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FAYETTEVILLE PFOA EXPOSURE ASSESSMENT REPORT FINAL REPORT

Report of Exposure Assessment of Measured Serum Perfluorooctanoic acid (PFOA) Anion in the Manufacture of Ammonium Perfluorooctanoate (APFO) at Fayetteville, NC

Interim Report
Covering study period
process start-up through December 31, 2005

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Introduction

An occupational exposure study was initiated at the DuPont Company site in Fayetteville, North Carolina upon start-up in the 4th quarter of 2002 of the APFO (ammonium perfluorooctanoate) manufacturing process(1). The study is estimated to be complete on December 31, 2009. This report covers the period from process start-up through December 31, 2005.

The major objective of the study is to measure worker exposure by sampling airborne levels of PFOA (perfluorooctanoic acid) and monitoring serum levels of PFOA anion in manufacturing, to provide supporting data to management and workers in APFO areas to evaluate the effectiveness of the industrial hygiene controls and to affect changes in the controls as appropriate. It is not a study of the health status of the participants.

To date, no consistent causative associations between excess risk of disease or cancer and exposure to PFOA have been determined in occupationally or non-occupationally exposed individuals. However, because of PFOA's biopersistence, DuPont is committed to minimizing blood concentrations in our employees who make or handle PFOA or APFO in the course of their work.

The study protocol also proposed that the data might provide answers to these additional questions:

1. What is the major route of exposure? (inhalation, dermal contact or other)
2. What is the timing and reversibility of steady state serum levels following exposure? (i.e. how long does it take to achieve steady state when exposure levels remain constant or to go down once the exposure ceases?)

Background

Perfluorooctanoic acid (PFOA) has an extended biological half-life in humans. Questions continue to be raised and research continues to be done to better understand the potential human health effects of PFOA. It is known that PFOA is found in blood serum and appears to be an excellent biomarker of long-term exposure. Controlling exposure to PFOA should reduce the amount of PFOA in the blood serum. New analytical methods with limits of quantitation in the 0.5 ppb range enable accurate measurement of serum PFOA at very low levels.

In Fayetteville, APFO production began in the fall of 2002. Prior to start-up, baseline blood serum samples were taken from workers initially assigned to the operation. Providing a baseline sample enables each worker to serve as his/her own control so that levels can be observed over time and compared to the original baseline. Measurement of the blood serum levels of PFOA provides an assessment of the effectiveness of the industrial hygiene controls by integrating a worker's total dose of PFOA both from inhalation and dermal contact. The goal of DuPont is to minimize exposure to PFOA to the greatest extent possible and to comply with the DuPont Acceptable Exposure Limit (AEL) of 0.01 mg/m^3 in air for an 8-hour time-weighted average exposure.

For most analytical determinations of perfluorooctanoic acid (PFOA) or ammonium perfluorooctanoate (APFO), either liquid chromatography with mass spectrometry (LC/MS) or liquid chromatography tandem mass spectrometry (LC/MS/MS) is used. In either technique the anion, perfluorooctanoate (PFO), is measured. (Note that neither LC/MS or LC/MS/MS can differentiate between PFOA or APFO since only PFO is measured.) The finished product manufactured at the Fayetteville site is an aqueous solution of APFO (10-20% APFO) although PFOA is produced as an intermediate. Since the analytical standard used to calibrate the instrument is PFOA, most analysts report the findings in terms of PFOA concentration. Therefore, PFOA concentration is reported for the air and blood samples in this report.

This report reviews serum PFO anion levels in workers and air monitoring data collected through December 31, 2005.

Methods

Serum PFOA Levels

Every employee assigned, either directly or in a support capacity, to APFO manufacturing operations at the Fayetteville site was invited to participate in the study. Participation in the blood monitoring program was and is voluntary. Employees were asked to sign a consent form prior to having their blood drawn. The study attempted to gather baseline samples before employees began working in the APFO area. However, in some cases, workers were assigned to process areas between sampling campaigns and had opportunities for workplace exposure before baseline samples were collected. The baseline samples fulfilled the role of a control group – that is, each person's results were compared to his/her baseline and previous samples over time. For each participant, the date of birth and date of hire were recorded. For each job assignment with potential for exposure to APFO, the job title, work area and begin/end dates were recorded. The Fayetteville site nurse collected the blood samples using sampling media and the sampling protocol provided by Exygen Research, State College, PA.

The sampling and analytical materials and equipment had been screened to assess background contamination with PFOA. Exygen analyzed the serum samples using liquid chromatography with a dual mass spectrometer detector[2]. Every tenth sample was analyzed twice (called duplicate samples in this report) for quality control purposes throughout the study. The analytical chemist assigned to the project determined the stability of the method by monitoring the variation in the duplicate samples using the acceptance criteria of $\leq$15% variation[3]. For the duplicate samples, the average values are shown and used in the data analyses described in this report. This quality control check will continue throughout the study.

Monitoring was offered to all employees in the area at the time of each sampling campaign. As previously indicated, some individuals began work in the area before baseline samples were obtained. In other cases, baseline samples were collected between campaigns and analyzed with the next group of samples so that the samples

could be grouped for analysis. Newly assigned employees were added to the study as they began working in the area. Active employees, who no longer worked in the area but who were still employed at the site, were also offered the opportunity to continue to have their blood drawn during the sampling campaigns. However, people who left the employment of DuPont (e.g. pensioners) or transferred from the Fayetteville site were not included in the subsequent sampling campaigns. During the course of the report period, 51 people participated in the blood monitoring program (see Table 1) representing 20 unique job assignments (see Table 2). Only one APFO CCR/Field Technician declined total participation in the program. The rest of the eligible employees participated in at least one round of sampling. This report covers sampling from October 2002 through December 2005 in seven discrete blood sampling campaigns.

There are two major process areas involved in the production of APFO.

1. Oxidation (intermediate produced is PFOA)
   Process steps include
   1) Oxidation reactor (oleum + telomer)
   2) Distillation column (refine to C8)
   3) AF feed tank (sampled for purity)

2. Purification – the feed stock could be virgin material from oxidation (PFOA) or totes for recovery from Washington Works – there is a slightly different processing sequence for each. The acid wash changes the APFO to PFOA in the first step of purification. The purification cycle time is dependent upon the fluoride content. Higher fluoride material needs at least 3 washes to clean and lower fluoride material can be cleaned in only 2 washes.
   Process steps include:
   1) Hydrolysis reactor - different sequences are used for purified vs. virgin material: virgin material is a water wash, purified material is 93% sulfuric acid to remove the HF.
   2) Phase settling – prior to late 2004 this was done via a centrifuge. When recovered material began to be processed, the centrifuge was removed and replaced with a wash tank and vaporizer. (This replacement of the centrifuge is the only major process change since process startup.)
   3) Decanted PFOA material is sent to the wash tank. The wastewater acid goes to the dilution tank. The drop leg is cleaned out. At this point it is ready to have the concentration adjusted and the material is converted to linear APFO and is transferred as finished product to a tote.

During the first year of operation, only virgin material was produced. Production of virgin material starts in the oxidation area and then moves to purification. Recovery of material began in late 2004. However, totes of used material began arriving on the site prior to that time and were stored in the Dymetrol warehouse awaiting processing. When material is recovered, only the purification process is run. The length of a

campaign is dependent upon the orders that have been received. Either virgin or purified material is run at a single time. Both processes are not run concurrently.

In the analyses in this report, results are rounded off to the nearest whole number to simplify the data reporting, regardless of the number of significant figures reported by the lab. (see Appendix 2 for the raw data) When the result was less than the limit of quantitation, one-half of that limit is used when calculating the descriptive statistics in Excel and the limit of quantitation is used for the Mini-Tab analyses.

Table 1 – Number of Participants in Blood Monitoring Program by Blood Sampling Campaign

	October 2002 1st campaign	March 2003 2nd campaign	December 2003 3rd campaign	June 2004 4th campaign	December 2004 5th campaign	June 2005 6th campaign	December 2005 7th campaign
Number of employees participating	17	20	26	27	27	31	25

Table 2 – Breakdown of Job Assignments of Participants in Blood Monitoring Program

Job Assignment	Number of Participants
1. APFO Field/Central Control Room (CCR) Technician	12
2. APFO/PMDF Technician	8
3. APFO/PMDF Engineer	4
4. APFO Superintendent	4
5. Nafion® Lab Technician	4
6. Nafion®/APFO Chemist	3
7. Nafion® Technicians	2
8. RCRA Facilitator	2
9. APFO Lab Technician	1
10. APFO Facilitator/Work Order Team Leader	1
11. Nafion®/APFO Analytical Technician	1
12. APFO Mechanical Technician	1
13. APFO Area Resource	1
14. Site Industrial Hygienist	1
15. Contract Physician	1
16. Plant Manager	1
17. Nafion® Chemist	1
18. Nafion® Engineer	1
19. Mechanical Integrity Resource	1
20. APFO Facilitator	1
Total	51

Descriptive statistics (average, median, minimum, maximum and standard deviation) for blood serum PFOA levels were generated for all study results by campaign, by number of samples collected and by job assignment. For each individual, changes in blood serum levels over time were evaluated to assess the effectiveness of the industrial hygiene controls. Blood serum levels were grouped by job assignment to identify exposure potential associated with each job. To assist with interpretation of the data, we assigned employees to the job role they were in when they first participated in the monitoring program.

Adjustments were made to industrial hygiene controls throughout the study period when exposure opportunities were identified to keep exposure as low as possible.

Although it was anticipated that the employees with the highest potential for exposure would be the APFO Field/CCR technicians, we tested this hypothesis by categorizing the workers based upon serum PFOA levels and the number of samples collected for each as follows:

Category A – serum PFOA levels appear to be at or near background at all sampling intervals (≥ 3 samples available)
Category A' – serum PFOA levels appear to be at or near background but not enough samples are available to draw a conclusion (< 3 samples available)
Category B – minimal increases in serum PFOA levels (<100 ppb) over time but no consistent increasing trend over time apparent (≥ 3 samples available)
Category B' - minimal increases in serum PFOA levels (<100 ppb) but not enough samples are available to draw a conclusion (< 3 samples available)
Category C – serum PFOA levels >1000 ppb
Category D1 – serum PFOA levels <1000 ppb with levels not staying the same or not decreasing but trend is obvious
Category D2 – serum PFOA levels <1000 ppb with levels not staying the same or not decreasing but trend is not obvious
Category E – only serum PFOA baseline samples available
Category F – only one sample available which was not a baseline sample

Results were also evaluated by Similar Exposure Group (SEG) for the groups with the highest serum PFOA levels and the serum PFOA levels were correlated to length of time in a PFOA-related job assignment.

Airborne Concentrations

Both personal and area samples were collected periodically throughout the study by the site industrial hygienist. Personal samples were collected by placing the sampling device in the breathing zone of the worker so that the sampler stayed with the person as he/she moved from work area to work area (i.e. hung on the person). Area samples were usually placed in the work zone at breathing zone height near where a person would work. However, in some cases in this study, the area samples were collected to quantify the contribution from a particular source or event rather than to estimate worker exposure and these samples were placed near the source rather than near the worker breathing zone.

Initially, samples were collected on tenax tubes and analyzed by gas chromatography in the industrial hygiene laboratory at the DuPont Washington Works site [4]. This method targeted the vapor phase by adsorption on the tenax.

During the study period, a new method was developed that utilizes OVSs (OSHA Versatile Samplers) [5] that allows separate collection of the particulate on a filter and the vapor phase on an XAD-2 resin. Beginning in March 2004, this new method was

used for sampling and the analysis was done at Clayton Environmental Laboratories in Novi, Michigan [6].

During the period from December 16, 2002 to March 9, 2004, 115 area samples were collecting using the Washington Works tenax tube/gas chromatography method. During this time period, no personal samples were collected. From March 15, 2004 through December 31, 2005, 90 area and 34 personal samples were collected using the new OVS/LC/MS/MS method.

Job Assignments

APFO CCR/Field Technician (Shift) (n=12 over study period)

The APFO CCR/Field Technician job title contained the largest group of workers and, as a group, represented the greatest opportunity for exposure. There are 2 technicians assigned to each of four 12-hour rotating shifts. Originally, the shift technicians were assigned to either the field or the control room. Technicians in the field had a greater opportunity for exposure than those in the control room. Over the course of the report period, only 3 of the original shift technicians continued working full-time in the APFO area. Of these 3 original shift technicians, two were assigned to the control room and one was assigned to the field. In late 2004, the shift APFO CCR/Field Technicians began to split their time between the APFO central control room and the field with about 50% of the time spent in each area. The control room is in a separate building from the APFO process area and involves sedentary work monitoring the APFO production operations. By late 2004, all of the APFO CCR/Field Technicians were rotating through both assignments. However, it is left up to each shift team to determine how the rotation is done (e.g. one person might work all of the days in the control room and the nights in the field while the other person on that shift would work days in the field and nights in the control room; another team might choose to alternate the work each day).

The field assignment work takes place primarily in four areas: 1) waste service, 2) oxidation, 3) purification, and 4) pack out. First breaks, that is opening a system for the first time which had previously been closed (e.g. connect/disconnect a transfer hose, remove a flange, etc.), regardless of location within the process area, require a full acid suit with air-line supplied respirator.

> Waste Service Area: This area is a general-purpose area and entry into it does not require special personal protective equipment. Waste is collected from the front end of the process (Oxidation) into a tanker that is shipped off-site. Work in this area involves hooking and unhooking hoses to totes/cylinders (e.g. KOH, NH_4OH, Antifoam), raw material tank trailers and the APFO waste trailer. These tasks are considered first breaks and require additional PPE. Other specific tasks such as sampling the waste stream also require a full acid suit (butyl one-piece suit with gloves and boots) with an airline supplied 3M helmet respirator (primarily for protection against acid fluoride rather than APFO although trace quantities of APFO could be present).

Oxidation Area: The Oxidation area consists of 5 floors. Oxidation takes place on the 4th floor of the tower area. Telomer iodide and oleum are charged into the reactor and the technician adds catalyst via a closed system once every 36 hours (time required for each batch). Quality control samples are taken once a shift on the second floor area and are hand-carried back to the lab for analysis. Any entry into the oxidation side of the APFO process requires full butyl acid suit with airline supplied 3M helmet respirator.

Purification Area: The purification area consists of 4 floors. The technician is required to take samples in this area every 36 hours (estimated time for one batch). Originally, this was designated as a general-purpose area and no special PPE was required for skin or respiratory protection. However, when area sampling revealed airborne concentrations of PFOA, block walls were constructed around the area during the first quarter of 2003 to prevent contamination of adjacent areas. Since that time, entry into the Purification area has required a negative pressure air purifying respirator (full face) w/organic vapor/acid gas cartridges and particulate filter, neoprene gloves (or disposal nitrile gloves) and standard PPE- hard hat and steel toe acid suit boots. If entry into the area involves performing work (i.e. more than reading a gauge), a Tyvek® coverall must be worn.

Pack Out: This is an automated process where the finished APFO product is loaded into totes for shipping. Three totes are loaded every 36 hours. Occasional forklift operation is involved in this area. This is still considered a general-purpose area with no special PPE requirements for skin or respiratory protection. Entry into the Pack Out area requires standard PPE (i.e. hard-hat with safety glasses and steel toe shoes). The actual pack-out takes place in a ventilated enclosure. The door to the enclosure is kept closed while the tote is open. There is a glove box that is used to cap the totes so that when the door is opened, the tote is already sealed. However, after the tote is removed from enclosure, the cap is removed and a quality control sample is dipped from the tote in the general-purpose area. PPE for the tote sampling task may be either apron + long gauntlet neoprene gloves, negative pressure respirator and safety shoes or Tyvek® coveralls, neoprene gloves, negative pressure respirator and acid suit boots. The dipping ladle and the sample bottle are carried into the first floor of the Purification area for decontamination. Quality control samples are collected from each tote after it is filled.

Process samples throughout the operation are drawn from a low point drain into an 8-ounce sample bottle with no local exhaust ventilation. The drain line is purged first into a container before the sample is drawn. The PPE required for collection of samples is dependent upon the area in which the sample is collected. Once collected, the exterior of the sample bottle is decontaminated under the safety shower when the PPE is decontaminated. Samples are taken to the lab either by hand carrying the bottle or by putting it into secondary containment and then taking it to the lab. Gloves are worn during the transport of the samples. The purged material container is kept closed when

not in use. Any PFOA-purged material is taken to the lab for transfer into a larger container for disposal.

Neoprene gloves are reused until physical inspection shows they are damaged. They are washed under the safety showers as part of the decontamination of the acid suit or washed as part of the decontamination of the sampling equipment/container. Nitrile gloves are worn once and then disposed of with the other PPE waste.

Each use of a butyl acid suit requires decontamination under a safety shower. The water is captured and sent off-site for treatment and disposal. Once the person has decontaminated the acid suit, the helmet is removed but the suit is typically removed in the general-purpose bay area by the tank trailers. Suits are usually hung on the outside rack during the shift and are often moved to the oleum room at the end of the shift to facilitate drying. At the end of a shift cycle, the suits are stored in the lockers provided in the acid suit building.

Tyvek® coveralls are used one time only, placed into a special container and disposed of as process waste.

All respirators are personally issued. Workers are instructed to clean them after each use. Storage lockers are provided in the acid suit building. Negative pressure facepieces are washed in a dishwasher periodically. 3M helmets are decontaminated under the safety showers after each use.

There are also 2 APFO CCR/Field Technicians assigned to day work. However, since the potential exposure to workers in these assignments is different than the shift technicians with that title, they are considered different jobs in this report. One of the day technicians, assigned to the APFO process lab, assists the APFO chemist with various analytical tasks within the lab and field sampling of totes and is called "APFO Lab Technician" in this report. The other day technician is assigned to work as a mechanical technician for the process area and is called "APFO Mechanical Technician" in this report. It is important to note that most of the hands-on mechanical work is performed by a contract employee with planning and oversight of that work being the primary responsibility of the DuPont mechanical technician.

APFO/PMDF Technicians (n=8 over study period)

This job assignment was created in March 2005 to provide greater flexibility in the work force. The primary assignment is in the PMDF unit but the workers have been cross-trained to provide additional coverage in the APFO area. It is anticipated that the potential exposure for this group will be the same as for the APFO CCR/Field technicians but with fewer days working in the APFO process area. This group spent ~4-6 weeks in the APFO area for training and they have not been back to work in the area since June 2005.

APFO/PMDF Engineer (n=4 over study period)

This position is assigned full-time to technical support of the APFO and PMDF processes. Time is split between the office and the field (~30% field/70% office). Only ~5% of the time in the field is in areas requiring additional PPE.

Nafion® Chemist/ Nafion® Lab Technician (n=1, n=4 over study period)
The description for these positions is combined since the exposures are anticipated to be similar. Work is done in the Nafion® Lab in the same lab where some work with APFO has been done in the past but there is currently no APFO work performed there.

APFO Superintendent/Plant Manager/Physician/ Industrial Hygienist (n=4, n=1, n=1, n=1) over study period)
The description for these positions is combined since the exposures are anticipated to be similar. Limited time is spent in the area. These positions do not require entry into any areas that require special PPE. However, the plant manager had previously worked in the Teflon® area at Washington Works. The physician is contracted and works ½ day per week. This position is a site role that involves occasional walk-throughs of the process areas that do not require special skin or respiratory protection.

Nafion®/APFO Chemist (n=3 over study period)
The chemists provide analytical support to the operation. They do not go into the process areas. Their time is split between the Nafion® lab (~95%) and the APFO lab (~5%). In the APFO lab, they prepare APFO standards and analyze process samples that are brought to the laboratory by the operating technicians. Work with APFO is performed in laboratory hoods rather than on the open bench.

Nafion® Technician (n=2 over study period)
This position is primarily assigned to the Nafion® process areas. The Nafion® technicians do not routinely enter the APFO process area or APFO lab. They are included in the study since they may be required to perform special tasks (e.g. vessel inspection in the APFO process area) or occasional analysis of samples. One of the technicians spent a brief time between December 2004 and June 2005 in the APFO lab working on the wipe test method development.

RCRA Facilitator (n=2 over study period)
The RCRA Facilitators' primary role is to oversee the RCRA facility in the Nafion® area. Hazardous waste generated in the APFO area is stored in the RCRA facility but the facilitators do not do any hands-on work with the waste. They may occasionally spend time in the general purpose areas of APFO but do not enter any areas that require special PPE.

APFO Lab Technican (Day APFO Field/CCR Technician) (n=1 over study period)
This position includes field sampling of totes, running routine quality control analyses in the laboratory and performing industrial hygiene sampling. The day technician does not get involved in other field work associated with the shift technicians. Time is split between the field (5%) and the lab (95%). This position also transfers any PFOA-

purged waste material and retainer samples into waste receptacles. This transfer is done in the laboratory hood. Another task is the daily pulling of the scrubber sample that could contain up to 100-200 ppm PFOA. The sample tap is located outside and the line is purged into a jug and then the sample is collected in an 8-ounce sample bottle. PPE for this task is goggles and nitrile gloves. No respiratory protection is worn. No decontamination is done of the sample container before it is taken into the lab. The APFO lab technician also performs the analysis of this sample in the lab.

APFO Mechanical Technician (Day APFO Field/CCR Technician) (n=1 over study period)
This position does most of the troubleshooting for the instrumentation. The mechanical technician does not get involved with the physical breakdown or repair of the equipment but spends ~30% of the time in the field ensuring that the equipment is operating properly. The rest of the time is split between the control room and the office.

Nafion®/APFO Analytical Technician (n=1 over study period)
This position is shared with the Nafion® area. Only 1-5% of the technician's time is spent in the APFO area. The rest of the time is spent in the Nafion® area working on instrumentation such as in-line analyzers.

APFO Area Resource (n=1 over study period)
This position does not routinely require entry into any areas that require special PPE but does spend ~20% of each day in the field in the APFO area. It is possible that occasional entry may occur in the restricted areas to troubleshoot or observe activities.

APFO Facilitator (n=1 over study period)
This position was eliminated in late 2004 and a new position of Work Order Team Leader was created. From process startup to the time it was eliminated, it involved at least 80% of the time in the field with occasional hands-on work including entry into the areas that require special skin and respiratory protection. Upon elimination of the job, the APFO Area Resource picked up most of this work. Although the APFO facilitator position was eliminated, the person in his new role continues to provide some support to the operations, which occasionally (<5%) involves entry into the APFO area.

Nafion® Engineer/Mechanical Integrity Resource (n=1, n=1 over study period)
These positions split their time between the field and office. Less than 5% of the time would be spent in the APFO area since the primary assignment is Nafion® for the engineer and site-wide for the Mechanical Integrity Resource.

Day APFO Facilitator (n=1 over study period)
This position involves keeping track of production schedules, issuing product orders, and keeping track of inventory and cycle time. The position also coordinates mechanical activities by helping to plan maintenance activities in the area, ordering equipment and supplies, coordinating work by site maintenance and construction, writing work orders, etc. Time is split between the field (10%) and office (90%).

Results

Blood

By Number of Samples Collected (approximates time in assignment)

Fifty-one workers participated in the blood monitoring program during the study period and a total of 121 blood samples were collected (total does not include duplicate samples collected for quality control purposes). In the first six months of assignment, the average results for the entire work group started to increase and continued to rise over time. (see Table 3 and Figure 1)

Since not all of the workers started work at the beginning of the study in October 2002, we aligned the baseline data for the entire population to show the trend over time in assignment (see Table 3). In this table, column one represents the baseline level. The other columns show the additional samples collected by individual by sampling campaign, generally at six-month intervals after 2003. Only 12 workers participated in all 7 sampling campaigns. Since not all workers participated in every sampling campaign, there may be more than 6 months between samples. Results are color-coded by campaign to provide a visual indication of when the sample was collected. (see Appendix 2 for a breakdown of the sampling campaign distribution). Since this view is attempting to show changes over time, if a worker chose not to participate in a campaign after the baseline sample, the space is left blank in the table. Ten individuals did not have a baseline sample collected before assignment to a job with potential exposure. However, since their first values were higher than what we would expect for a baseline, these results are shown in the second column (baseline samples are defined as $\leq$25 ppb for the purpose of this report).

The group results show a gradual trending upward of serum PFOA levels over time (see table 3 and figure 1). The average serum level rose from a baseline average of 11 ppb, to an average of 96 ppb at the end of six months and an average of 951 ppb at the end of 3 years with a slightly lower median of 629 ppb. This view of the data includes workers with low potential for exposure and workers with higher potential for exposure so it is still difficult to draw conclusions about what is happening in the higher potential exposure group. It is also recognized that even for workers in the same job assignment, the exposure conditions have changed over the course of the study. It should be noted that both the average and median levels are rising over the course of the study period. The standard deviation is also increasing as the average levels increase because of the variation between the low and high exposure potential jobs.

Eleven people had only baseline samples collected at the time of this report, so there is no capability to evaluate a trend over time. There are also limited data for the APFO/PMDF Technician position that was created in March 2005. Baseline samples were collected between the December 2004 and June 2005 sample campaigns. These samples were analyzed with the June 2005 campaign samples but are not included in

the descriptive statistics for that campaign since there is a second sample within the same time period (see Table 6 and Appendix 1). However, these baseline results do appear in the view with the baseline samples aligned (see Table 3).

Table 3 - Entire Group Serum PFOA Level by Individual with Baselines Aligned (column 1 = baseline sample)

Baseline sample	Sample two	Sample three	Sample four	Sample five	Sample six	Sample seven
8	8	9	10	29	14	12
8	6	6	9			
29	26	28				
10	22					
	25	32				
5						
24	33					
8	67	75	63	51	60	
11	20	21	26	27		
	70	64			63	
4		40	42			
11	20	48				
3	48	41				
20	98	88	85			
9	41					
7	50					
11	51					
17	89					
5	144	1290	1530	1057	2325	4540
6	156	664	1440	49	1780	1990
	580	1290	1850	1850	3125	
	322	1390	1550	1550	1600	
		2280	1870	65		
	79	420	61	1320		
	224	402	39		1200	
10	35	60	159	1	301	439
19	236	87	264	1	225	709
5	27	67	261	1	1440	672
7	202	349	415	1	685	971
	73	357	358	1		350
9	13		188	1	409	586
14	77	135	136	1	151	
15	91	92	93	1	119	130
9	244	364	610	1	556	678
18	125	222	196	1	266	334
9	101	142	108			
23	142	156				
18						
16						
3						
10						

PRIVACY INFORMATION REMOVED

PRIVACY INFORMATION REMOVED

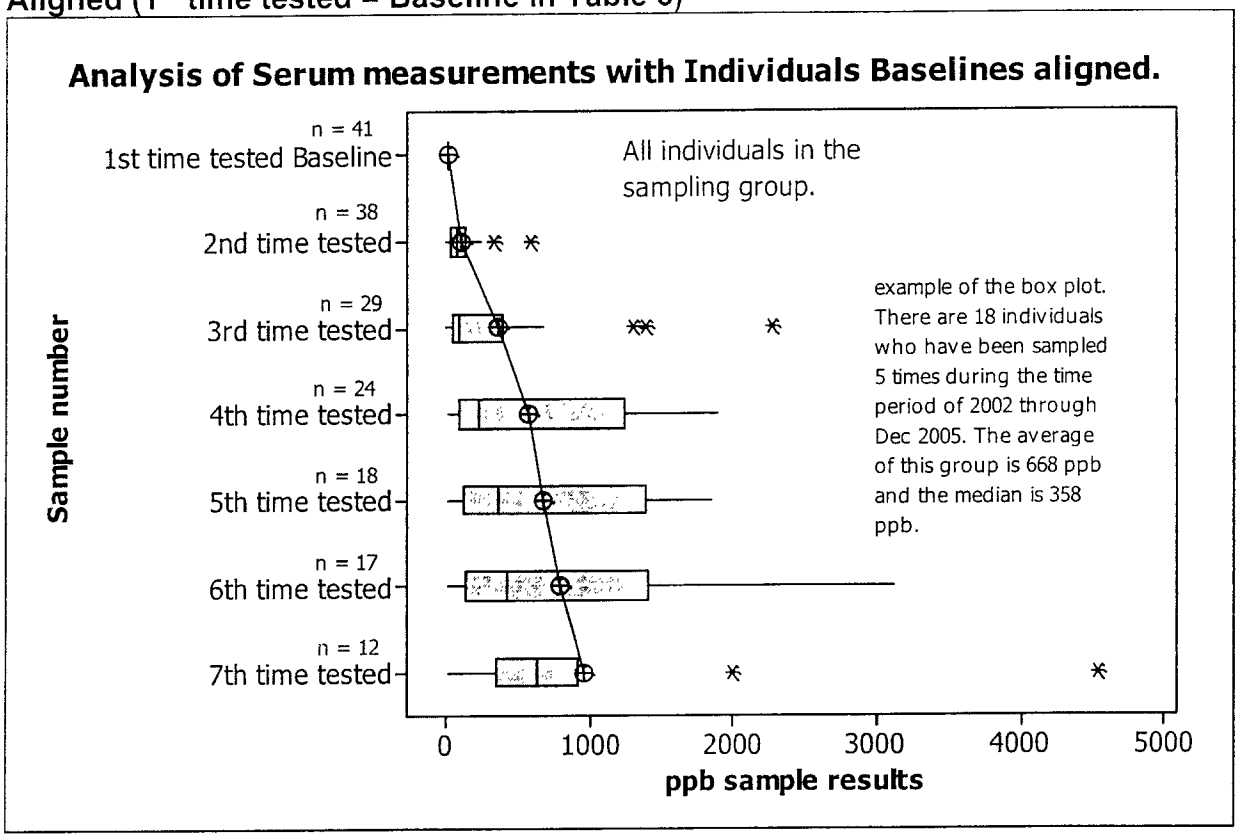
Baseline sample	Sample two	Sample three	Sample four	Sample five	Sample six	Sample seven
[redacted]						
9						
[redacted] 10						
7	7					
13						
10						
10						
[redacted] 30						
	[redacted] 120					
	[redacted] 59					

	1 sample	2 samples	3 samples	4 samples	5 samples	6 samples	7 samples
Count	41	39	29	24	15	17	12
Average	11	96	352	568	668	783	951
Median	10	67	92	229	358	409	629
Minimum	3	6	6	9	9	14	12
Maximum	24	580	2280	1897	1850	3125	4540
Std Dev	5	110	540	683	663	912	1238

Key (color code identifies campaign in which sample was collected)

10/02 Report	[redacted] Report
6/03 Report	6/05 Report
12/03 Report	12/05 Report
6/04 Report	

Figure 1 - Statistical Analysis of Entire Group Serum PFOA Level with Baselines Aligned (1st time tested = Baseline in Table 3)



By Serum PFOA Category

Another way to view the data is by serum PFOA Category. The following table shows the groupings based upon the groups described in the methods section (Categories A-F). Category A contains 3 individuals with 3 or more samples whose levels remained at or near background over the time of the study. Category A' contains four individuals with less than 3 samples but who are also at or near background levels. Category B contains 7 individuals whose levels don't appear to be increasing and are <100 ppb. Category B' contains 4 individuals with less than 3 samples whose levels also appear to be fairly stable and are <100 ppb. Categories A and A' and Categories B and B' appear to be consistent but they are broken out separately since there are fewer data points in the A' and B' categories. Category C has 7 people whose serum PFOA levels exceed 1000 ppb. The most recent sample of 5 of the 7 people is their highest indicating that their levels are still increasing. Category D1 and D2, with 6 individuals each, have serum PFOA levels <1000 ppb but whose levels do not appear to be going down. Individuals in D2 appear not to be increasing at a rate as great as those in D1. Category E has 12 individuals for which there are only baseline samples. Category F has two individuals with only 1 sample each above background suggesting exposure prior to collection of the baseline sample.

This view of the data suggests that the jobs with the highest blood levels (Category C) are the APFO Field/CCR technicians and the APFO lab/analytical technicians. See Appendix 1 for the raw data by job assignment.

Table 4 – Breakdown by Serum PFOA Category

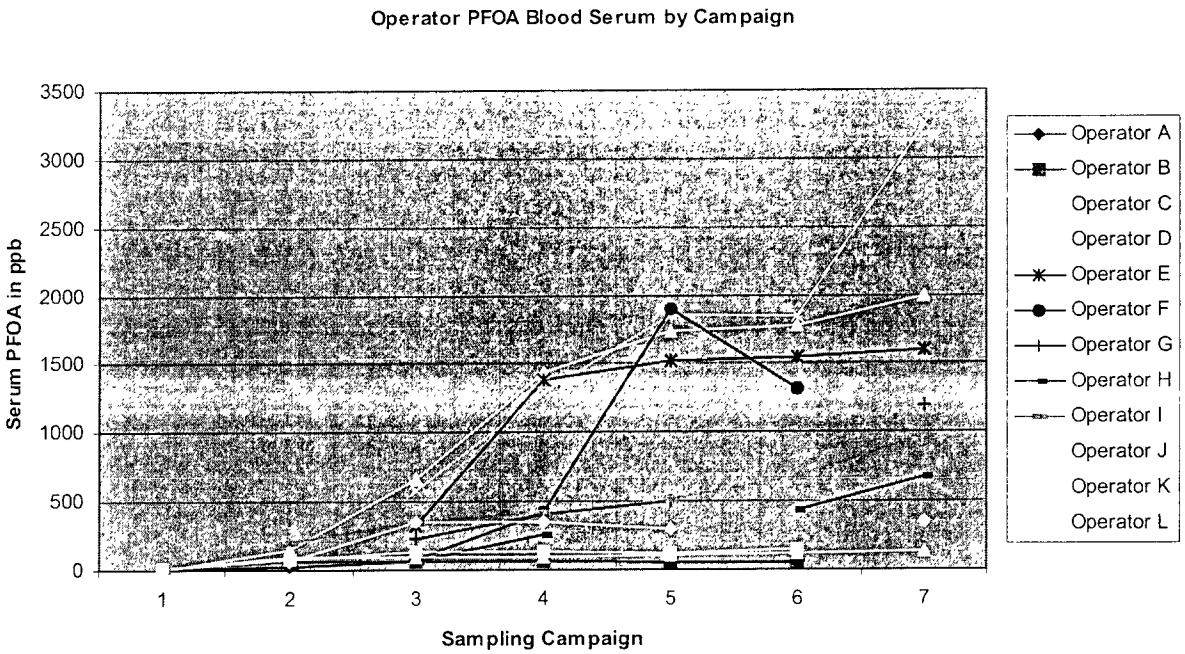
Category	Number of Individuals Assigned	Job Assignments of Individuals in Category
A ≥3 samples still at or near background	3	Site industrial hygienist + Chemist + Nafion® Technician
A' <3 samples still at or near background	4	APFO Field/CCR Technician who left assignment + Chemist + Engineer + PMDF Technician
B ≥3 samples results <100 ppb levels appear to have stabilized	7	APFO Field/CCR Technician + Superintendent (2)+ Nafion® Technician + Area Resource + PMDF Technician (2)
B' <3 samples results <100 ppb levels appear to have stabilized	4	PMDF Technician (3) + Superintendent
C Results >1000 ppb	7	APFO Field/CCR Technician (5) + APFO Analytical Technician + APFO Lab Technician
D1 serum PFOA levels <1000 ppb but levels not staying the same or not decreasing but trend is obvious	6	APFO Field/CCR Technician (3) + Engineer + Chemist + Mechanic
D2 serum PFOA levels <1000 ppb with levels not staying the same or not decreasing but trend is not obvious	6	Field/CCR tech (2), First Line Supervisor, Engineer, Nafion®/VE Chemist, PMDF Technician
E Only baseline sample available	12	PMDF Technician, Engineer, Nafion® Engineer, Nafion® Technician (3), Plant MD Superintendent, RCRA Facilitator (2), Mechanical Planner, Mechanical Supervisor
F Only one sample available but it is not a baseline	2	Plant manager + Nafion® Technician
Total	51	

APFO Field/CCR Technicians

Since the APFO Field/CCR Technicians showed the highest serum PFOA levels, this entire work group was broken out separately to represent a similar exposure group (SEG). This view permits a look at the data for workers with similar potential exposure although the exposure potential changed over the course of the study due to changes in job rotation, work practices, controls, etc. Unfortunately, not all of the workers in this job assignment stayed in the assignment over the course of the study. Figure 2 shows the blood serum results by date of sample collection for the APFO Field/CCR Technicians (labeled in the figure and described below as Operators). From the graph, it is easy to

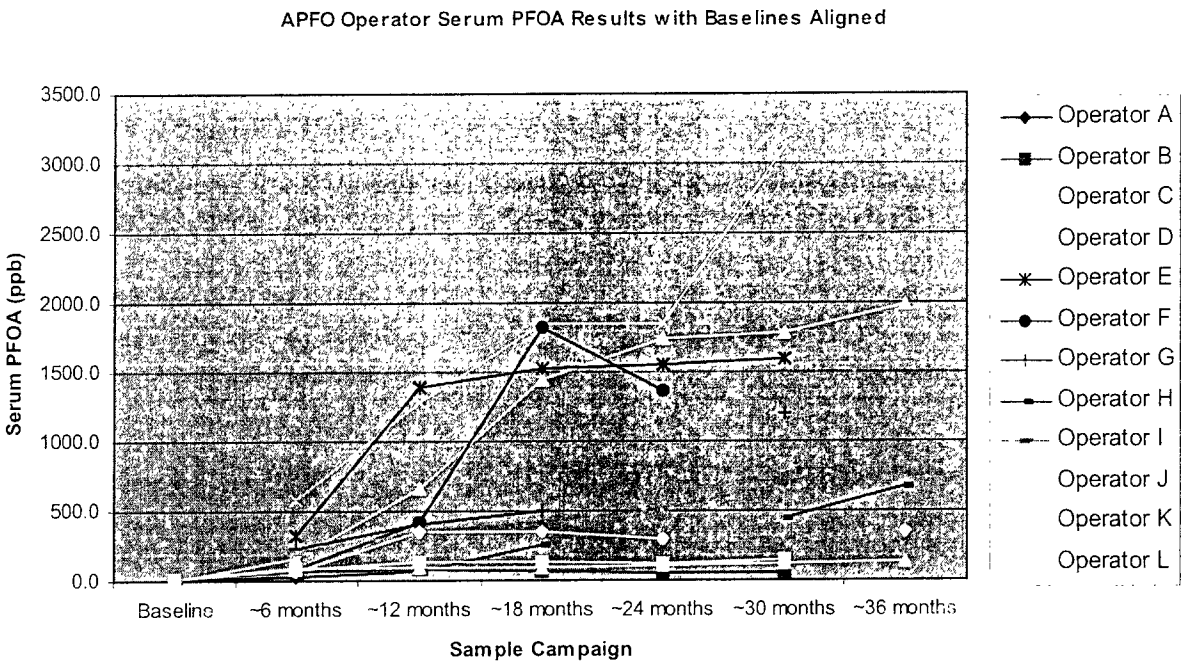
see that there is a difference between the operators with some of the lines remaining essentially flat while others show changes over time. Only three of the original eight technicians are still working in the area (Operator I, Operator H, and Operator C). Operator C was originally assigned to the field while Operators H and I were originally assigned to the control room. Operator C has the highest level of the original three, which supports the assumption that the greatest potential for exposure is in the field.

Figure 2 – APFO Field/CCR Technician Results by Sample Campaign



To compensate for the employee movement from the job assignment, the results were also evaluated with the baselines aligned (see figure 3). In this view of the data, all of the baseline samples appear in the first column. As noted previously, baseline samples were not collected on 5 of the operators so their first results appear in the 2 samples column. If a person chose not to participate in a given sample campaign, no result is put into that column to enable a view over time. The worker with the highest result thus far (Operator D) has been in the area less time so the high result appears in the next to the last column rather than the last column. One of original operators moved out of the assignment in December 2002 (Operator A) and four others moved out of the assignment in July 2003 (Operator B, Operator J, Operator K and Operator L). Although officially moved out of the APFO Field/CCR assignment, these operators could be temporarily assigned to the APFO operations. These temporary assignments could have impacted the serum PFOA levels since the levels continued to increase slightly but not at the rate of the people still active in an APFO assignment. Operator D, with the highest level in the most recent sampling campaign, started in the area in July 2003 assigned to the field. Operator G also was assigned to the area in July 2003 but with initial assignment to the control room. Operator F started in the area in September 2003.

Figure 3 – Operator Serum PFOA Results with Baselines Aligned



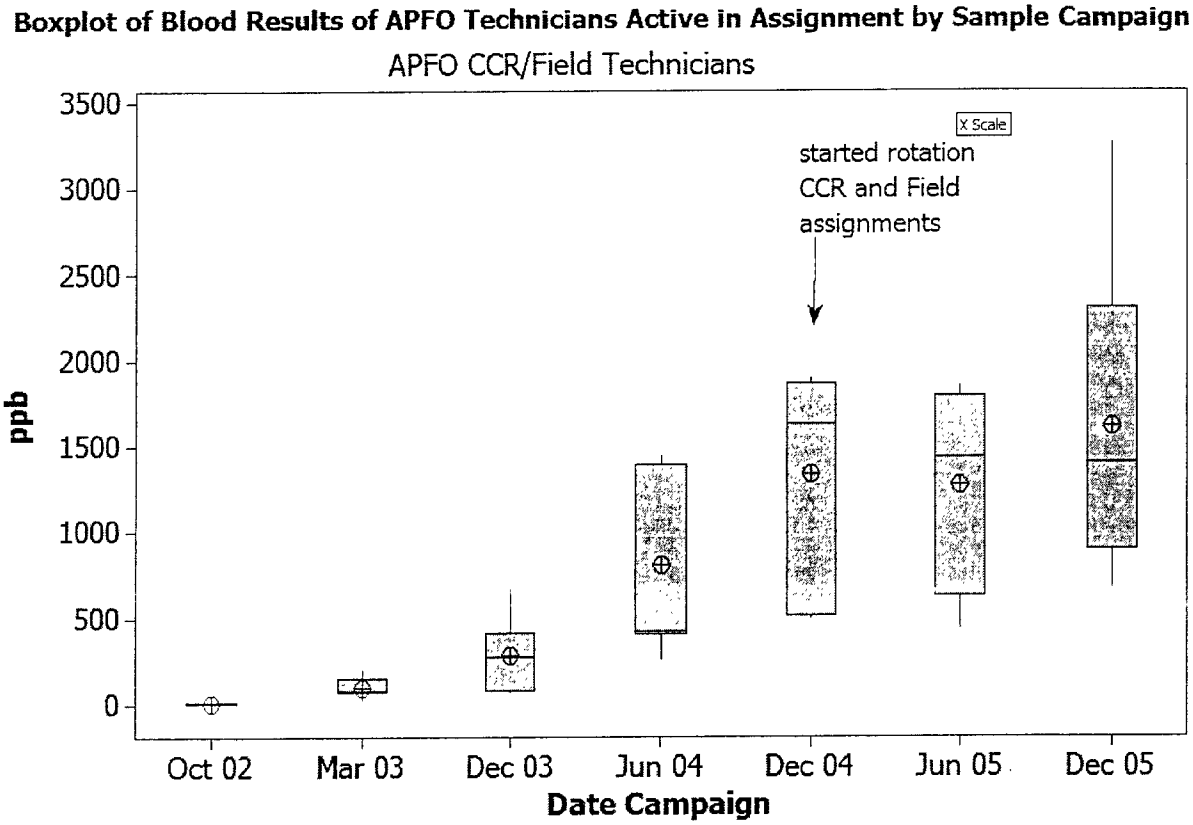
The descriptive statistics for this group are shown below (see Table 5). The average is higher for the 7th column (~30 months) than for the 8th column since the highest measured value appeared in someone who has not been in the area since startup. Of the 5 operators participating in the program since startup, only 3 are still working in the area.

Table 5 – Changes in Serum PFOA Levels in Blood of APFO Field/CCR Technicians over Time (Descriptive Statistics) with Baseline Samples Aligned

	Baseline	~6 months	~12 months	~18 months	~24 months	~30 months	~36 months
Count	7	12	11	11	9	9	5
Average	9	160	476	776	840	1018	823
Median	8	85	357	415	511	685	672
Min	5	22	67	63	51	60	130
Max	15	580	1390	1897	1850	3125	1990
Std Dev	4	159	465	738	761	1020	726

Since including the results for the people no longer currently assigned to the area may bias the data low, box plots were created to display the data only for those still active in the assignment (see Figure 4).

Figure 4 – Serum PFOA Levels of APFO Field/CCR Technicians (active in assignment) over time by Statistical Attributes



This view of the data is analyzed by sample campaign but includes only technicians still working in the area. From this view, it appears that the levels may be reaching equilibrium. However, each campaign may include people newly assigned to the area and this could bias the results low (see description in following section).

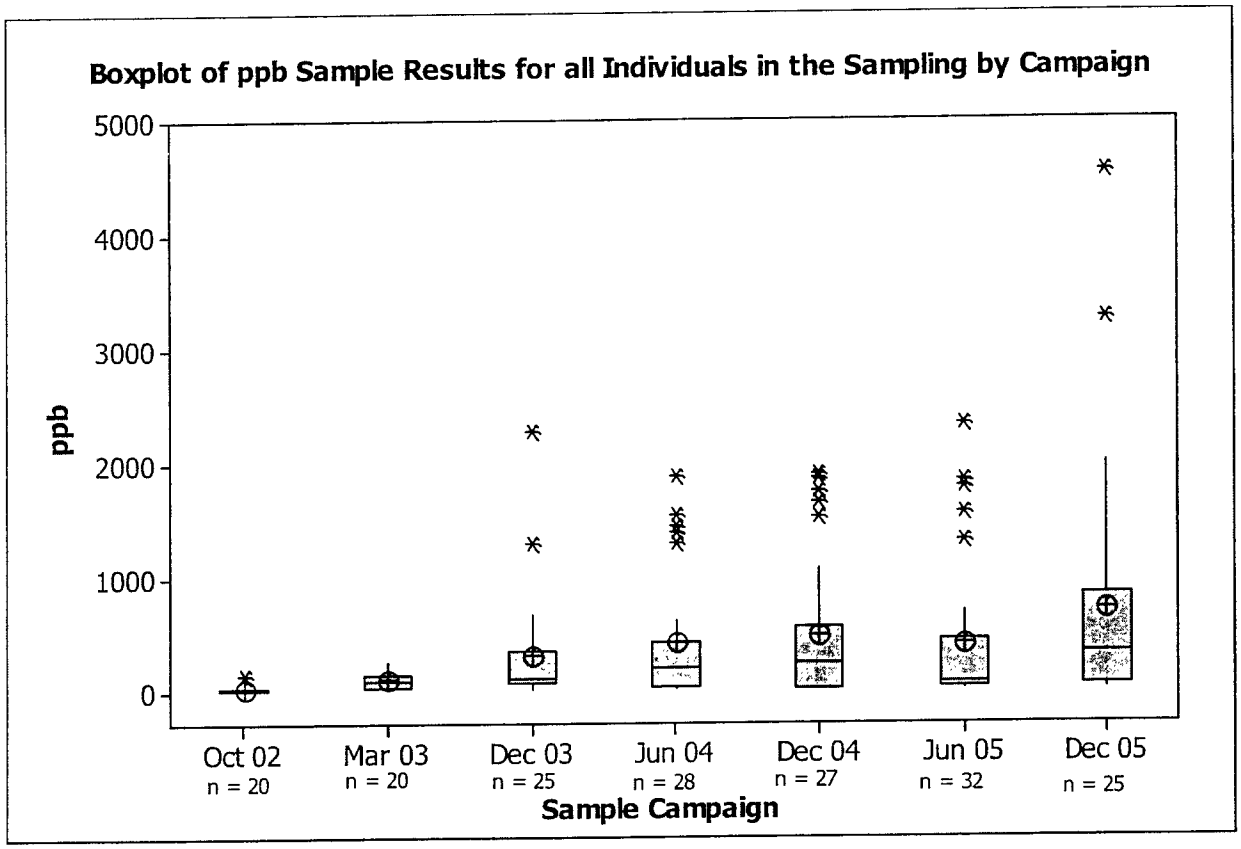
By Sample Campaign

The descriptive statistics by each sampling campaign are shown in Table 6 and graphically displayed in Figure 5 (see Appendix 1 for complete raw data by individual). This view does not show an overall increase in serum PFOA levels over time after the initial increase until the last sample campaign. However, since new workers were assigned throughout the period of the study, this view is biased low due to the inclusion of worker baseline and shorter time in assignment samples in each sample campaign. These results are included in this report to provide a complete record of the results but should not be used to draw conclusions about exposure levels over time.

Table 6 - Statistical Analysis of Entire Group Serum PFOA Level by Blood Sampling Campaign (includes newly assigned workers in each campaign)

	Baseline 10-2002	2nd Sample 3-2003	3rd Sample 12-2003	4th Sample 6-2004	5th Sample 12/04	6th Sample 6/05	7th Sample 12/05
Count	20	20	25	28	27	32	25
Average	11	92	309	407	487	396	715
Median	9	83	120	174	241	61	334
Min	4	8	8	3	3	7	7
Max	20	244	2280	1870	1897	2325	4540
Std Dev	5	73	497	550	655	637	1111
Count	20	20	25	28	27	32	25

Figure 5 – Entire Group Data Trend Over Time



Air

All of the personal air sample results have been below the Acceptable Exposure Limit (0.01 mg/m^3 for an 8-hour or 12-hour time-weighted average exposure). The AEL can be converted to parts per billion (ppb) by the following formula:

$$ppb = \frac{0.01\ mg/m^3 \times 22.4\ Liters/mol}{431\ g/mol\ (molecular\ weight)} \times 1000\ ug/mg$$

Thus, the AEL of 0.01 mg/m^3 is equivalent to 0.56 ppb.

Table 7 – Personal Air Monitoring Data – March 2004 – February 2005 (OVS sampler/analysis by Clayton Laboratories)

Type of Sample	< Limit of Quantitation	< Action Level (<0.28 ppb = <0.005 mg/m3)	> Action Level and < AEL (>0.28 and <0.56 ppb)	> AEL (>0.56 ppb = >0.01 mg/m3)
Personal (34 samples)	10	22	2	0
Operation Field Technician (25)	2	22	1	0
Mechanic (1)	1	0	0	0
Lab Technician (4)	3	0	1	0
Salary/Support (4)	4	0	0	0

Table 8 – Personal Air Monitoring Data – March 2004 - February 2005 (OVS sampler/analysis by Clayton Laboratories) Statistical Attributes

Count	24	(+ 10 non-detects)
Minimum	0.000055	(detects only)
Maximum	0.0077	(detects only)
Average	0.0018719	(detects only)
Median	0.0015	(detects only)

Area samples have also been below the AEL, with the exception of those collected in the Oxidation and Purification areas. As noted previously, entry into these areas requires wearing additional PPE including respiratory protection. A rule of thumb in industrial hygiene is to set an action level at ½ of the exposure limit to allow intervention before over-exposures would occur. Complete air results are provided in Attachments 3-5.

Table 9 – Area Air Monitoring Data – March 2004 – December 2005 Sample Collection on OVS/Analysis by Clayton

Type of Sample	< Limit of Quantitation	< Action Level (<0.0285 ppb = <0.005 mg/m3) Results in mg/m3	> Action Level and < AEL (>0.0285 and <0.057 ppb) Results in mg/m3	> AEL (>0.057 ppb = >0.01 mg/m3) Results in mg/m3
Area (90 samples)	23	40	3	24
CCR (3)	3	0	0	0
Oxidation* (13)	1	0	0	12
Acid Suit Building (2)	2	0	0	0
Packout (9)	3	6	0	0
Lab (7)	3	4	0	0
Warehouse (8)	0	6	1	1
Tote (16)	3	10	1	2
Inside trailer (16)	4	10	0	2
Truck unloading Packout (4)	2	2	0	0
On forklift (2)	2	0	0	0
Purification (9)	0	2	1	6
Blower intake (oxidation + purification) (1)	0	0	0	1

Table 11 - Area Air Monitoring Data – March 31, 2004 – December 9, 2005 Sample Collection on OVS/Analysis by Clayton - Statistical Attributes

Count	67	(+23 non-detects)
Minimum	0.00027	(detects only)
Maximum	1.9	(detects only)
Average	0.05524	(detects only)
Median	0.0023	(detects only)
Standard Deviation	0.23476	(detects only)

Table 12 –Area Air Monitoring Data Collected December 2002 through March 2004 via Tenax Tube Method

Type of Sample	< Limit of Quantitation	< Action Level (<0.28 ppb = <0.005 mg/m3) Results in ppb	> Action Level and < AEL (>0.28 and <0.056 ppb) Results in ppb	> AEL (>0.56 ppb = >0.01 mg/m3) Results in ppb
Area (115 samples)	1	74	12	28
Centrifuge (5 samples)	0	0	2	3
Near room exit exhaust (back corner) (17 samples)	0	8	2	7
Near room exit exhaust (close to sump) (22 samples)	0	11	3	8
Outside curtain area (4 samples)	0	4	0	0
Outside curtain area by packout desk (4 samples)	0	4	0	0
Old Dymetrol Building (4 samples)	0	2	2	0
Trailer 9508/9509 (8 samples)	0	8	0	0
Batch 1, tote 1 (3 samples)	0	3	0	0
Tote 2 (3 samples)	0	3	0	0
#3 spot on floor (2 samples)	0	2	0	0
#4 spot on floor (2 samples)	0	2	0	0
Vicinity of exit exhaust pt. Centrifuge (12 samples)	0	3	3	6
Packout area by computer station (19 samples)	1	18	0	0
APFO Lab (7 samples)	0	6	0	1
Oxidation – near room exit exhaust (3 samples)	0	0	0	3

Looking at the results by their statistical attributes provides an indication of how much variation there is between the area samples taken at the same locations.

Table 13 Statistical Attributes of Area Samples Collected December 2002 through March 2004 via Tenax Tube Method

Sample Location	Number of Samples	Average (ppb)	Standard Deviation	Median (ppb)	Minimum (ppb)	Maximum (ppb)
Centrifuge (Spot 15)	5	0.8471	0.4750	0.7521	0.3349	1.3882
Near room exit exhaust (back corner)	17	0.8526	1.0812	0.3239	0.0571	3.57
Near room exit exhaust (close to sump)	22	3.0258	6.5535	0.2934	0.0105	26.1685
Outside curtain area	4	0.0929	0.0598	0.0680	0.0538	0.1819
Outside curtain area by packout desk	4	0.0441	0.0163	0.0388	0.0312	0.0675
Old Dymetrol Building	4	0.2807	0.2208	0.2806	0.0801	0.4814
Trailer 9508/9509	8	0.0649	0.0328	0.0557	0.0245	0.1237
Batch 1, Tote 1	3	0.0638	0.0657	0.0366	0.0162	0.1387
Tote 2	3	0.0436	0.0161	0.0529	0.0250	0.0529
#3 Spot on floor	2	0.0444	0.0156	0.0444	0.0334	0.0554
#4 Spot on floor	2	0.0751	0.0795	0.0751	0.0188	0.1313
Vicinity of exit exhaust pt. Centrifuge room	12	0.7276	0.9098	0.4937	0.0200	3.4480
Packout area by computer desk	19	0.0829	0.0795	0.0478	0.0031	0.2343
APFO lab	7	0.4889	1.1872	0.0432	0.0042	3.18
Near room exhaust	3	1.3667	0.8386	0.97	0.8	2.33

Industrial Hygiene Considerations and Discussion

This study was designed to follow a group of workers at the Fayetteville plant associated with the manufacture of APFO from startup of operations through the first few years of production. Individual serum samples from plant personnel expected to be involved in the production of APFO or in support of the APFO operations, collected prior

to assignment and at approximately six-month intervals, were analyzed for PFOA (APFO dissociates readily in water to PFOA and the ammonium anion). Serum PFOA measurements appear to be an effective way to monitor worker exposure.

Since participation in the program is voluntary, there are gaps in the data if an individual did not choose to participate in a given campaign. During the course of the study, personnel moved into and out of job assignments such that exposures were not constant. Even within a given job assignment, exposures are not expected to be the same due to the changes in the tasks performed, upgrades to the industrial hygiene controls and differences in work practices. For these reasons, the exposure and the resultant PFOA serum levels could be considerably different for people in the same job assignment. Following each individual's serum PFOA levels over time taking into account the work history provides the best indication of the exposure.

Changes in the workforce and the job roles over the duration of the study period made it difficult to interpret the data. However, the blood serum PFOA results suggest that exposures are continuing to occur in spite of the controls that have been implemented. This increase is most easily seen in the view of the data with the baseline samples aligned (see Figure 1) and in the operator SEG (see Table 5 and Figure 3). Of special note is the initial rise in serum PFOA levels within 6 months of assignment and the apparent increase over time that is still occurring (even between the last two sample campaigns).

The results suggest that the jobs with the greatest potential for exposure are the APFO Field/CCR Techs, the Lab/Mechanical Techs and jobs providing direct technical support to the area. The jobs with the lowest potential for exposure appear to be those not directly assigned to the manufacturing area including industrial hygienists, chemists, engineers, technicians assigned primarily to other areas and supervision. Figure 4 shows the data over time for the APFO CCR/Field Technicians. Prior to 2004, the control room and field work were assigned to different individuals. Therefore, the operators assigned to the control room had fairly low serum PFOA levels and those assigned to the field had higher serum PFOA levels. Once the operators started to rotate through both assignments, the levels started to rise for everyone in the job assignment.

The air monitoring data also suggest that the APFO CCR/Field technicians have the greatest potential for inhalation exposure. Although none of the 34 personal samples showed results in excess of the DuPont AEL, quantifiable results were found in 23/25 CCR/field technician samples with one result above the action level, generally defined as one half of the AEL. There was only one sample collected for the APFO Lab Technician and this result was above the action limit but lower than the AEL. Tasks performed during the sampling period as listed by the technician on the air sampling worksheet included working on liquid chromatography samples for 4.5 hours, dumping lab samples of 20% APFO solution for 2 hours (notation that aerosol forms on the top of the tote) and working at desk for the remainder of the day. From this description, it is likely that the major contribution to the elevated air sample result is the sample dumping

activity. Three samples collected on the Nafion® Lab Technician were less than the limit of quantitation.

Most of the area air samples were collected in areas where the APFO CCR/Field technicians would spend time although it is unlikely that a full shift would be spent in any single location. Area samples in the Purification and Oxidation areas showed results in excess of the AEL. However, entry into these areas required full skin and respiratory protection so it is unlikely that exposures are occurring while people are working in those areas. Some of the area samples were collected in response to an event rather than to characterize background levels. The amount of variation in the sample results validates that these events contributed to differences in the airborne concentrations of PFOA on different days.

Area samples were also collected when there was visible evidence of a leak in an attempt to quantify the airborne contribution of surface contamination. These results suggested that surface contamination could result in elevated airborne concentrations. Operations responded by immediately cleaning up any evidence of leaks.

During the initial shipments of totes from Washington Works to Fayetteville, there was evidence of residual material on exterior of the totes. This observation led to the creation of an APFO task team at Fayetteville to identify the source of this contamination. The operators noted that the material was most obvious by the vacuum breakers suggesting that during shipment PFOA was being released through the vacuum breakers. Several samples were collected in the box trailers before unloading the totes (see March 2003 samples in Attachment 5) and also on the totes by the vacuum breakers to verify that the surface contamination could be a source of airborne PFOA. Upon identification of this exposure source, the vacuum breakers began to be replaced with tight-fitting caps to eliminate this exposure source. In 4th quarter 2004, the vacuum breakers began to be phased out and were completely replaced by the end of the 2nd quarter 2005.

Between the June and December 2004 campaigns, the operators again observed that some of the totes from Washington Works were arriving with visible external contamination. This observation triggered increased communication with the Washington Works plant and improved decontamination procedures prior to the totes leaving their site. When the contamination was observed at Fayetteville, workers donned respirators, gloves and Tyvek® coveralls and cleaned the surfaces prior to allowing unprotected work around the totes.

After these exposure problems were solved, the APFO task team continued to meet and expanded their scope to include other potential exposure sources. In October 2004, a team from Washington Works visited the Fayetteville site and members of the APFO task team from Fayetteville visited the Washington Works site to become more familiar with the operations and exposure controls so that best practices could be shared.

In the summer of 2004, the industrial hygienists identified the tote sampling task as being the primary contributor to the PFOA dose for the APFO Lab Technician. At this time, the totes were stored and sampled in the old Dymetrol building where there was no ability to decontaminate the sampling equipment and no local exhaust ventilation. The area stopped sampling the totes in the Dymetrol building and moved the sampling to the packout area where there was better general ventilation. The serum PFOA results in December 2004 decreased suggesting that the moving this particular task reduced the exposure. In January 2005, the new warehouse facility was put into service.

When the results in June 2005 showed another increase, the industrial hygienist reviewed the potential exposures again. During this review, the industrial hygienist noted that the housekeeping in the laboratory had deteriorated and there appeared to be a potential exposure from the contaminated exteriors of sample bottles temporarily stored on the open bench. Air sampling confirmed that quantifiable levels of PFOA were measured in the lab in the August 2005 area samples whereas in the past, there had no quantifiable results. The lab was cleaned, work practices improved and a weekly audit program implemented. Investigation of this increase also revealed that the area had begun sampling totes in the new warehouse. There was still no immediate facility for decontaminating the sampling equipment and container so they were put into secondary containment and carried to the 1st floor of the purification area for decontamination. It is not clear if starting up the tote sampling task again in the new warehouse area contributed to the increase in serum PFOA. PPE for the tote sampling task may be either apron + long gauntlet neoprene gloves, negative pressure respirator and safety shoes or Tyvek® coveralls, neoprene gloves, negative pressure respirator and acid suit boots.

The tote sampling task may represent a potential for inhalation exposure. Area samples collected on the totes indicate that working near them may contribute to an increased inhalation dose since two of the area samples showed results in excess of the AEL. While it is unlikely that a worker would spend an appreciable amount of time near the totes, short-term exposures to concentrations in excess of the AEL may contribute to the PFOA measured in blood serum.

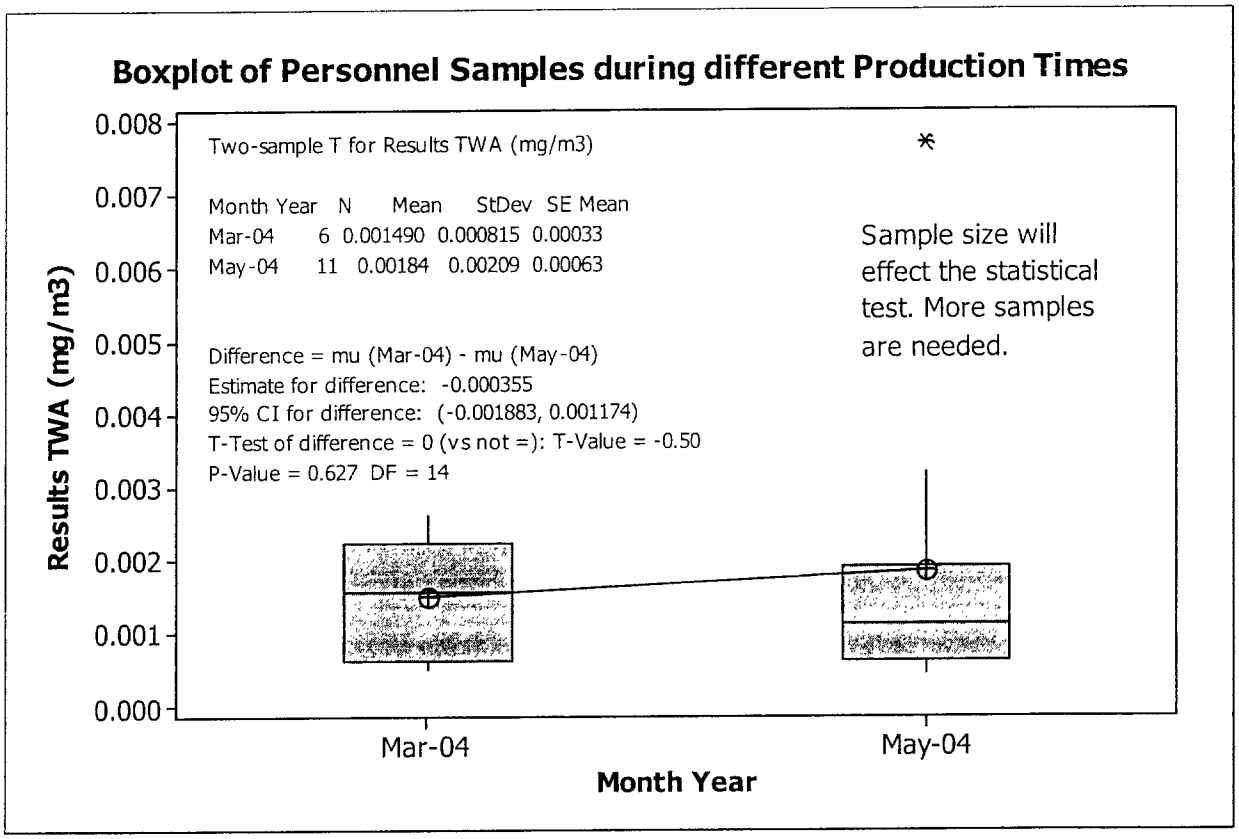
Some of the higher results may be attributed to specific tasks (e.g. APFO Analytical Technician - 2280 ppb in December 2003). This result was probably the consequence of a one time exposure from opening a cabinet coated with material in the purification area with no respiratory or skin protection. The area was designated as a general-purpose area at the time of the incident but entry into that area now requires full skin protection and full-face air-purifying respirator. These additional controls were implemented based upon the air monitoring results.

As part of the investigation of the increases in PFOA blood serum levels, we noted that on September 13, 2004, an event involving the pollution control system occurred. A similar event occurred on December 23, 2005. It is unclear what impact these events had on the workers' exposure and therefore on their serum PFOA levels. However,

during the 2004 event, the APFO field/CCR operator who was working during the event showed an increase of 303 ppb in the next sampling campaign. The operator who worked that night showed an increase of 563 ppb in the next campaign. The night operator would have worked again the next 3 nights whereas the operator working during the event finished his shift cycle on that day and would not have been back on site until 4 days later. The operator who worked the next day showed an increase of 133 ppb from the previous campaign. His next sample (June 2005) showed only an increase of 27 ppb. There are not enough data points to draw firm conclusions about the impact of the event on the serum PFOA levels but it does appear that others who worked in the days immediately after the event also had elevated results. There are even less blood data are available for the December 2005 event. The same operator who worked the day after the September event was working during the December 2005 event. He had blood drawn the morning of the event, which showed a decrease of 310 ppb from the June 2005 sample campaign. However, to help understand the potential exposure impact of the event, he also had a sample drawn about 3 weeks later that showed an increase of 720 ppb versus the previous sample collected on 12/23. All of other operators had their blood drawn after the 12/23 event. These limited observations suggest that events could be contributing significantly to the overall exposure. Even though PPE was worn during the actual event response, it is possible that days after the event exposure could continue to occur even after the area was believed to be decontaminated.

To determine whether there is a difference in air concentration based upon production activities, the personal operator samples collected during March 2004 (when the area was recovering Washington Works material (purification only) were compared with the personal operator samples collected in May 2004 (during a virgin campaign) were compared. The analysis suggests that there is a 63% (p-value = 0.627) probability that the results are the same. (see figure 6)

Figure 6 - Comparison of Personal Air Sampling Results from Oxidation vs. Purification



The APFO building is designed so that the areas with higher concentrations are under negative pressure with respect to the areas with lower concentrations. If there were movement of airborne material, it would be from an area of lower concentration to an area of higher concentration. However, under conditions of change, e.g. doors open, material (e.g. totes) moving from a high airborne concentration area to a lower airborne concentration area, it is not clear that the negative pressure is maintained. This could contribute to temporarily elevated airborne concentrations and also to surface contamination and, therefore, dermal exposure, in areas where respiratory and skin protection are not required. If there is surface contamination, this could also contribute to airborne concentrations of PFOA. Some exposure could also occur when operators with contaminated PPE move from the Purification/Oxidation areas into general-purpose areas and during the decontamination and removal of the PPE.

No area samples have been taken in the Decontamination room. When constructed, this room was designed as a general-purpose room. However, shortly after start-up, operators reported seeing a visible mist when cleaning out equipment so the PPE requirements were upgraded to airline respiratory protection and a full acid suit. The floors are sloped to the sump. There is generally a small amount of water in the sump so its bottom is usually kept wet. However, there may be material on the sides of the sump that may be subliming and contributing to airborne levels. No air monitoring has

been conducted in the Decontamination room. No local exhaust ventilation is provided. The general exhaust ventilation vent is currently located in the corner of the room opposite from the drain. This configuration will tend to draw air across and spread the contamination throughout the room. It would be better to have a local exhaust provided at the wash area so that the contaminants would be removed at their source. It may also be appropriate to clean material out of the sump periodically to minimize the potential for the material to become airborne.

Having a reliable wipe test method and an understanding of what surface contamination could result in an airborne concentration or a concentration in the blood would facilitate the development of a strategy to routinely include wipe sampling as part of an exposure control strategy. The area samples collected on totes with visible material on the exterior suggest that surface contamination will contribute to airborne levels.

In the design of the study, monitoring the serum PFOA levels every six months versus a longer time period permits a look at the data over time. However, this approach does not provide frequent enough samples to relate exposure to specific tasks or incidents. Since this monitoring is invasive, it is unlikely that more frequent blood draws would be acceptable to workers. A urine monitoring method might provide more useful information relative to controlling exposures since more frequent sampling could be performed and high exposure potential tasks could be targeted for pre- and post-task monitoring.

The flexibility of the work force presents challenges to keeping the exposures as low as possible since it is likely that operators may move in and out of the area. This turnover in personnel may make it difficult to emphasize the need for following the control strategy and good understanding of the potential exposure. The use of maintenance contractors in the production and lab areas also introduces a need to ensure that anyone working in the facility get good hazard communication training about the material and the controls. This should extend to decontamination of personnel and equipment leaving the area.

Conclusions

This study confirms that blood serum monitoring provides a useful tool for evaluating the overall control of the operations and effectiveness of the industrial hygiene controls. Having a baseline sample for each individual is helpful, but since the baseline levels were fairly consistent across the entire study population, it can be demonstrated that unexposed people have similar baselines. Blood serum monitoring is helpful to understand exposures integrated over time. However, the ability to monitor specific tasks as they occur would enable better understanding of what tasks are contributing to the exposure and improve the ability to implement controls before further exposures occur.

Even though most of the air sampling in general purpose areas showed results below the AEL, it is possible that even low levels in the air could contribute to increases in the blood serum. Better understanding the reasons for measurable concentrations of PFOA

in the air would allow controls to be implemented to reduce the airborne concentrations and improve decontamination of surfaces in the work areas. The data suggest that it might be possible that exposure could result from both inhalation and dermal absorption. Since PPE is required to be worn in areas with known potential for exposure, it is likely that other exposures are still occurring since the serum PFOA levels are continuing to rise. It is possible that exposure could result from working around contaminated work surfaces in general purpose areas where additional skin protection is not required or from inhalation of airborne APFO when respirators are not worn.

When there is an incident involving PFOA, it is important to collect air samples during the incident to characterize the airborne concentration to enable a better understanding of the contribution of incidents to the overall exposure. It is also important to collect additional samples after the decontamination process is complete to ensure that the decontamination is effective. This is especially critical in general-purpose areas where unprotected people may be potentially exposed. Although the building ventilation system was designed to maintain negative pressure in areas with potential high airborne concentrations, modifications may have compromised the effectiveness of the pressure differential. A thorough review of the ventilation system under varying conditions of use would rule out the possibility that contaminated air is flowing into general-purpose areas.

The study suggests that it is difficult to control exposure to PFOA. Better understanding of potential exposure sources and their control is needed to prevent serum PFOA levels from rising. Additional task-specific air sampling may provide perspective on what tasks are contributing to the exposure and what additional controls may be appropriate. Education, in combination with the on-going audits, should help to keep the exposure levels low. As new workers and/or contractors are assigned to jobs with the potential for exposure, it is important to provide education and on-going dialogue about the possible exposure sources and the controls required to minimize exposure.

This study should be continued through the target completion date of December 31, 2009 to monitor worker exposure and to better understand the sources of exposure and effectiveness of controls.

Recommendations

1. Continue to closely monitor the operations, both in the field and in the lab, that involve PFOA to assure that the specified procedures and work practices are being followed.
2. Periodically perform industrial hygiene walk-through surveys and interview workers for ideas for ways to further reduce exposure through additional controls or changes in work practices or tasks.
3. Continue the work of APFO task team to engage the workers in exposure reduction efforts.
4. Continue the voluntary monitoring of the serum PFOA levels at 6-month intervals through the duration of the study (i.e. through December 31, 2009) for recently

assigned workers (e.g. Categories A', B', E and F) and for those whose levels have not yet stabilized (e.g. Categories C and D). Workers whose levels have stabilized (e.g. categories A and B) can be monitored on a 2-year frequency. Collect exit samples when workers leave an assignment with potential for PFOA exposure to an assignment without potential exposure. Complete a review of the results after each campaign.

5. Evaluate the feasibility of developing a urine monitoring or other less invasive method to assess short-term exposures.
6. Conduct additional personal air sampling to better characterize potential airborne exposure for all of the jobs covered by the blood sampling program where the blood serum PFOA levels have been elevated (e.g. Category C and Category D). Where possible this monitoring should be coordinated with blood monitoring to see if the airborne levels correspond to changes in the blood results.
7. Identify production activities occurring during air sampling to see if there is any correlation between steps in the process and elevated airborne levels so that additional controls can be implemented to reduce airborne concentrations. Collect additional samples as appropriate to characterize specific tasks in the production process.
8. If an incident occurs, where possible, collect air samples during the incident to characterize the airborne concentration and potential contribution to overall exposure.
9. When there is an event that could represent an exposure potential, blood samples should be drawn to better characterize the event-related exposure.
10. When contamination is detected that is not incident-related, collect air samples after cleaning to verify that airborne levels have been reduced (e.g. lab contamination identified in August 2005).
11. Develop a strategy for periodically assessing surface contamination via wipe sampling to better understand its contribution to serum PFOA levels.
12. Review the ventilation design for the general and local exhaust ventilation in the building and periodically evaluate the systems to assure that the actual flow is achieving the design parameters.
13. Continue the hazard communication training program given to people assigned to work in the area. Pay special attention to newly assigned workers and contractors to ensure there is good understanding of the potential for exposure and the control strategy for minimizing exposure.

Acknowledgements

Kim Kreckmann, Dr. Robin Leonard and Dr. Chuck Powley of Haskell Laboratory provided assistance in the preparation of this report.

References

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5. Kaiser, Mary A. et al, **Method for the Determination of Perfluorooctanoic Acid in Air Samples Using Liquid Chromatography with Mass Spectrometry,** *Journal of Occupational and Environmental Hygiene*, 2: 307–313

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Attachment 1

Raw Blood Data by Sample Campaign

PRIVACY INFORMATION REMOVED

Initial Baseline 10-2002	2nd Campaign 3-2003	3rd Campaign 12-2003	4th Campaign 6-2004	5th Campaign 12-2004	6th Campaign 6-2005	7th Campaign 12-2005
4.15	144	1290	1530	1057	2325	4540
4.91						
12.4	77.3	135	136	128	151	no sample
16.4						
5.3	27.4	66.6	261	no sample	440	672
15.3	91	92.2	93.1	112	119	130
7.76	66.7	74.6	62.6	51	59.6	no sample
8.54	244	364	610	559	556	678
8.76						
18.2	125	222	196	241	265.5	334
10.2	34.9	60.2	159	246	300.5	439
19.3	236	87.3	264	252	225	709
8.86	101	142	108	no sample	no sample	no sample
5.63	156	664	1440	1743	1780	1990
7.45	202	349	415	511	685	971
8.28	8.34	9.14	9.9	9.27	14	12.2
no sample	73.4	357	358	294	no sample	350.1
8.56	12.5	no sample	188	421	409	586
no sample	11.2	19.8	21.1	19.8	27.4	no sample
no sample	no sample	580	1290	1853	1850	3260
no sample	no sample	322	1390	1523	1550	1600
no sample	no sample	2280	1870	1653	no sample	no sample
no sample	no sample	69.9	63.7	no sample	62.8	no sample
no sample	no sample	78.9	420	1897	1320	no sample
no sample	no sample	224	402	499	no sample	1200
no sample	no sample	no sample	4.08	16.1	40.3	42.1
no sample	no sample	no sample	5.38	7.23	no sample	no sample
no sample	no sample	8.15	6.28	6.29	8.65	no sample
no sample	no sample	no sample	no sample	18.7	26.3	27.6
no sample	no sample	no sample	no sample	no sample	33.4	no sample
no sample	no sample	no sample	no sample	no sample	8.85	40.8
no sample	no sample	no sample	no sample	no sample	50.3	no sample
no sample	no sample	no sample	no sample	no sample	20.4	47.9
no sample	no sample	no sample	no sample	no sample	47.9	41.1
no sample	no sample	no sample	no sample	no sample	17.7	no sample
no sample	no sample	no sample	no sample	no sample	50.5	no sample
no sample	no sample	no sample	no sample	no sample	142	156
20.3	98.2	88.4	85.2	no sample	no sample	no sample
16.7	89	no sample	no sample	no sample	no sample	no sample
no sample	no sample	15.8 ppb	no sample	no sample	no sample	no sample
no sample	no sample	no sample	2.57	3.06	no sample	no sample
no sample	no sample	no sample	no sample	10	no sample	no sample
no sample	no sample	no sample	no sample	7.37	no sample	no sample
no sample	no sample	120	no sample	no sample	no sample	no sample
no sample	no sample	no sample	8.9	no sample	no sample	no sample
9.5	22	no sample	no sample	no sample	no sample	no sample
no sample	no sample	no sample	no sample	no sample	58.9	no sample
no sample	no sample	no sample	no sample	no sample	9.72	no sample
no sample	25	32.1	no sample	no sample	no sample	no sample
no sample	no sample	no sample	no sample	9.79	no sample	no sample
no sample	no sample	no sample	no sample	no sample	6.67	7.11
no sample	no sample	no sample	no sample	no sample	no sample	12.6
no sample	no sample	no sample	no sample	no sample	no sample	9.63
no sample	no sample	no sample	no sample	no sample	no sample	9.55

	Initial Baseline 10-2002	2nd Campaign 3-2003	3rd Campaign 12-2003	4th Campaign 6-2004	5th Campaign 12-2004	6th Campaign 6-2005	7th Campaign 12-2005
Count	20	20	25	28	27	32	25
Average	10.83	92.25	309.45	407.14	486.95	395.67	714.63
Median	8.81	83.15	120.00	173.50	241.00	61.20	334.00
Min	4.15	8.34	8.15	2.57	3.06	6.67	7.11
Max	20.30	244.00	2280.00	1870.00	1897.00	2325.00	4540.00
Std Dev	5.07	73.21	497.23	550.03	654.53	636.60	1110.72

Attachment 2
Fayetteville Works
Personal Protective Equipment Requirements for Work Involving APFO

Area/ Equip	Telomers Unloading/ Feed	Oleum Unloading/ Storage Feed	Oxidation Reactor	Catalyst Addition	Dilution Tank	Sample Waste Addition	A/F Column (Heels)	Hydrolysis Reactor	Centrifuge or Wash Tank	APFO Reactor	Tote	Sulfuric Acid Unloading/ Storage Feed
Primary Chemical Hazard	Telomer Iodide	~65% Oleum	C8 A/F, Oleum	P2O5	Sulfuric Acid	Sulfuric Acid, C8 A/F	A/F and Sulfonated Compound	C8 A/F, Sulfuric Acid	C8 A/F	APFO	APFO	93% Sulfuric Acid
Activity												
Entering the area	Min	Min	Acid Suit+ 3M Helmet	Acid Suit+ 3M Helmet	Acid Suit+ 3M Helmet	Acid Suit+ 3M Helmet	Acid Suit+ 3M Helmet	Min Purification Area	Min Purification Area	Min Purification Area	Min Purification Area	Min
Operating Valves	Min+Goggles+ Ngloves	Min+Goggles+ Ngloves	Acid Suit+ 3M Helmet	Acid Suit+ 3M Helmet	Acid Suit+ 3M Helmet	Acid Suit+ 3M Helmet	Acid Suit+ 3M Helmet	Min Purification Area+Ngloves	Min Purification Area+ Ngloves	Min Purification Area+ Ngloves	Min Purification Area+ Ngloves	Min+Goggles+ Ngloves
Line Breaks	Acid Suit+ 3M Helmet	Acid Suit+ 3M Helmet	Acid Suit+ 3M Helmet	Acid Suit+ 3M Helmet	Acid Suit+ 3M Helmet	Acid Suit+ 3M Helmet	Acid Suit+ 3M Helmet	Acid Suit+ 3M Helmet	Acid Suit+ 3M Helmet	Acid Suit+ 3M Helmet	Min Purification Area+Apron+ Long Gauntlet+ Ngloves	Acid Suit+ 3M Helmet
Sampling	Acid Suit+ 3M Helmet	Acid Suit+ 3M Helmet	Acid Suit+ 3M Helmet	Acid Suit+ 3M Helmet	Acid Suit+ 3M Helmet	Acid Suit+ 3M Helmet	Acid Suit+ 3M Helmet	Acid Suit+ 3M Helmet	Acid Suit+ 3M Helmet	Min Purification Area+Apron+ Long Gauntlet+ Ngloves	Apron+ Long Gauntlet Ngloves	Acid Suit+ 3M Helmet
Cylinder/Truck Connect/Disconnect	Acid Suit+ 3M Helmet	Acid Suit+ 3M Helmet					Acid Suit+ 3M Helmet				Min Purification Area+Apron+ Long Gauntlet+ Ngloves	Acid Suit+ 3M Helmet

* When looking in the Centrifuge sight glass - a cartridge filter must be worn (under the ventilation hood).

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Codes:												
Min *(Outside Area)*	Hard Hat, Safety Glasses, Steel Toe Shoes, Tyvek [2]					**Acid Suit**	Butyl Suit, Neoprene Gloves,	**3M**	3M Helmet	**Ngloves**		
Min Purification Area For Patrolling	Full Face Respirator, Rubber Boots, Disposable Rubber Gloves, Tyvek[2]			**Min Purification Area For Doing Work**	All of the Min. for Patrolling PLUS NGloves & Tyvek Suit EXCEPT for sampling APFO Rx		**Vapor Suit**	Butyl Suit	**Goggles**			
NOTE: In areas other than General Purpose Tyvek can only be worn ONCE, they MUST be DISPOSED OF AFTER EACH USE.												
Raw Materials	**KOH, Ammonium, Sodium BiSulfite**	**Anti Foam**										
Entering the area	Min	Min										
Operating Valves	Min+Goggles+ Ngloves	Min+Goggles+ Ngloves										
Line Breaks	Acid Suit+ 3M Helmet	Min+Goggles+ Ngloves										
Sampling	Acid Suit+ 3M Helmet	Min+Goggles+ Ngloves										

Attachment 3
Fayetteville Works
Area Air Monitoring Data – March 2004 – December 2005
OVS Method/Analysis by Clayton

Date	Sample Location	Results TWA (mg/m3)	Comments
3/31/2004	Area Sample (CCR)	<0.00043	12 hr TWA sample
5/3/2004	Area Sample (CCR)	<0.00045	12 hr TWA sample
5/10/2004	Area Sample (CCR)	<0.00065	8 hr TWA sample
5/4/2004	Area Sample (Acid suit bldg.)	<0.00055	12 hr TWA sample
5/17/2004	Area Sample (Acid suit bldg.)	<0.00039	12 hr TWA sample
5/11/2004	Area Sample (Lab)	<0.00058	8 hr TWA sample
5/20/2004	Area Sample (Lab)	<0.00048	12 hr TWA sample
6/15/2004	Area Sample (Lab)	<0.00039	12 hr TWA sample
8/22/2005	APFO Lab (Center of Lab) by Sample tray	0.00043	8 hr TWA
8/22/2005	APFO Lab near Lab supply rack	0.00027	8 hr TWA
8/29/2005	APFO Lab Bench top (middle of lab)	0.00055	8 hr TWA
8/29/2005	APFO Lab Bench top	0.00096	8 hr TWA
4/21/2004	**Area Sample (Oxidation) ***	**0.037**	12 hr TWA sample
4/23/2004	**Area Sample (Oxidation) ***	**0.026**	12 hr TWA sample
4/24/2004	**Area Sample (Oxidation) ***	**0.056**	12 hr TWA sample
5/5/2004	**Area Sample (Oxidation) ***	**1.9**	12 hr TWA sample
5/12/2004	**Area Sample (Oxidation) ***	**0.036**	8 hr TWA sample
9/23/2004	**Area Sample (1st Floor Oxidation)***	**0.28**	8 hr TWA sample
9/23/2004	**Area Sample (1st Floor Oxidation)***	**0.13**	8 hr TWA sample
9/23/2004	**Area Sample (2nd Floor Oxidation)***	**0.096**	8 hr TWA sample
9/23/2004	Area Sample (2nd Floor Oxidation)	<0.00046	8 hr TWA sample
9/23/2004	**Area Sample (3rd Floor Oxidation)***	**0.2**	8 hr TWA sample
9/23/2004	**Area Sample (3rd Floor Oxidation)***	**0.12**	8 hr TWA sample
9/23/2004	**Area Sample (1st Floor Oxidation -Sump)***	**0.023**	8 hr TWA sample
9/23/2004	**Area Sample (1st Floor Oxidation Sump)***	**0.084**	8 hr TWA sample
5/6/2004	Area Sample (Packout)	0.002	12 hr TWA sample
6/2/2004	Area Sample (Packout)	0.0028	12 hr TWA sample
7/30/2004	Area Sample (Packout by tote #3)	<0.00040	12 hr TWA sample
8/3/2004	Area Sample (Packout near grating area)	<0.00021	12 hr TWA sample
8/3/2004	Area Sample (Packout near trailer area)	0.00055	12 hr TWA sample
8/4/2004	Area Sample (Packout area near grating)	0.00048	12 hr TWA sample
8/5/2004	Area Sample (Packout near grating area)	0.00068	12 hr TWA sample
8/19/2004	Area Sample (Packout)	<0.00039	12 hr TWA sample
5/27/2005	Packout Area	0.0017	8 hr TWA

Date	Sample Location	Results TWA (mg/m3)	Comments
6/15/2004	Area Sample (Tote)	0.00094	12 hr TWA sample
6/15/2004	Area Sample (Tote)	0.0071	12 hr TWA sample
6/15/2004	Area Sample (Tote)	0.0014	12 hr TWA sample
7/27/2004	Area Sample (tote 012102)	0.0023	12 hr TWA sample
7/27/2004	**Area Sample (tote 120501)***	**0.19**	12 hr TWA sample
7/27/2004	Area Sample (tote AFPOFW123)	0.0014	12 hr TWA sample
8/19/2004	**Area Sample (tote 120501)***	**0.042**	8 hr TWA sample
9/16/2005	Reclaimed totes(center of warehouse)	0.00098	8 hr TWA
9/17/2005	Blue totes (center of warehouse)	0.001	8 hr TWA
10/4/2005	WW Return Totes	0.0033	8 hr TWA
10/21/2005	WW Return Totes	0.00032	8 hr TWA
11/11/2005	WW Return Totes	0.0005	8 hr TWA
11/28/2005	WW Return Totes	0.0025	8 hr TWA
12/3/2005	WW Return Totes	<0.00027	8 hr TWA
12/9/2005	WW Return Totes	<0.00046	4 hr TWA
11/18/2005	Diaken Return Totes	<0.00025	8 hr TWA
6/23/2004	Area Sample (APFO Warehouse)	0.0015	12 hr TWA sample
6/24/2004	Area Sample (APFO Warehouse)	0.0011	12 hr TWA sample
5/16/2005	AFPO Warehouse (near spill area)	0.0013	8 hr TWA
5/16/2005	AFPO Warehouse (near spill area)	0.0011	8 hr TWA
5/17/2005	AFPO Warehouse (center of whs.)	0.0091	8 hr TWA
5/17/2005	**APFO Warehouse (back single door area)**	**0.038**	8 hr TWA
5/25/2005	APFO Warehouse (center of whs.)	0.00036	8 hr TWA
5/25/2005	APFO Warehouse (back single door area)	0.00029	8 hr TWA
7/27/2004	Area Sample (Truck unloading Packout)	0.00087	12 hr TWA sample
7/30/2004	Area Sample (Truck unloading Packout)	<0.00039	12 hr TWA sample
8/4/2004	Area Sample (Truck unloading Packout)	<0.00036	12 hr TWA sample
8/5/2004	Area Sample (Truck unloading Packout)	0.00079	12 hr TWA sample
8/12/2004	**Area Sample (Inside Truck from WW)***	**0.024**	8 hr TWA sample
9/2/2004	Area Sample (Inside Truck from WW)*	0.0023	12 hr TWA sample
9/14/2004	**Area Sample (Inside Truck from WW)***	**0.093**	12 hr TWA sample
1/7/2005	Inside WW trailer, returned WW totes	<0.0025	8 hr TWA
1/17/2005	Inside trailer empty+recovered totes	0.00057	8 hr TWA
2/3/2005	Inside trailer WW totes	0.0011	8 hr TWA
2/15/2005	Inside trailer WW totes	0.0014	8 hr TWA
3/1/2005	Inside trailer WW totes	0.0039	8 hr TWA
3/22/2005	Inside trailer WW totes	0.00071	8 hr TWA
3/25/2005	Inside trailer WW returned totes	<0.00021	8 hr TWA
4/28/2005	Inside trailer WW returned totes	<0.00022	8 hr TWA
5/25/2005	WW Truck (return truck)	<0.00049	8 hr TWA
6/30/2005	Inside WW trailer, returned WW totes	0.0023	8 hr TWA

7/28/2005	Inside WW trailer, empty WW totes	0.0017	8 hr TWA
8/23/2005	WW Truck (return truck)	0.0025	8 hr TWA
Date	**Sample Location**	**Results TWA (mg/m3)**	**Comments**
9/9/2005	WW Truck	0.00096	8 hr TWA
8/19/2004	Area Sample (Fork truck mast 36" to tote)	<0.00068	8 hr TWA sample
8/19/2004	Area Sample (Fork truck seat 79" to tote)	<0.00073	8 hr TWA sample
8/11/2004	Area Sample (1st Floor Purification)	0.00091	12 hr TWA sample
1/9/2005	1st Floor Purification	0.0071	8 hr TWA
1/9/2005	**2nd Floor Purification**	**0.042**	8 hr TWA
1/9/2005	**3rd Floor Purification**	**0.043**	8 hr TWA
1/9/2005	Sump Grating Purification	0.001	8 hr TWA
9/15/2005	**1st Floor Purification**	**0.023**	8 hr TWA
9/15/2005	**2nd Floor Purification**	**0.02**	8 hr TWA
9/15/2005	**3rd Floor Purification**	**0.03**	8 hr TWA
9/15/2005	**Sump Grating Purification**	**0.032**	8 hr TWA
9/16/2005	**Blower intake (oxidation + purification)**	**0.061**	8 hr TWA

Attachment 4
Fayetteville Works
Personal Air Monitoring Data – March 2004 – August 2004
OVS Method/Analysis by Clayton Labs

Date	Sample Location	Results TWA (mg/m3)	Comments	Job Assignment
3/16/2004	Personnel Sample	<0.00039	8 hr TWA sample	Area Supt.
3/16/2004	Personnel Sample	<0.00038	8 hr TWA sample	Technical
3/25/2004	Personnel Sample	<0.00038	8 hr TWA sample	Technical
3/17/2004	Personnel Sample	<0.00055	8 hr TWA sample	Nafion Lab Tech.
3/23/2004	Personnel Sample	<0.00040	8 hr TWA sample	Nafion Lab Tech.
3/31/2004	Personnel Sample	<0.00059	8 hr TWA sample	Nafion Lab Tech.
3/17/2004	Personnel Sample	<0.00053	8 hr TWA sample	Area Resource
3/16/2004	Personnel Sample	0.00065	12 hr TWA sample	Field Technician
3/17/2004	Personnel Sample	0.0016	12 hr TWA sample	Field Technician
3/18/2004	Personnel Sample	0.0015	12 hr TWA sample	Field Technician
3/24/2004	Personnel Sample	0.0021	12 hr TWA sample	Field Technician
3/25/2004	Personnel Sample	0.00049	12 hr TWA sample	Field Technician
3/31/2004	Personnel Sample	0.0026	12 hr TWA sample	Field Technician
5/3/2004	Personnel Sample	0.0019	12 hr TWA sample	Field Technician
5/4/2004	Personnel Sample	0.001	12 hr TWA sample	Field Technician
5/5/2004	Personnel Sample	0.00053	12 hr TWA sample	Field Technician
5/6/2004	Personnel Sample	0.0032	12 hr TWA sample	Field Technician
5/11/2004	Personnel Sample	0.0011	12 hr TWA sample	Field Technician
5/12/2004	Personnel Sample	0.0012	12 hr TWA sample	Field Technician
5/17/2004	Personnel Sample	0.00062	12 hr TWA sample	Field Technician
5/14/2004	Personnel Sample	0.0015	12 hr TWA sample	Field Technician
5/18/2004	Personnel Sample	<0.00044	12 hr TWA sample	Field Technician
5/19/2004	Personnel Sample	0.0077	12 hr TWA sample	Field Technician
5/20/2004	Personnel Sample	0.0011	12 hr TWA sample	Field Technician
6/2/2004	Personnel Sample	0.00034	12 hr TWA sample	Field Technician
7/30/2004	Personnel Sample	0.0016	8 hr TWA sample	CCR/Field Technician
8/11/2004	Personnel Sample	0.0041	12 hr TWA sample	Field Technician
8/11/2004	Personnel Sample	0.00094	12 hr TWA sample	Field Technician
8/12/2004	Personnel Sample	0.0017	12 hr TWA sample	CCR/Field Technician
8/13/2004	Personnel Sample	0.0017	12 hr TWA sample	Field Technician
8/17/2004	Personnel Sample	0.000055	12 hr TWA sample	CCR/Field Technician

Date	Sample Location	Results TWA (mg/m3)	Comments	Job Assignment
8/18/2004	Personnel Sample	<0.00037	12 hr TWA sample	CCR/Field Technician
3/23/2004	Personnel Sample	0.0057	8 hr TWA sample	Lab Technician
3/23/2004	Personnel Sample	<0.00054	8 hr TWA sample	Mechanical Technician

Attachment 5
Area Monitoring December 16, 2002 – March 9, 2004
Tenax Tube Method
Analysis by DuPont Washington Works

Date	Sample Location	Result TWA (ppb)	Comments
12/16/2002	Centrifuge (spot 15)	1.3882	Area sample, taken in vicinity of centrifuge (Purification 2nd floor)
12/18/2002	Centrifuge (spot 15)	0.7521	"
12/19/2002	Centrifuge (spot 15)	1.29	"
12/20/2002	Centrifuge (spot 15)	0.4702	"
1/30/2003	Centrifuge (spot 15)	0.3349	"
2/11/2003	Near room exit exhaust (back corner)	0.1311	Area sample, taken near the room exit exhausts (Purification 1st Floor)
2/11/2003	Near room exit exhaust (close to sump)	0.1742	"
2/12/2003	Near room exit exhaust (back corner)	0.8696	"
2/12/2003	Near room exit exhaust (close to sump)	0.3257	"
2/13/2003	Near room exit exhaust (back corner)	0.1805	"
2/13/2003	Near room exit exhaust (close to sump)	0.2163	"
3/10/2003	Near room exit exhaust (close to sump)	0.0854	"
3/10/2003	Near room exit exhaust (back corner)	0.1073	"
3/10/2003	Outside curtain area	0.0538	Area sample, taken outside the curtain area (Purification 1st Floor)
3/10/2003	Outside curtain area - by Packout desk	0.0349	"
3/11/2003	Near room exit exhaust (close to sump)	0.0721	Area sample, taken near the room exit exhausts (Purification 1st Floor)
3/11/2003	Near room exit exhaust (back corner)	0.0571	"
3/11/2003	Outside curtain area	0.1819	Area sample, taken outside the curtain area (Purification 1st Floor)
3/11/2003	Outside curtain area - by Packout desk	0.0312	"
3/12/2003	Near room exit exhaust (close to sump)	0.1393	Area sample, taken near the room exit exhausts (Purification 1st Floor)
3/12/2003	Near room exit exhaust (back corner)	0.2401	"

Date	Sample Location	Result TWA (ppb)	Comments
3/12/2003	Outside curtain area	0.0629	Area sample, taken outside the curtain area (Purification 1st Floor)
3/12/2003	Outside curtain area- by Packout desk	0.0426	"
3/13/2003	Near room exit exhaust (close to sump)	0.0986	Area sample, taken near the room exit exhausts (Purification 1st Floor)
3/13/2003	Outside curtain area	0.0731	Area sample, taken outside the curtain area (Purification 1st Floor)
3/13/2003	Outside curtain area - by Packout desk	0.0675	"
3/21/2003	Trailer 9508	0.0992	Area sample collected inside Trailer 9508 (trailer contained totes of APFO)
3/21/2003	Trailer 9509	0.0509	Area sample collected inside Trailer 9509 (trailer contained totes of APFO)
3/21/2003	Old Dymetrol bldg.	0.4814	Area sample collected inside the old Dymetrol bldg (stored totes of APFO)
3/22/2003	Trailer 9508	0.1237	Area sample collected inside Trailer 9508 (trailer contained totes of APFO)
3/22/2003	Trailer 9509	0.0245	Area sample collected inside Trailer 9509 (trailer contained totes of APFO)
3/22/2003	Old Dymetrol bldg.	0.4619	Area sample collected inside the old Dymetrol bldg (stored totes of APFO)
3/24/2003	Old Dymetrol bldg.	0.0801	Area sample collected inside the old Dymetrol bldg (stored totes of APFO)
3/24/2003	Trailer 9509	0.074	Area sample collected inside Trailer 9509 (trailer contained totes of APFO)
3/24/2003	Trailer 9508	0.0384	Area sample collected inside Trailer 9508 (trailer contained totes of APFO)
3/26/2003	Trailer 9508	0.0481	Area sample collected inside Trailer 9508 (trailer contained totes of APFO)
3/26/2003	Trailer 9509	0.0605	Area sample collected inside Trailer 9509 (trailer contained totes of APFO)

Date	Sample Location	Result TWA (ppb)	Comments
3/26/2003	Old Dymetrol bldg.	0.0993	Area sample collected inside the old Dymetrol bldg (stored totes of APFO)
4/7/2003	Batch 1, tote 1	0.0366	Area sample collected near APFO Tote 1 (inside old Dymetrol bldg.)
4/7/2003	Tote 2	0.0529	Area sample collected near APFO Tote 2 (inside old Dymetrol bldg.)
4/8/2003	#3 spot on floor	0.0554	Area sample collected near APFO Tote at spot #3 (inside old Dymetrol bldg.)
4/8/2003	#4 spot on floor	0.0188	Area sample collected near APFO Tote at spot #4 (inside old Dymetrol bldg.)
4/8/2003	Batch 1, tote 1	0.01615	Area sample collected near APFO Tote 1 (inside old Dymetrol bldg.)
4/8/2003	Tote 2	0.025	Area sample collected near APFO Tote 2 (inside old Dymetrol bldg.)
4/9/2003	#3 spot on floor	0.0334	Area sample collected near APFO Tote at spot #3 (inside old Dymetrol bldg.)
4/9/2003	#4 spot on floor	0.1313	Area sample collected near APFO Tote at spot #4 (inside old Dymetrol bldg.)
4/9/2003	Batch 1, tote 1	0.1387	Area sample collected near APFO Tote 1 (inside old Dymetrol bldg.)
4/9/2003	Tote 2	0.0529	Area sample collected near APFO Tote 2 (inside old Dymetrol bldg.)
6/10/2003	Vicinity of exist exhaust pt. Centrifuge room	0.3779	Area sample, taken inside Centrifuge room (Purification 2nd floor)
6/10/2003	Packout area by computer station	0.0287	Area sample, taken near the Packout computer station (Packout 1st Floor)
6/10/2003	Near room exit exhaust (back corner)	0.4175	Area sample, taken near the room exit exhausts (Purification 1st Floor)
6/10/2003	Near room exit exhaust (close to sump)	0.4704	"
6/11/2003	Vicinity of exist exhaust pt. Centrifuge room	0.1883	Area sample, taken inside Centrifuge room (Purification 2nd floor)

Date	Sample Location	Result TWA (ppb)	Comments
6/11/2003	Packout area by computer station	0.031	Area sample, taken near the Packout computer station (Packout 1st Floor)
6/11/2003	Near room exit exhaust (back corner)	0.2389	Area sample, taken near the room exit exhausts (Purification 1st Floor)
6/11/2003	Near room exit exhaust (close to sump)	0.2611	Area sample, taken near the room exit exhausts (Purification 1st Floor)
6/12/2003	Vicinity of exist exhaust pt. Centrifuge room	0.4272	Area sample, taken inside Centrifuge room (Purification 2nd floor)
6/12/2003	Packout area by computer station	0.0067	Area sample, taken near the Packout computer station (Packout 1st Floor)
6/12/2003	Near room exit exhaust (close to sump)	0.3356	Area sample, taken near the room exit exhausts (Purification 1st Floor)
6/12/2003	Near room exit exhaust (back corner)	0.7359	Area sample, taken near the room exit exhausts (Purification 1st Floor)
6/16/2003	Vicinity of exist exhaust pt. Centrifuge room	0.9575	Area sample, taken inside Centrifuge room (Purification 2nd Floor)
6/16/2003	Packout area by computer station	0.2343	Area sample, taken near the Packout computer station (Packout 1st Floor)
6/16/2003	Near room exit exhaust (close to sump)	0.0105	Area sample, taken near the room exit exhausts (Purification 1st Floor)
6/16/2003	Near room exit exhaust (back corner)	0.3239	Area sample, taken near the room exit exhausts (Purification 1st Floor)
6/19/2003	Vicinity of exist exhaust pt. Centrifuge room	3.448	Area sample, taken inside Centrifuge room (Purification 2nd floor- Centrifuge open***)
6/19/2003	Packout area by computer station	0.0225	Area sample, taken near the Packout computer station (Packout 1st Floor)
6/19/2003	Near room exit exhaust (close to sump)	1.8155	Area sample, taken near the room exit exhausts (Purification 1st Floor)
6/19/2003	Near room exit exhaust (back corner)	3.0686	"
6/23/2003	Packout area by computer station	0.0252	Area sample, taken near the Packout computer station (Packout 1st Floor)

Date	Sample Location	Result TWA (ppb)	Comments
6/25/2003	Vicinity of exist exhaust pt. Centrifuge room	0.7818	Area sample, taken inside Centrifuge room (Purification 2nd floor)
6/25/2003	Packout area by computer station	0.0575	Area sample, taken near the Packout computer station (Packout 1st Floor)
6/25/2003	Near room exit exhaust (close to sump)	0.1951	Area sample, taken near the room exit exhausts (Purification 1st Floor)
6/25/2003	Near room exit exhaust (back corner)	0.1162	"
7/7/2003	Vicinity of exit exhaust pt. Centrifuge room	0.5602	Area sample, taken inside Centrifuge room (Purification 2nd floor)
7/7/2003	Packout area by computer station	0.1329	Area sample, taken near the Packout computer station (Packout 1st Floor)
7/7/2003	Near room exit exhaust (close to sump)	26.1685	Area sample, taken near the room exit exhausts (Purification 1st Floor)
7/7/2003	Near room exit exhaust (back corner)	2.0168	"
7/15/2003	Vicinity of exit exhaust pt. Centrifuge room	0.62	Area sample, taken inside Centrifuge room (Purification 2nd Floor)
7/15/2003	Packout area by computer station	0.02	Area sample, taken near the Packout computer station (Packout 1st Floor)
7/15/2003	Near room exit exhaust (back corner)	3.57	Area sample, taken near the room exit exhausts (Purification 1st Floor)
7/15/2003	Near room exit exhaust (close to sump)	16.56	"
7/23/2003	Vicinity of exit exhaust pt. Centrifuge room	0.09	Area sample, taken inside Centrifuge room (Purification 2nd Floor)
7/23/2003	Packout area by computer station	0.19	Area sample, taken near the Packout computer station (Packout 1st Floor)
7/23/2003	Near room exit exhaust (back corner)	0.79	Area sample, taken near the room exit exhausts (Purification 1st Floor)
7/23/2003	Near room exit exhaust (close to sump)	1.62	"
8/8/2003	Vicinity of exit exhaust pt. Centrifuge room	0.02	Area sample, taken inside Centrifuge room (Purification 2nd Floor)

Date	Sample Location	Result TWA (ppb)	Comments
8/8/2003	Packout area by computer station	0.01	Area sample, taken near the Packout computer station (Packout 1st Floor)
8/8/2003	Near room exit exhaust (back corner)	0.07	Area sample, taken near the room exit exhausts (Purification 1st Floor)
8/8/2003	Near room exit exhaust (close to sump)	0.06	"
8/11/2003	Vicinity of exit exhaust pt. Centrifuge room	0.33	Area sample, taken inside Centrifuge room (Purification 2nd Floor)
8/11/2003	Packout area by computer station	0.18	Area sample, taken near the Packout computer station (Packout 1st Floor)
8/11/2003	Near room exit exhaust (back corner)	1.56	Area sample, taken near the room exit exhausts (Purification 1st Floor)
8/11/2003	Near room exit exhaust (close to sump)	0.18	"
8/13/2003	Vicinity of exit exhaust pt. Centrifuge room	0.93	Area sample, taken inside Centrifuge room (Purification 2nd Floor)
8/13/2003	Packout area by computer station-sample pt. #1	0.22	Area sample, taken near the Packout computer station (Packout 1st Floor)
8/13/2003	Packout area by computer station-sample pt. #2	0.11	"
8/13/2003	Near room exit exhaust (close to sump)	3.46	Area sample, taken near the room exit exhausts (Purification 1st Floor)
8/15/2003	Packout area by computer station	0.16	Area sample, taken near the Packout computer station (Packout 1st Floor)
8/15/2003	APFO lab near LC	0.05	Area sample, taken in APFO lab area near LC
8/15/2003	APFO lab near main sink (outside lab hood)	3.18	Area sample, taken in APFO lab area main sink - glass ware washing area
8/15/2003	APFO lab counter top area (right side)	0.11	Area sample, taken in APFO lab (right side of lab on a counter top outside lab hood)
10/1/2003	APFO lab near main sink (outside lab hood)	0.0042	Area sample, taken in APFO lab area main sink - glass ware washing area
10/1/2003	Packout area by computer station	0.0054	Area sample, taken near the Packout computer station (Packout 1st Floor)

Date	Sample Location	Result TWA (ppb)	Comments
10/2/2003	APFO lab near main sink (outside lab hood)	0.0058	Area sample, taken in APFO lab area main sink - glass ware washing area
10/2/2003	Packout area by computer station	<0.0061	Area sample, taken near the Packout computer station (Packout 1st Floor)
10/6/2003	APFO lab near main sink (outside lab hood)	0.0432	Area sample, taken in APFO lab area main sink - glass ware washing area
10/6/2003	Packout area by computer station	0.0478	Area sample, taken near the Packout computer station (Packout 1st Floor)
10/13/2003	APFO lab near main sink (outside lab hood)	0.0293	Area sample, taken in APFO lab area main sink - glass ware washing area
10/13/2003	Packout area by computer station	0.0894	Area sample, taken near the Packout computer station (Packout 1st Floor)
2/5/2004	Near room exit exhaust (close to sump)	0.56	Area sample, taken near the room exit exhaust (Purification 1st floor)
2/9/2004	Near room exit exhaust (close to sump)	2.96	"
2/10/2004	Near room exit exhaust (close to sump)	10.8	"
2/10/2004	Near room exit exhaust	2.33	Area sample, taken near the room exit exhaust (Oxidation)
3/11/2004	Near room exit exhaust	0.8	"
3/9/2004	Near room exit exhaust	0.97	"