR Generalist to C-410/420 Superintendent– STD approval
37. Email from ES&H Manager to Industrial Hygiene Supervisor – respirator restriction
38. Witness statement – Senior RCT – February 23, 2012
39. Paducah Bioassay Sample Record of Receipt – Employee bioassay samples and ORNL results from Feb 23 and Feb 9 samples

40A. PGDP Urine Sample Record of Receipt (for spot bioassay) February 14, 2012 with associated USEC analytical results

40B PGDP Urine Sample Record of Receipt (for spot bioassay) February 27, 2012 with associated USEC analytical results

41. LATA Kentucky Procedure PAD-RAD-1201, Rev 1, ***Internal Dosimetry***
42. LATA Kentucky Procedure PAD-RAD-1216, Rev 0, *Management of Non-Routine Bioassay Samples*
43. LATA Kentucky Procedure PAD-IH-5110, Rev 0, *Biological Monitoring For Industrial Chemicals*
44. LATA Kentucky Procedure PAD-RAD-0103, *The Internal Dosimetry Program for the LATA Environmental Services of Kentucky, LLC*
45. Radiation Work Permit PAD-FD-29415, Rev 0 (for removing UF_6 systems)
46. Radiation Work Permit PAD-FD-29419, Rev 0 (for removing TRU contaminated UF_6 systems)
47. SNR-LK-2012-007, Worker has metallic taste in mouth, February 27, 2012
48. Notes from Industrial Hygiene Specialist while conducting interview with USW Worker and FLS "G" crew on February 24, 2012
49. Witness Statement – USW Worker – February 14, 2012 regarding February 8, 2012
50. Plan of the Day – February 6, 2012 to February 10, 2012
51. Pre-Shift Briefing & Worker Feedback –FLS 'B" crew – February 7, 2012 to February 9, 2012
52. IH Release Of C-410/420 HVAC Dust Collection Work Suspension, email from Industrial Hygiene Program Supervisor
53. Radiation Work Permit PAD-FD-29336, Rev 1, (for U Powder Removal), effective 5/25/11, expires 2/28/12.
54. Email from employee's Legal Counsel to PPPO FR, Employee Response to Questions
55. Healthworks Medical, LLC Worker Statements
56. Interview Notes with USW Safety and Health Representative
57. Air Monitoring Results Received on 4/11/12

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58. LATA Kentucky Supplier QA Assessment of ALS Environmental and ALS AIHA Certificate
59. Interview Notes with C-410 RCT
60. Interview Notes with Radiation Protection Manager and Project Health Physicist
61. Interview Notes with OMP
62. Operator Aide IH-OA-0001 Rev.0, *Respirator Reuse*
63. Interview Notes with IH Specialist
64. Interview Notes with USW Safety Representative
65. Worker statements from metallic taste on February 27, 2012
66. Email from FLS "G" crew to PPPO FR describing areas walked down on February 8, 2012
67. Additional Radiological Air monitoring results
68. Email from Industrial Hygiene Specialist to Industrial Hygiene Supervisor on Inspection of respirators on February 28, 2012
69. Email from Industrial Hygiene Supervisor about respirator inspection on February 8, 2012
70. RWP-FD-29336, Rev 1, Entry Control Form, February 8, 2012
71. RWP-FD-29835, Rev 0, Entry Control Form, February 8, 2012
72. Radio communication Feb 8, 2012, 0800 – 1500 – channels 8 and 13
73. LATA KY case file, employee illness –OUO
74. FDD-RM-C410-0001R0, *Facility Description Document for the C-410 Complex, Paducah Gaseous Diffusion Plan, Paducah, KY,* Hazard Analysis for the C-410 Complex, Job No. WBS 1.12.04.04.01.04, C-410 DSA Applicability Area, Nuclear Safety Analysis, Uranium Inventory Development of the C-410 DSA Applicability Area, CAN-C41000-A001, Rev.1, Assumption Number 3, page 9.
75. FDD-RM-C410-0001 R0, *Facility Description Document for the C-410 Complex, Paducah Gaseous Diffusion Plant, Paducah Kentucky*
76. Radiological Survey Form for Respirator DOE 9093, February 14, 2012.
77. Bioassay results for C-410 workers for January and February 2012
78. PAD-IH-5151, *Issue, Control, and Use of Respiratory Equipment*
79. Investigation Team notes

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ATTACHMENT A
Combined Timeline

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January 5, 2012
Zone 23 and Zone 24 mezzanine (TRU area), C-410; a four inch pipe was being cut and then staged in zone 31.

January 19, 2012
RADCON found concerning levels of activity on piping removed from dip tank. Gross Alpha activity was much greater than the Gross Beta activity. The first conclusion was that the numbers had been switched, since this was such an unusual result. Recount confirmed results were correct.

January 26, 2012
Conducted sample survey inside existing four inch UF_6 header piping using hot tap.

January 28, 2012
Analytical results indicated high levels of TRU, in particular, Pu.

February 3, 2012
Official isotopic results were reported by USEC laboratory. The project superintendent stated that if they expected to find Pu at all, it would have been in Zone 26 at the UF_6 filters. (USEC laboratory report)

February 8, 2012
Employee working on HVAC Stabilization experiences metallic taste in mouth while working on ventilation piping removal Work Releases 12WR-DD-011, EW12-DD-005, EW12-DD-006, and EW12-DD-007 (Pre-Shift Briefing and Worker Feedback (2-8-12). Employee does not report.

February 13, 2012
Employee went to his PCP with a persistent cough and upper respiratory pain. His doctor suggested that his condition might have been due to exposure to harsh chemicals. A complete blood count lab/blood draw was taken. Results were within normal limits.

Work logs indicate other employees on work crew were also sick [Pre-Shift Briefing and Worker Feedback (2-8-12)].

February 14, 2012
(E-mail from employee to his superintendent, February 14, 2012, 5:03:54 AM). A C-410/420 front-line supervisor reported that the previous Wednesday (February 8, 2012) his respirator was uncharacteristically easy to breathe through and also recalled experiencing a strong metallic taste. He asked two co-workers, an operator and an RCT, to look at his filter for evidence that the filter media was in-tact. The operator was unable to see anything amiss with the filter and the RCT directed the FLS to the BCS for evaluation of the respirator and cartridge assembly. However, it was reported that the employee continued with scheduled work activities, primarily located in zone 22 of the C-410 Facility. Following cessation of HVAC stabilization for the day, the FLS toured additional areas in C-410/420 with a fellow FLS.

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He'd been assigned to supervise HVAC stabilization work. The general work process is to cut holes in duct work (cold-cut method with skill saw), vacuum any contents, and apply fixative (Asbestos Binding Compound). By the time the employee exited the contamination area into the BCS, he'd forgotten about his suspicion and did not re-inspect the respirator and discarded the cartridge into the trash receptacle.

The employee requested on this date (February 14, 2012) that his management looks into the possibility of a link between a chemical or radiological exposure and his current illness.

February 14, 2012 – 7:30 AM
LATA Kentucky coordinated treatment for employee through the LATA Kentucky OMP, in Paducah, Kentucky. Status post; "Potential Exposure"
During this visit, the following labs were ordered:
Complete Metabolic Profile– normal results
Magnesium levels – normal results
2 Chest x-rays – left lower lobe infiltrate
Antibody tests – negative
LATA Kentucky RADCON provided spot bioassay and a 24 hour bioassay (Bioassay #1), prior to visit with OMP. Spot sample was submitted to USEC laboratory in the afternoon.

February 14, 2012 –9:22 AM
Email from Manager of Projects to the C-410/420 Facility Manager and the OMP case lead.

The employee left OMP and took a half day of Personal Time Off.

February 14, 2012 - 9:29 AM
E-mail - Employee reported to C-410 management that his illness had progressed to pneumonia. (This had been determined by the LATA Kentucky OMP, the "oversight" physician.)

February 14, 2012 – 9:42 AM
Email from OMP lead to C-410/420 superintendent
Respirator restriction for employee pending results from blood work and chest x-rays.

February 14, 2012- 12:00
A Formal Suspend Work was instituted to cease cutting UF_6 piping systems (i.e. cold traps) including and/or tied into the two, 4 inch headers which had been determined to contain a significant concentration of Pu.

February 14, 2012 – 2:23 PM
OMP lead to superintendent; Follow-up x-rays scheduled for the following Wednesday, February 22, 2012. Respirator restriction to continue pending those results.

February 14, 2012
DOE site office informed of employee illness.

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I was admitted for Chemical Pneumonitis

February 22, 2012
Employee admitted into the hospital for pneumonia.

February 22, 2012
Employee began 24-hour non-routine bioassay – 0600 to 0600 2/23 according to record of receipt. Result for Pu and U are all normal and below detection levels. (Chain-of-Custody form)(ORNL report)

February 23, 2012
LATA Kentucky and USW have meeting to discuss rumors about employee. OMP states, at that time, there was no evidence to suspect a work related exposure or injury.

February 26, 2012
Received verbal results from ORNL on 24 hour bioassay (Bioassay #2), Pu and U results were normal and below detection levels.

February 27, 2012
Worker reports metallic taste in mouth while sampling HVAC ductwork. Entire crew submits a spot bioassay sample. Bioassay results for Fluorides and Uranium were below detectable limits. Received bioassay results for Am and ^{99}Tc Testing from ORNL for bioassay submitted by employee on 2/23/12 (Bioassay #2).

March 5, 2012
IH lifted the temporary suspension of work associated with HVAC work.

March 12, 2012
LATA Kentucky completes all associated actions and lifts Suspend Work on UF_6 piping.

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ATTACHMENT B
Building Diagram

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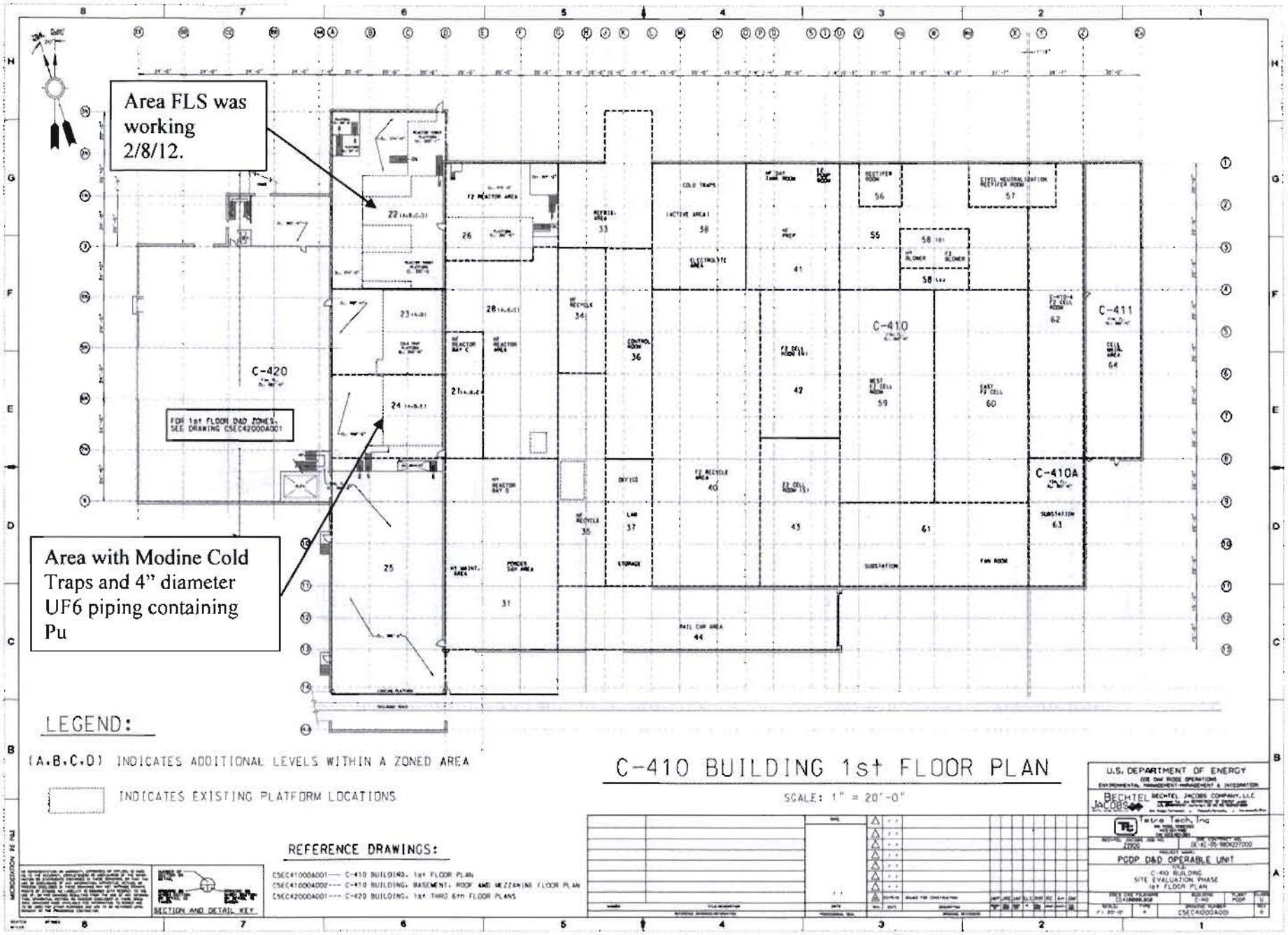
Area FLS was working 2/8/12.
Area with Modine Cold Traps and 4" diameter UF6 piping containing Pu
C-420
C-410
C-411
C-410A
FOR 1st FLOOR D&D ZONES, SEE DRAWING CSEC42000A001
LEGEND:
(A,B,C,D) INDICATES ADDITIONAL LEVELS WITHIN A ZONED AREA
INDICATES EXISTING PLATFORM LOCATIONS
REFERENCE DRAWINGS:
CSEC41000A001 — C-410 BUILDING, 1st FLOOR PLAN
CSEC41000A002 — C-410 BUILDING, BASEMENT, ROOF AND MEZZANINE FLOOR PLAN
CSEC42000A001 — C-420 BUILDING, 1st, THIRD & 4th FLOOR PLANS
SECTION AND DETAIL KEY
C-410 BUILDING 1st FLOOR PLAN
SCALE: 1" = 20'-0"
U.S. DEPARTMENT OF ENERGY
BECHTEL JACOBS COMPANY, LLC
Tetra Tech, Inc
PGDP D&D OPERABLE Unit
C-410 BUILDING
SITE EVALUATION PHASE
1st FLOOR PLAN
CSEC41000A001

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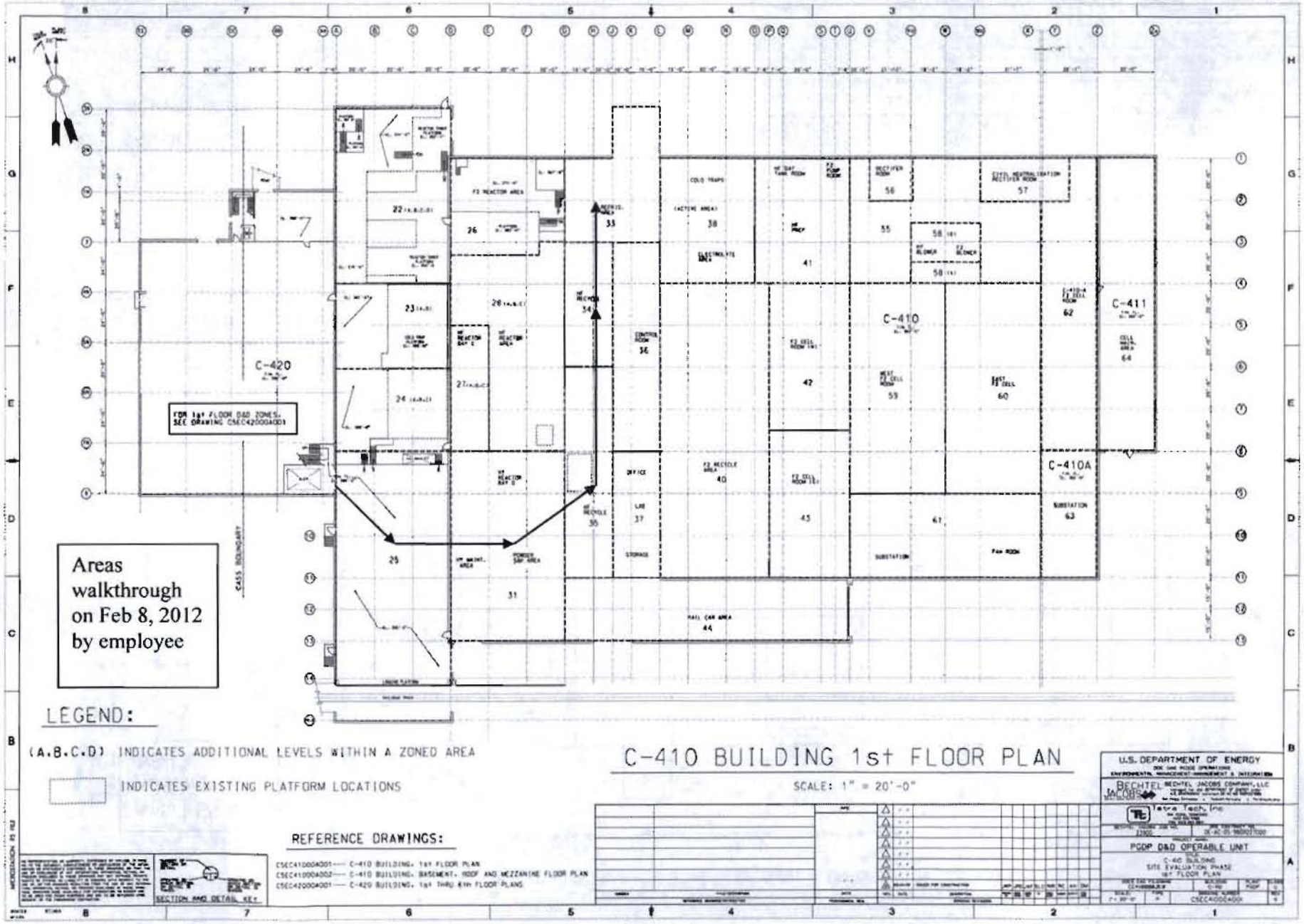
Areas walkthrough on Feb 8, 2012 by employee
LEGEND:
(A.B.C.D) INDICATES ADDITIONAL LEVELS WITHIN A ZONED AREA
INDICATES EXISTING PLATFORM LOCATIONS
REFERENCE DRAWINGS:
C-410 BUILDING 1st FLOOR PLAN
SCALE: 1" = 20'-0"
C-420
C-410
C-411
C-410A
U.S. DEPARTMENT OF ENERGY
BECHTEL JACOBS COMPANY, LLC
Tetra Tech, Inc.
PGDP D&D OPERABLE UNIT
C-410 BUILDING
SITE EVALUATION PHASE
1st FLOOR PLAN

B-4

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ATTACHMENT C
Air Sampling Data

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Table 7 Personal Air Sampling Metal Results

Date	Sample ID	Zone	Uranium in $\mu g/m^3$ (% of limit)	Zinc in mg/m^3 (% of limit)	Lead in $\mu g/m^3$ (% of limit)	Copper in mg/m^3 (% of limit)	Iron in mg/m^3 (% of limit)
2/6/12	020612-006	31	191 (136%)	0.138 (9.9%)	9.22 (23.1%)	0.002 (1.3%)	Less than 1%
2/7/12	020712-022	22	17.1 (12.2%)	0.0092 (1%)	Less than 1%	Less than 1%	Less than 1%
2/8/12	020812-007	22	33.6 (24%)	0.00501 (0.42%)	Less than 1%	Less than 1%	Less than 1%
2/8/12	020812-008	22	34.7 (25%)	0.0131 (1%)	Less than 1%	Less than 1%	Less than 1%
2/8/12	020812-009	50	48.0 (34%)	0.0178 (1.2%)	1.45 (3.6%)	Less than 1%	Less than 1%
2/9/12	020912-004	22	10.5 (7.5%)	0.00203 (0.1%)	Less than 1%	Less than 1%	Less than 1%
2/9/12	020912-005	22	151 (108%)	0.0229 (1.6%)	0.918 (2.3%)	Less than 1%	Less than 1%
2/10/12	021012-006	33& 38	10.6 (7.6%)	0.00794 (0.6%)	2.51 (6.3%)	0.00165 (1.2%)	0.152 (4.3%)
2/10/12	021012-038	22	3.44 (2.5)	0.0132 (0.1%)	Less than 1%	Less than 1%	Less than 1%
2/10/12	021012-039	22	3.24 (2.3%)	0.00086 (0.06%)	Less than 1%	Less than 1%	Less than 1%

Table 8 HF Monitoring on Systems

Date	Zone	Number of HF samples collected	Number of samples above detection limit (0.5 ppm)
2/6/12	25, 31, 33	21	2 (in Zone 33)
2/7/12	25,33	14	0
2/8/12	25,33	20	2 (In Zone 33)
2/9/12	28	7	0
2/10/12	25,28	16	1 (in Zone 28)
2/13/12	26	10	0
2/14/12	22	4	0

Table 9 Fluoride air sample results

Date	Sample Number	Zone	F in mg/m^3	% of limit
2/6/12	020612-006	33	<0.00501	<1
2/7/12	020712-017	33	0.00628	0.4
2/7/12	020712-039	25	<0.00498	<1
2/8/12	020812-018	25	0.00528	0.3
2/8/12	020812-034	33	0.00281	0.2
2/9/12	020912-006	28	<0.00503	<1
2/10/12	021012-003	28	<0.00501	<1

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Table 10 Radiological Air Monitoring Results

Date	Time	Sample ID	Location (Zone)	Type of work	Sample Volume (ml)	Alpha Activity (dpm)	Air Conc. (µCi/ml)	Assigned Protection Factor (APF)[24]	Fraction of DAC[25] without respirator APF	Fraction of DAC[26] with respirator APF
2/6/2012	0815	201202060815B19432-269545	25	D&D	5.38E+08	766	9.65E-13	1	0.0096	0.0097
2/10/2012	1415	20120210141514290-269647	24/26	D&D	3.77E+08	1040	1.87E-12	1	0.0187	0.0187
2/10/2012	1325	201202101325B9321-269655	22	D&D	1.68E+08	610.	2.46E-12	1	0.0246	0.0246
2/10/2012	1400	201202101400B19437-269652	25	D&D	2.98E+08	506	1.15E-12	1	0.0115	0.0115
2/10/2012	1405	201202101405B798-269660	33	D&D	3.61E+08	963	1.81E-12	1	0.0181	0.0181
2/8/2012	1445	201202081445LP120132-269590	24/25	Deconning Drums	7.88E+05	2.62	2.25E-12	1000	0.0225	0.0000
2/10/2012	1300	201202101300LP120127-269643	22	Duct Disassembly	3.00E+05	20.7	4.66E-11	50	0.4662	0.0093
2/10/2012	1300	201202101300LP120132-269642	22	Duct Disassembly	2.25E+05	5.02	1.51E-11	50	0.1510	0.0030
2/6/2012	1500	201202061500LP120132-269564	31/48	Duct Removal	1.76E+06	39.2	1.51E-11	1000	0.1507	0.0002
2/6/2012	1410	201202061410B12039-269563	22,O/S 16	Duct Removal	7.81E+05	15.5	1.34E-11	50	0.1339	0.0027
2/9/2012	1430	201202091430B12637-269620	22/31	Electrical Support	1.28E+06	13.6	7.21E-12	50	0.0720	0.0014
2/8/2012	1000	201202081000B12510-269601	22/23	Electrical Support	6.37E+05	2.00	2.12E-12	50	0.0212	0.0004
2/6/2012	0950	201202060950B12504-269565	31	Electrical Support	5.23E+05	3.25	4.22E-12	1000	0.0422	0.0000
2/8/2012	1455	201202081455LP120137-269599	31	Electrical Support	5.03E+05	7.78	1.05E-11	50	0.1047	0.0021

[24] APF is the workplace level of respiratory protection that a respirator or class of respirators is expected to provide to employees when the employer implements a continuing, effective respiratory protection program as specified by 29 CFR 1910.134.

[25] The Derived Airborne Concentration (DAC) is for the airborne concentration that equals the Annual Limit on Intake (derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year) divided by the volume of air breathed by an average worker for a working year of 2000 hours (assuming a breathing volume of 2400 m^3) as specified by 10 CFR 835.

[26] The Derived Airborne Concentration (DAC) is for the airborne concentration that equals the Annual Limit on Intake (derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year) divided by the volume of air breathed by an average worker for a working year of 2000 hours (assuming a breathing volume of 2400 m^3) as specified by 10 CFR 835.

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Date	Time	Sample ID	Location (Zone)	Type of work	Sample Volume (ml)	Alpha Activity (dpm)	Air Conc. (µCi/ml)	Assigned Protection Factor (APF)[24]	Fraction of DAC[25] without respirator APF	Fraction of DAC[26] with respirator APF
2/7/2012	1430	201202071430B12510-269571	48/50	HVAC	1.27E+06	1.06	5.66E-13	1000	0.0057	0.0000
2/7/2012	1430	201202071430B12595-269572	48/50	HVAC	1.27E+06	2.94	1.57E-12	1000	0.0157	0.0000
2/7/2012	1435	201202071435B12135-269582	22	HVAC	1.45E+06	117	5.48E-11	50	0.548	0.0110
2/8/2012	1455	201202081455B12595-269596	48/50	HVAC	2.31E+06	35.8	1.05E-11	50	0.1049	0.0021
2/8/2012	1455	201202081455LP120143-269595	48/50	HVAC	2.15E+06	137	4.32E-11	50	0.432	0.0086
2/8/2012	1415	201202081415B12684-269598	22	HVAC	1.31E+06	112	5.79E-11	50	0.579	0.0116
2/8/2012	1440	201202081440B12683-269597	22	HVAC	1.90E+06	262	9.34E-11	50	0.934	0.0187
2/9/2012	1440	201202091440B12685-269615	48/50	HVAC	2.11E+06	164	5.27E-11	1000	0.527	0.0005
2/9/2012	0925	201202090925B12664-269618	22	HVAC	7.69E+05	955	8.41E-10	50	8.41	0.168
2/9/2012	0925	201202090925B12704-269616	22	HVAC	9.06E+05	4.18	3.13E-12	50	0.0313	0.0006
2/10/2012	1355	201202101355B12697-269661	48/50	HVAC	1.63E+06	15.4	6.41E-12	50	0.0641	0.0013
2/10/2012	1355	201202101355B12704-269633	48/50	HVAC	1.91E+06	6.69	2.37E-12	50	0.0237	0.0005
2/10/2012	1340	201202101340B12595-269640	22	HVAC	1.42E+06	7.94	3.78E-12	50	0.0378	0.0008
2/6/2012	1500	201202061500LP120134-269549	31/48	Lift Setup	1.69E+06	126	5.02E-11	1000	0.5024	0.0005
2/9/2012	1510	201202091510LP120137-259531	23/24	Observation	1.05E+06	6.06	3.93E-12	50	0.0393	0.0008
2/6/2012	1340	201202061340B12637-269559	22/24	UF_6	1.31E+06	31.1	1.60E-11	50	0.1604	0.0032
2/6/2012	1345	201202061345B12704-269560	22/24	UF_6	1.39E+06	6.07	2.95E-12	50	0.0295	0.0006
2/6/2012	1300	201202061300B12595-269567	24	UF_6	2.43E+06	12.3	3.44E-12	50	0.0344	0.0007
2/6/2012	1445	201202061445B12684-269558	25	UF_6	2.11E+06	231	7.40E-11	50	0.7403	0.0148
2/6/12	1450	201202061450B12683-269557	25	UF_6	1.39E+06	75.5	3.67E-11	50	0.3670	0.0073
2/6/2012	1445	201202061445B12720-269550	33	UF_6	4.26E+06	4.5	7.16E-13	50	0.0072	0.0002
2/6/2012	1510	201202061510B12697-269551	33	UF_6	2.71E+06	12.3	3.08E-12	50	0.0308	0.0006
2/7/2012	1420	201202071420B12504-269585	22/24	UF_6	1.88E+06	3.57	1.28E-12	50	0.0128	0.0003
2/7/2012	1420	201202071420LP120132-269586	22/24	UF_6	1.69E+06	19.8	7.96E-12	50	0.0796	0.0016
2/7/2012	1415	201202071415B12684-269587	25	UF_6	1.43E+06	24.2	1.14E-11	50	0.1144	0.0023
2/7/2012	1445	201202071445B12637-269584	25	UF_6	2.29E+06	1.38	4.08E-13	50	0.0041	0.0004
2/7/2012	1430	201202071430B12683-269583	33	UF_6	1.95E+06	474	1.65E-10	50	1.65	0.0329

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Date	Time	Sample ID	Location (Zone)	Type of work	Sample Volume (ml)	Alpha Activity (dpm)	Air Conc. (µCi/ml)	Assigned Protection Factor (APF)[24]	Fraction of DAC[25] without respirator APF	Fraction of DAC[26] with respirator APF
2/7/2012	1430	201202071430B12712-269588	33	UF_6	4.12E+06	2.94	4.84E-13	50	0.0048	0.0002
2/8/2012	0710	201202080710B12039-269603	22/24	UF_6	9.55E+05	1.06	7.50E-13	50	0.0075	0.0002
2/8/2012	1455	201202081455B12637-269608	22/24	UF_6	1.57E+06	14.8	6.40E-12	50	0.0640	0.0013
2/8/2012	1455	201202081455LP120131-269609	22/23	UF_6	1.80E+06	14.8	5.57E-12	50	0.0557	0.0011
2/8/2012	1430	201202081430B12135-269606	25	UF_6	1.71E+06	44.2	1.75E-11	50	0.1752	0.0035
2/8/2012	0930	201202080930B12712-269604	33	UF_6	9.95E+05	2.00	1.36E-12	50	0.0136	0.0003
2/8/2012	1415	201202081415B12504-269605	33	UF_6	9.55E+05	4.81	3.41E-12	50	0.0341	0.0007
2/8/2012	1425	201202081425B12704-269607	33	UF_6	2.18E+06	44.8	1.39E-11	50	0.1391	0.0028
2/8/2012	1445	201202081445B12720-269610	33	UF_6	2.28E+06	9.19	2.73E-12	50	0.0273	0.0005
2/9/2012	1445	201202091445B12697-269630	25/33	UF_6	2.43E+06	2.93	8.18E-13	50	0.0082	0.0004
2/9/2012	1515	201202091515B12135-269628	22/24	UF_6	1.55E+06	191	3.21E-11	50	0.321	0.0064
2/9/2012	1515	201202091515B12689-269632	22/24	UF_6	1.19E+06	1.06	6.00E-13	50	0.0060	0.0003
2/9/2012	1210	201202091210B12715-269627	24	UF_6	2.35E+06	7.62	2.20E-12	50	0.0220	0.0004
2/9/2012	1210	201202091210B12039-269625	33	UF_6	1.91E+06	2.31	8.18E-13	50	0.0082	0.0002
2/9/2012	1415	201202091415LP120124-269623	33	UF_6	7.15E+05	17.6	1.67E-11	50	0.1669	0.0033
2/9/2012	1430	201202091430B12587-269624	33	UF_6	2.24E+06	10.8	3.25E-12	50	0.0325	0.0007
2/10/2012	1410	201202101410B12135-269634	22/24	UF_6	1.59E+06	1.06	4.50E-13	50	0.0045	0.0003
2/10/2012	1425	201202101425B12639-269635	22/24	UF_6	1.72E+06	9.81	3.86E-12	50	0.0386	0.0008
2/10/2012	0700	201202100700B12680-269658	24	UF_6	9.54E+05	1.37	9.73E-13	50	0.0097	0.0002
2/10/2012	1410	201202101410B16025-269650	24	UF_6	9.42E+07	6.06	4.36E-14	1	0.0004	0.0005
2/10/2012	1325	201202101325B12683-269639	25	UF_6	1.23E+06	12.3	6.77E-12	50	0.0677	0.0014
2/10/2012	1400	201202101400B12510-269638	33	UF_6	1.46E+06	141	6.55E-11	50	0.655	0.0131
2/10/2012	1425	201202101425B12684-269637	33	UF_6	2.11E+06	2.93	9.42E-13	50	0.0094	0.0002
2/10/2012	1430	201202101430B12039-269636	33	UF_6	1.99E+06	2.93	9.98E-13	50	0.0100	0.0002
2/6/2012	1020	201202061020B12712-269562	22	Walkdown	4.78E+05	1.38	1.95E-12	50	0.0195	0.0004
2/6/2012	1425	201202061425LP120127-269568	50, 52	Walkdown	3.38E+05	1.06	2.13E-12	1000	0.0213	0.0000
2/7/2012	0920	201202070920LP120131-269579	22	Walkdown	4.13E+05	11.2	1.84E-11	50	0.1843	0.0037

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Radiological Survey Data

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Table 11 HVAC Radiological Survey Results

(note; interpret gaps as areas where no surveys were performed for that particular date)

Date	Survey number	Zone 27		Zone 38		Zone 45		Zone 48	
		Alpha (dpm/100cm^2)	Beta (dpm/100cm^2)	Alpha (dpm/100cm^2)	Beta (dpm/100cm^2)	Alpha (dpm/100cm^2)	Beta (dpm/100cm^2)	Alpha (dpm/100cm^2)	Beta (dpm/100cm^2)
2/6/2012	12-FD-0084-S	275-482	3138-5877						
2/7/2012	12-FD-0089-S								
2/8/2012	12-FD-0091 -S								
2/10/2012									
12/13/2012	12-FD-0100-S	42 - 946	<L_c - 2467	26 -810	<L_c - 4653	226-286	687-850	1077-1569	3665-10,620

Date	Survey number	Zone 47		Zone 22		Zone 22 Mezzanine	
		Alpha (dpm/100cm^2)	Beta (dpm/100cm^2)	Alpha (dpm/100cm^2)	Beta (dpm/100cm^2)	Alpha (dpm/100cm^2)	Beta (dpm/100cm^2)
2/6/2012	12-FD-0084-S						
2/7/2012	12-FD-0089-S			807-2254	3654-38,871		
2/8/2012	12-FD-0091 -S					5583-19,695	28,559-117,350[27]
2/10/2012				1886-9042	5014-56,589		
12/13/2012	12-FD-0100-S	760-3558	2589-13745				

[27] Near upper limit of RWP PAD-FD-29385, Rev 0

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Table 12 HVAC Ductworks Radiological Survey Results

Date	Survey number	Zone Vacuum ductwork Outside of duct		Zone Vacuum ductwork Inside of duct – pre gross decon		Zone Vacuum ductwork Inside of duct – post gross decon	
		Alpha (dpm/100cm²)	Beta (dpm/100cm²)	Alpha (dpm/100cm²)	Beta (dpm/100cm²)	Alpha (dpm/100cm²)	Beta (dpm/100cm²)
2/10/2012	12-FD-0096-S	221-497	1729-2562	6770-15,851	17,702-88,923	13,697-19,007	73918-99873[28]

Table 13 General Radiological Survey Results

(Note; interpret gaps as areas where no personnel were assigned for that particular date)

Date	Survey number	Zone 25 HCA		Zone 25		Zone 25 SOP		Zone 24	
		Alpha (dpm/100cm²)	Beta (dpm/100cm²)	Alpha (dpm/100cm²)	Beta (dpm/100cm²)	Alpha (dpm/100cm²)	Beta (dpm/100cm²)	Alpha (dpm/100cm²)	Beta (dpm/100cm²)
2/6/2012	12-FD-00080-S	10,488	37,562			90	40	341	849
2/7/2012	12-FD-00085-S							99	<117
2/8/2012	12-FD-00087-S	35	145	151	326	52	77	55	68
2/9/2012	12-FD-00092-S			1053		70	77	20	50
2/10/2012	12-FD-00095-S			139	<85	174	343	20	468

[28] Near upper limit of RWP PAD-FD-29385, Rev 0

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Date	Survey number	Zone 24 HCA		Zone 24 SOP		Zone 33		Zone 33 Piping	
		Alpha (dpm/100cm²)	Beta (dpm/100cm²)	Alpha (dpm/100cm²)	Beta (dpm/100cm²)	Alpha (dpm/100cm²)	Beta (dpm/100cm²)	Alpha (dpm/100cm²)	Beta (dpm/100cm²)
2/6/2012	12-FD-00080-S	10,488	37,562	28	$<L_c$	730	8565	931 & 710	2030 & 2757
2/7/2012	12-FD-00085-S					73	308	2100	14364
2/8/2012	12-FD-00087-S					84	124	1117	7595
2/9/2012	12-FD-00092-S					102	189		
2/10/2012	12-FD-00095-S					87,174	243,397		

Date	Survey number	Zone 28		Zone 22 Basement		Zone 22		Zone 22 Mezzanine	
		Alpha (dpm/100cm²)	Beta (dpm/100cm²)	Alpha (dpm/100cm²)	Beta (dpm/100cm²)	Alpha (dpm/100cm²)	Beta (dpm/100cm²)	Alpha (dpm/100cm²)	Beta (dpm/100cm²)
2/6/2012	12-FD-00080-S			431	1110	1834	8624		
2/7/2012	12-FD-00085-S					102	208		
2/8/2012	12-FD-00087-S							4118	42,550
2/9/2012	12-FD-00092-S					17	151		
2/10/2012	12-FD-00095-S	200	870			43	320		

Table 14 Radiation Surveys

Date	Survey Number	Results (mrem/hr)
2/20/12	12-FD-0114-S	<0.2
2/3/12	12-FD-0079-S	<0.2

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Summa Canister Data

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Table 15 Summa Canister Results from Zone 26 on February 28, 2012

Sample ID	Agent	Result	
022812-016	1,1,1-Trichloroethane	No Detection	
	1,1,2,2-Tetrachloroethane	No Detection	
	1,1,2-Trichloroethane	No Detection	
	1,1-Dichloroethane	No Detection	
	1,1-Dichloroethene	No Detection	
	1,2,4-Trichlorobenzene	No Detection	
	1,2,4-Trimethylbenzene	1.4 ppb	NIOSH REL 25 ppm Time Weighted Average (TWA)
	1,2-Dibromoethane	No Detection	
	1,2-Dichlorobenzene	No Detection	
	1,2-Dichloroethane	No Detection	
	1,2-Dichloropropane	No Detection	
	1,3,5-Trimethylbenzene	0.56 ppb	NIOSH REL 25 ppm TWA
	1,3-Butadiene	No Detection	
	1,3-Dichlorobenzene	No Detection	
	1,4-Dichlorobenzene	No Detection	
	2-Butanone	0.64 ppb	OSHA 200 ppm TWA
	2-Hexanone	No Detection	
	4-Ethyl Toluene	0.76 ppb	None established, irritant
	4-Methyl-2-Pentanone	No Detection	
	Acetone	2.8 ppb	NIOSH REL 250 ppm TWA, OSHA PEL 1000 ppm TWA
	Benzene	0.28 ppb	NIOSH REL 0.1 ppm TWA, OSHA PEL 1 ppm TWA
	Benzyl Chloride	No Detection	
	Bromodichloromethane	No Detection	
	Bromoform	No Detection	
	Bromomethane	No Detection	
	Carbon Disulfide	0.39 ppb	NIOSH REL 1 ppm TWA, OSHA PEL 20 ppm TWA
	Carbon Tetrachloride	0.17 ppb	NIOSH REL 2 ppm TWA, OSHA PEL 10 ppm STEL
	Chlorobenzene	No Detection	
	Chloroethane	No Detection	
	Chloroform	No Detection	
	Chloromethane (Methyl Chloride)	0.52 ppb	OSHA PEL 100 ppm TWA
	Cis-1,2-Dichloroethene	No Detection	
	Cis-1,3-Dichloropropene	No Detection	
	Cyclohexane	0.31 ppb	NIOSH REL 300 ppm TWA, OSHA PEL 300 ppm TWA

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Sample ID	Agent	Result	
	Dibromochloromethane	No Detection	
	Dichlorodifluoromethane	0.57 ppb	NIOSH REL 300 ppm TWA, OSHA PEL 300 ppm TWA
	Ethyl Acetate	No Detection	
	Ethyl Alcohol (Ethanol)	4.5 ppb	NIOSH REL 1000 ppm TWA, OSHA PEL 1000 ppm
	Ethyl Benzene	No Detection	
	Freon 11	0.29 ppb	NIOSH REL 1000 ppm C, OSHA PEL 1000 ppm TWA
	Freon 113	0.17 ppb	NIOSH REL 1000 ppm TWA, OSHA PEL 1000 ppm TWA
	Freon 114	No Detection	
	Hexachlorobutadiene	No Detection	
	Hexane	No Detection	
	Isopropyl Alcohol	1.7 ppb	NIOSH REL 400 ppm TWA, OSHA PEL 400 ppm TWA
	M,P-Xylene	1.4 ppb	NIOSH REL 100 ppm TWA, OSHA PEL 100 ppm TWA
	Methyl T-Butyl Ether	No Detection	
	Methylene Chloride	0.27 ppb	OSHA PEL 25 ppm TWA
	N-Heptane	0.18 ppb	NIOSH REL 85 ppm TWA, OSHA PEL 500 ppm TWA
	O-Xylene	0.72 ppb	NIOSH REL 100 ppm TWA, OSHA PEL 100 ppm TWA
	Styrene	No Detection	
	Tetrachloroethene	0.18 ppb	100-400 ppm acute irritation of nose, throat 400-600 ppm; metallic taste
	Tetrahydrofuran	No Detection	
	Toluene	0.26 ppb	NIOSH REL 100 ppm TWA, OSHA PEL 200 ppm TWA
	Trans-1,2-Dichloroethene	No Detection	
	Trans-1,3-Dichloropropene	No Detection	
	Trichloroethene	No Detection	
	Vinyl Acetate	No Detection	
	Vinyl Chloride	No Detection	

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ATTACHMENT F
Worker Dose Calculation

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The DOE investigative review team performed a rough order of magnitude estimate of the worst case exposure of the worker as part of this report. These calculations are a rough but conservative estimate of the internal dose; they are not definitive dose evaluations. A more rigorous calculation utilizing current International Commission on Radiological Protection (ICRP) internal dose determination methods should be conducted to discuss estimated doses in the context of compliance with DOE Guidance documents[29], if warranted.

To perform the estimate, the following information was used:

1. Exposure time: 1.25 hours (based on RWP Entry log)
2. Airborne Concentration: 9.34e-11 µCi/cc (maximum concentration in C-410 on 2/8/12)
3. USEC Analytical urinary uranium Results: 0.50 µCi/L
4. Incident Date: 2/8/2012 1300-1415
5. Urine Sample Date: 2/14/2012
6. Since chemical form is unknown, the most restrictive effective dose coefficient is used (this corresponds to absorption type F).[30]

The air volume breathed is:

air volume = breathing rate* exposure time
= 1500 L/hr[31] * 1.25 hr
= 1875 L
= 1.875e6 cc

The highest airborne radioactivity concentration measured on February 8th was of 9.34e-11 µCi/cc alpha activity. Therefore, the total U activity intake is

Total U activity = air volume breathed * airborne concentration
= 9.34e-11 µCi/cc * 1.875e3 cc
= 1.75e-4 µCi

For this calculation, it is assumed that the uranium isotopic concentration is 2% enriched (by activity 49% ^{234}U, 2% ^{235}U, 49% ^{238}U). This would give the maximum concentration of ^{234}U, which would have the largest dose. The Effective DOSE Coefficients from Inhaled Air values were taken from Derived Concentration Technical Standard, DOE-STD-1196-2011, Table A-2, page 145. This then generates the following information:

Isotopic intake:

^{234}U Activity:	8.6E-05 µCi	= 3.18 Bq
^{235}U Activity:	3.5E-06 µCi	= 0.13 Bq
^{238}U Activity:	8.6E-05 µCi	= 3.18 Bq

Isotopic dose estimate:

^{234}U dose estimate:	1.96e-6 Sv = 0.20 mrem
^{235}U dose estimate:	7.45e-8 Sv = 0.0075 mrem
^{238}U dose estimate:	1.76e-6 Sv = 0.18 mrem

Using these calculations, the total dose to the worker assuming a complete failure of his respirator and being in the highest concentrated airborne activity area for the entire time he was in the area would have resulted in an estimated dose of 0.39 mrem, which is not a recordable worker exposure.

[29] Such as DOE-STD-1136-2000, *Guide of Good Practices for Radiological Protection in Uranium Facilities*, Table 2-5 (August, 2000)
[30] See *Derived Concentration Standard*, DOE-STD-1196-2011 for further guidance
[31] Breathing rate for the standard reference man is 1500 L/hr (ICRP-23, page 346).

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ATTACHMENT G
Calculating Detection Limit using Effective Half-life

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The DOE investigative review team performed another method for estimating the intake is to use the USEC Analytical Lab urinary uranium analysis results. This method takes the measured urinary uranium concentration by USEC and decay corrects (using the effective biological half-life) to the exposure time. Since the analysis did not detect any uranium above the minimum detectable concentrations, it is assumed the worker urine had U at the minimum detectable concentration. This alternative method uses the follows:

Elapsed time between incident and sample dates: 6 days
Intake Retention Function[32]: 1.09e-2
Estimated uranium intake: 64 µg (Based on minimum detectable U by USEC)

The total U activity intake is:

Total U activity = 0.47 µCi/g U* 6.4e-5 g
= 3.0e-5 µCi U

Using the same assumptions as above, the calculations then generates the following information:

Isotopic intake:

^{234}U Activity:	1.5E-05	µCi = 0.56 Bq
^{235}U Activity:	6.0E-07	µCi = 0.022 Bq
^{238}U Activity:	1.5E-05	µCi = 0.56 Bq

Isotopic dose estimate:

^{234}U dose estimate:	3.44e-7 Sv = 0.034 mrem
^{235}U dose estimate:	1.27e-8 Sv = 0.0013 mrem
^{238}U dose estimate:	3.10e-7 Sv = 0.031 mrem

The total estimated dose to the worker based on the minimum detectable concentration is 0.066 mrem.

[32] NUREG/CR-4884, *Interpretation of Bioassay Measurements*

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