AR226-3396 p.1

8EHQ-1204-15856S

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December 10, 2004

8EHQ-04-15856

Peter D. Robertson
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Mr. Charles M. Auer
Director
Office of Pollution Prevention and Toxics
U.S. Environmental Protection Agency
EPA East
1201 Constitution Avenue, NW
Washington, DC 20460

8905000011275

Re: Further Dupont Voluntary Response to EPA's November 4, 2004 Request Submission to AR 226 and TSCA 8(e) Office Blood Monitoring Information

Dear Charlie:

The attached document production and information submitted with this letter represents DuPont's continued good faith effort to respond to EPA's November 4, 2004 request for voluntary submission of certain material.

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Submission for December 10, 2004

The documents submitted with this letter pertain to the submission requested by December 10, 2004. Specifically, this submission pertains to occupational blood monitoring summary documents and/or reports. A summary of the steps taken to collect the information requested by EPA for this submission, along with the guidelines used to assess responsiveness to the EPA request, is provided on the Attachment 1 to this letter.

A summary of the contents of this submission is provided in Attachment 2 to this letter. There is a public version of the submission and a CBI version of the submission. In addition to a cumulative index for this submission, each individual binder also contains an index for the contents of the binder.

TSCA 8(e) Office Submission

DuPont does not believe that the information submitted with this letter triggers reporting obligations under TSCA section 8(e). However, in the course of discussions with OPPT and the

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Office of Regulatory Enforcement (ORE), it has become clear to DuPont that those two offices are applying standards of reporting under TSCA section 8(e) that DuPont cannot anticipate. Accordingly, DuPont initially informed EPA that DuPont intended to submit this production to both the AR-226 docket and the TSCA 8(e) office, as was done with the submission of November 15, 2004. EPA has, however, informed counsel for DuPont that it is not necessary to make a duplicate, formal submission to the 8(e) office in order to discharge any reporting obligations that EPA might otherwise assert. Instead, EPA has asked that DuPont make only a single submission and advised that DuPont should indicate in this cover letter that the submission is intended for both the AR-226 docket and the TSCA 8(e) office.

As such, DuPont states that the enclosed documents are intended to be a submission to both the AR-226 docket and, as a precaution, to the TSCA 8(e) office, notwithstanding DuPont's firm belief that the information does not trigger reporting obligations under that section of TSCA. This submission should not be construed as a direct or indirect admission that DuPont believes that any of the enclosed information triggers such reporting obligations. We understand that ORE has agreed that DuPont's submission shall not prevent DuPont from asserting, in any proceeding, that section 8(e) did not require submission of this information.

Continued Activity

After EPA has had the opportunity to review this letter and the documents, we are available at your convenience to discuss the documents in further detail to assist in your understanding. In the meantime, we will continue to gather materials for the remaining submissions, review and produce any additional documents that are located and are relevant to the topics that are the subject of this submission, and create the electronic files you requested.

Please contact me directly if you have any questions or need further clarification with respect to this submission.

Sincerely,

Peter D. Robertson

Attachments

- Attachment 1
- Attachment 2 – Summary of submission
- Public submission – number of boxes: 1
- CBI submission – number of boxes: 1

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ATTACHMENT 1

The sections below provide a summary of the steps taken to collect and produce the information requested in the particular category indicated. For each category, please note that DuPont does not maintain a comprehensive file of all such information for the entire Company. The documents were collected either from the over one million pages of documents collected for a class action lawsuit in West Virginia or from files of individuals most likely to have documents responsive to EPA's request. Note that the documents collected for purposes of the West Virginia litigation are primarily related to PFOA.

For purposes of this document production, and in the interest of attempting to make this production useful and purposeful to the Agency and to avoid redundancy, DuPont followed the guidelines provided below. Please note, however, that if the Agency wants DuPont to submit the type of information that is indicated below as not being submitted herewith, please notify us and we will provide the requested information.

General Guidelines for December 10 Submission

This submission does not include the following types of documents:

- Draft documents where it is known that a final version exists
- Documents known to be in the possession of EPA (either at headquarters or an EPA Regional Office)
- Non-DuPont documents (includes documents from other companies, plaintiffs' counsel, etc.)
- Presentations and other documents that reference data that is in a report submitted to EPA
- Documents that are subject to attorney-client privilege
- Documents concerning work-in-progress (Note though that DuPont will provide periodic updates to EPA on work-in-progress, per the November 10, 2004 presentation to EPA, and will submit reports on such work to EPA when final)
- Supporting reports (e.g., lab analysis, etc.) for blood monitoring results

Summary of Collection Process for Specific Categories of Requested Information

The documents for this submission were collected from review of the documents produced in the class action litigation, along with collection of documents from individuals in the Company most likely to possess such information.

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In addition, to aid in understanding the information submitted, DuPont summarized the blood data from Washington Works, Fayetteville, and Chambers Works. These summaries are found in Volume 35 as follows:

Tab 28 Chambers Works (non-telomer)
Tab 77 Chambers Works (telomers)
Tab 34 Fayetteville
Tab 64 Washington Works

Finally, Volume 36 is a printout of the Fluoropolymers Laboratory Analysis Information Retrieval (FLAIR) database as from the Washington Works facility. Each page contains the work history and blood monitoring results for an individual employee (the name of the employee has been redacted from each page for privacy purposes). Note that the FLAIR database contains monitoring data through 2003; it does not yet contain the monitoring data collected for 2004. Year 2004 data for Washington Works is provided in Volume 35, Tab 64.

ATTACHMENT 2

Summary of December 10, 2004 Submission

- Public Version

Box no.	Volume	Part no.	Topic
1	-	-	Cumulative index
1	35	-	Blood Monitoring
1	36	-	Fluoropolymers Laboratory Analysis Information Retrieval (FLAIR) database

- ***Confidential Version***

Box no.	Volume	Part no.	Topic
1	-	-	Cumulative index
1	35	-	Blood Monitoring
1	36	-	Fluoropolymers Laboratory Analysis Information Retrieval (FLAIR) database **[note that this binder does not contain TSCA CBI, but employee names have been redacted for privacy purposes**

Blood Monitoring

Volume 35

December 10, 2004
EPA PRODUCTION

Company Sanitized – Does Not Contain TSCA CBI

INDEX NUMBER	DATE	TITLE/DESCRIPTION	REPORT NUMBER	SUBJECT MATERIAL	TRADENAME or CODE	CAS REGISTRY NUMBER	DOCUMENT TYPE	EPA DOCKET	"Bates" NUMBER	SITE	CATEGORY
035-001 3397	19811109	Blood - Determination of Perfluorooctanoic Acid, Gas Chromatographic Method	B 465.5000	Perfluorooctanoic Acid	no further information identified	335-67-1	Method	no further information identified	no further information identified	no further information identified	Analytical Methods - PFOA in Blood
035-001 3397	19811109	Blood - Determination of Perfluorooctanoic Acid, Gas Chromatographic Method	B 465.5000	C-8	no further information identified	3825-26-1	Method	no further information identified	no further information identified	no further information identified	Analytical Methods - PFOA in Blood
035-002 3398	19980716	Analysis of C-8 in blood, status of interlab comparison	no further information identified	C-8	no further information identified	3825-26-1	Method	no further information identified	no further information identified	Dordrecht Works	Analytical Methods - PFOA in Blood
035-003 3399	20010129	Trip Report Reviewing National Medical Services Method	no further information identified	Perfluorooctanoic Acid	no further information identified	335-67-1	Report	no further information identified	no further information identified	no further information identified	Analytical Methods - PFOA in Blood
035-004 3400	20011109	National Medical Services (GC-ECD) PFOA Method Change Proposal	no further information identified	PFOA	no further information identified	335-67-1	Report	no further information identified	no further information identified	no further information identified	Analytical Methods - PFOA in Blood
035-005 3401	20011122	Draft European GC/MS Method	no further information identified	Perfluorooctanoic Acid	no further information identified	335-67-1	Method	no further information identified	no further information identified	no further information identified	Analytical Methods - PFOA in Blood
035-006 3402	20020129	Trip Report Reviewing National Medical Services Method	no further information identified	Perfluorooctanoic Acid	no further information identified	335-67-1	Report	no further information identified	no further information identified	no further information identified	Analytical Methods - PFOA in Blood
035-007 3403	20020604	Advion Site Manual for Sample Preparation and Submission	DUPONTSM.DOC	PFOA	no further information identified	335-67-1	Manual	no further information identified	no further information identified	no further information identified	Analytical Methods - PFOA in Blood
035-008 3404	20020712	Advion Method Validation Report: Method Validation for the Quantitation of Ammonium Perfluorooctanoate Anion (PFOA, 0.05 to 10 micrograms/milliliter Concentration Range), in Human Serum by Turbo Ion Spray LC/MS/MS	02120VDJA_DU.DOC	Ammonium Perfluorooctanoate	no further information identified	3825-26-1	Report	no further information identified	no further information identified	no further information identified	Analytical Methods - PFOA in Blood
035-008 3404	20020712	Advion Method Validation Report: Method Validation for the Quantitation of Ammonium Perfluorooctanoate Anion (PFOA, 0.05 to 10 micrograms/milliliter Concentration Range), in Human Serum by Turbo Ion Spray LC/MS/MS	02120VDJA_DU.DOC	Perfluorooctanoate Anion	no further information identified	335-67-1	Report	no further information identified	no further information identified	no further information identified	Analytical Methods - PFOA in Blood

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INDEX NUMBER	DATE	TITLE/DESCRIPTION	REPORT NUMBER	SUBJECT MATERIAL	TRADENAME or CODE	CAS REGISTRY NUMBER	DOCUMENT TYPE	EPA DOCKET	"Bates" NUMBER	SITE	CATEGORY
035-009 3405	20030131	Advion: Bioanalytical Method Validation for the Quantitation of Perfluorooctanoic Acid in Human Serum	no further information identified	Perfluorooctanoic Acid	no further information identified	335-67-1	Abstract	no further information identified	no further information identified	no further information identified	Analytical Methods - PFOA in Blood
035-010 3406	20030930	Advion: Quantitative Determination of Ammonium Perfluorooctanoate (APFO), Measured as the Perfluorooctanoate Anion (PFOA), in Human Serum from Study DW04 Using Turbo Ion Spray LC/MS/MS	02331ADJA_DU.DOC	Ammonium Perfluorooctanoate	no further information identified	3825-26-1	Report	no further information identified	no further information identified	no further information identified	Analytical Methods - PFOA in Blood
035-010 3406	20030930	Advion: Quantitative Determination of Ammonium Perfluorooctanoate (APFO), Measured as the Perfluorooctanoate Anion (PFOA), in Human Serum from Study DW04 Using Turbo Ion Spray LC/MS/MS	02331ADJA_DU.DOC	Perfluorooctanoate Anion	no further information identified	335-67-1	Report	no further information identified	no further information identified	no further information identified	Analytical Methods - PFOA in Blood
035-011 3407	20040108	Exygen: Method of Analyisis for the Determination of Perfluorooctanoic Acid (PFOA) in Serum by LC/MS/MS - Revision 2	ExM-008-276 Revision 2	Perfluorooctanoic Acid	no further information identified	335-67-1	Method	no further information identified	no further information identified	no further information identified	Analytical Methods - PFOA in Blood
035-012 3408	undated	Validation of Determination of Total Fluorine in Blood by Wickbold Torch With Direct Potentiometric Detection	no further information identified	Fluorine	no further information identified	7782-41-4	Method	no further information identified	no further information identified	no further information identified	Analytical Methods - PFOA in Blood
035-013 3409	19790723	Memo from B. C. McKusick to F.E. French, Jr., entitled: "Discussion of Fluorochemicals with 3M"	no further information identified	Perfluorooctanoic Acid	FC-143	3825-26-1	Memorandum	no further information identified	no further information identified	no further information identified	General PFOA in Blood Data
035-014 3410	19790725	Memo from J. W. Raines to R. L. Richards, entitled: "Organic Fluorocompounds in Blood"	no further information identified	Fluorine	no further information identified	7782-41-4	Memorandum	no further information identified	no further information identified	Chambers Works, Washington Works	General PFOA in Blood Data
035-014 3410	19790725	Memo from J. W. Raines to R. L. Richards, entitled: "Organic Fluorocompounds in Blood"	no further information identified	Ammonium Salt of Perfluorooctanoic Acid	FC-143	3825-26-1	Memorandum	no further information identified	no further information identified	Chambers Works, Washington Works	General PFOA in Blood Data

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INDEX NUMBER	DATE	TITLE/DESCRIPTION	REPORT NUMBER	SUBJECT MATERIAL	TRADENAME or CODE	CAS REGISTRY NUMBER	DOCUMENT TYPE	EPA DOCKET	"Bates" NUMBER	SITE	CATEGORY
035-015 3411	19791018	Table: C-8 (FC-143) - Ammonium Perfluorooctanoate Chronological Summary of Reports	no further information identified	Ammonium Perfluorooctanoate	FC-143	3825-26-1	Table	no further information identified	no further information identified	Chambers Works, Washington Works	General PFOA in Blood Data
035-016 3412	19800228	Table: F&F Department FC-143 Data February, 1980	no further information identified	Ammonium Perfluorooctanoate	FC-143	3825-26-1	Table	no further information identified	no further information identified	Fairfield, Marshall Lab, Philadelphia PE, Philadelphia Plant, Toledo	General PFOA in Blood Data
035-017 3413	19800303	Table: Summary Organic Fluorides in Blood Samples	no further information identified	Organic Fluorides	no further information identified	no further information identified	Table	no further information identified	no further information identified	Chambers Works, Experimental Station, Finishes Plants, Spruance, Washington Works, Wilmington	General PFOA in Blood Data
035-018 3414	19810514	Table: C-8 Level Locations Other than Washington Works	no further information identified	C-8	no further information identified	3825-26-1	Table	no further information identified	no further information identified	Circleville, Chestnut Run, Fairfield, Haskell, Spruance, Toledo, Wilmington	General PFOA in Blood Data
035-019 3415	19820825	Correspondence from Timothy P. Pastoor to J. G. Loschiavo entitled "Ammonium Perfluorooctanoate (C-8) in Human Blood"	no further information identified	Ammonium Perfluorooctanoate	no further information identified	3825-26-1	Correspondence	no further information identified	no further information identified	no further information identified	General PFOA in Blood Data
035-020 3416	undated	Additional Information for Supervision	no further information identified	Fluorine	no further information identified	7782-41-4	Correspondence	no further information identified	no further information identified	Chambers Works	General PFOA in Blood Data
035-021 3417	undated	Table: Employee Blood Data (1979, 1981, 1999)	no further information identified	Fluorine	no further information identified	7782-41-4	Table	no further information identified	no further information identified	Chambers Works, Wilmington	General PFOA in Blood Data
035-021 3417	undated	Table: Employee Blood Data (1979, 1981, 1999)	no further information identified	C-8	no further information identified	3825-26-1	Table	no further information identified	no further information identified	Chambers Works, Wilmington	General PFOA in Blood Data
035-022 3418	19810827	Table: Analytical Results: FC-143 in Blood Polymer Products - Chambers Works	no further information identified	Ammonium Perfluorooctanoate	no further information identified	3825-26-1	Table	no further information identified	no further information identified	Chambers Works	PFOA in Blood Data
035-023 3419	19990923	Memo from Robin C. Leonard to Barbara Dawson entitled "C-8 Surveillance"	no further information identified	C-8	no further information identified	3825-26-1	Memorandum	no further information identified	no further information identified	Chambers Works	PFOA in Blood Data
035-024 3420	20001019	E-mail from Barbara J. Dawson to multiple people entitled "C8 Follow-up Medical Surveillance"	no further information identified	C-8	no further information identified	3825-26-1	Email	no further information identified	no further information identified	Chambers Works	PFOA in Blood Data

INDEX NUMBER	DATE	TITLE/DESCRIPTION	REPORT NUMBER	SUBJECT MATERIAL	TRADENAME or CODE	CAS REGISTRY NUMBER	DOCUMENT TYPE	EPA DOCKET	"Bates" NUMBER	SITE	CATEGORY
035-025 3421	20001019	E-Mail from Barbara J. Dawson to multiple people entitled "C8 Medical Surveillance – Draft Letter to Participants"	no further information identified	C-8	no further information identified	3825-26-1	Email	no further information identified	no further information identified	Chambers Works	PFOA in Blood Data
035-026 3422	20010119	E-Mail from Barbara J. Dawson to Robin C. Leonard entitled "NMS Results"	no further information identified	C-8	no further information identified	3825-26-1	Email	no further information identified	no further information identified	Chambers Works	PFOA in Blood Data
035-027 3423	20041120	Summaries of Chambers Works PFOA in Blood	no further information identified	Perfluorooctanoic Acid	no further information identified	335-67-1	Table	no further information identified	no further information identified	Chambers Works	PFOA in Blood Data
035-028 3424	undated	Proposal for Feasibility Assessment entitled " Estimating Exposure, Biopersistence, and Potential Liver Effects from Workplace Exposures to Organofluorines: A determination of the feasibility of appropriate analyses of historical surveillance data",	no further information identified	C-8	no further information identified	3825-26-1	Proposal	no further information identified	no further information identified	Chambers Works	PFOA in Blood Data
035-029 3425	19811020	Table: DuPont de Nemours (Nederland) B.V. Dordrecht Works	no further information identified	C-8	no further information identified	3825-26-1	Table	no further information identified	no further information identified	Dordrecht Works	PFOA in Blood Data
035-030 3426	19970200	Two pages extracted from C-8 PACE Team Meeting Notes with blood data from the Dordrecht Works	no further information identified	C-8	no further information identified	3825-26-1	Graph	no further information identified	no further information identified	Dordrecht Works	PFOA in Blood Data
035-031 3427	undated	C-8 in Bloed Monitoring Results in FLPR Dordrecht	no further information identified	C-8	no further information identified	3825-26-1	Report	no further information identified	no further information identified	Dordrecht Works	PFOA in Blood Data
035-032 3428	19821101	Memo from S. R. Laas to J. D. De Laurentis, M.D. entitled "Analysis of Blood Samples for Perfluorooctanoate"	no further information identified	Perfluorooctanoate	no further information identified	3825-26-1	Memorandum	no further information identified	no further information identified	Experimental Station	PFOA in Blood Data
035-033 3429	20031215	Exposure Assessment Protocol entitled "Exposure Assessment of Measured Serum Perfluorinated Octanoic Acid Anion in the Manufacture of Ammonium Perfluorooctanoate (APFO) at Fayetteville, NC"	15076	Ammonium Perfluorooctanoate	no further information identified	3825-26-1	Study	no further information identified	no further information identified	Fayetteville Works	PFOA in Blood Data
035-034 3430	20041119	Summaries of Fayetteville Works PFOA in Blood Data	no further information identified	Perfluorooctanoic Acid	no further information identified	335-67-1	Table	no further information identified	no further information identified	Fayetteville Works	PFOA in Blood Data

INDEX NUMBER	DATE	TITLE/DESCRIPTION	REPORT NUMBER	SUBJECT MATERIAL	TRADENAME or CODE	CAS REGISTRY NUMBER	DOCUMENT TYPE	EPA DOCKET	"Bates" NUMBER	SITE	CATEGORY
035-035 3431	19800225	Memo from E. R. Purchase to G. L. Watts entitled "FC-143 Surfactant"	no further information identified	Ammonium Perfluorooctanoate	FC-143	3825-26-1	Memorandum	no further information identified	no further information identified	Spruance	PFOA in Blood Data
035-036 3432	undated	Table: Table II GC Precision	no further information identified	Ammonium Perfluorooctanoate	FC-143	3825-26-1	Table	no further information identified	SPR000321	Spruance	PFOA in Blood Data
035-037 3433	19791010	Table: Organic Fluorides in Blood Samples	no further information identified	Organic Fluorides	no further information identified	no further information identified	Table	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-038 3434	19791016	Hand-written table entitled "Organic Fluorides in Blood Samples Complete Results"	no further information identified	Organic Fluorides	no further information identified	no further information identified	Table	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-039 3435	19810514	Table: C-8 Level – Current Washington Works Female Employees	no further information identified	C-8	no further information identified	3825-26-1	Table	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-040 3436	19811201	Table: C-8 Blood Levels in Females Transferred Out of Teflon	no further information identified	C-8	no further information identified	3825-26-1	Table	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-041 3437	19820212	Memo from J. F. Doughty to R. D. Ingalls entitled "Work Histories of Females"	no further information identified	Fluorine	no further information identified	7782-41-4	Table	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-042 3438	19820714	Memo from J. G. Loschiavo to R. J. Burger entitled "Trends in Blood C-8 Levels for Various Teflon® Employee Groups"	no further information identified	C-8	no further information identified	3825-26-1	Memorandum	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-043 3439	19820729	Memo from J. G. Loschiavo to R. J. Zipfel entitled "Retention of Ammonium Perfluorooctanoate (C-8) in Blood of Teflon® Employees"	no further information identified	Ammonium Perfluorooctanoate	no further information identified	3825-26-1	Memorandum	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-044 3440	19820928	Memo from J. G. Lochiavo to R. J. Zipfel entitled "Ammonium Perfluorooctanoate in Blood of Teflon® Employees"	no further information identified	Ammonium Perfluorooctanoate	no further information identified	3825-26-1	Memorandum	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-045 3441	19830811	Memo from J. G. Loschiavo to T. M. Kemp entitled "Update on the C-8 Blood Sampling Program"	no further information identified	C-8	no further information identified	3825-26-1	Memorandum	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-046 3442	19831010	Hand-written table with no title	no further information identified	C-8	no further information identified	3825-26-1	Table	no further information identified	no further information identified	Washington Works	PFOA in Blood Data

INDEX NUMBER	DATE	TITLE/DESCRIPTION	REPORT NUMBER	SUBJECT MATERIAL	TRADENAME or CODE	CAS REGISTRY NUMBER	DOCUMENT TYPE	EPA DOCKET	"Bates" NUMBER	SITE	CATEGORY
035-047 3443	19831019	Tables with C-8 Blood Sample Results by Job	no further information identified	C-8	no further information identified	3825-26-1	Table	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-048 3444	19831027	Memo from J. G. Loschiavo to J. W. Raines entitled "Washington Works Blood C-8 Levels for Non-Fluoropolymers Division Employees"	no further information identified	C-8	no further information identified	3825-26-1	Memorandum	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-049 3445	19840611	Table entitled "Table 1: Teflon® Fine Powder/Dispersion Operators C-8 Blood Sample Results" hand-dated 6/11/84	no further information identified	C-8	no further information identified	3825-26-1	Table	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-050 3446	19840614	Memo from J. G. Loschiavo to T. M. Kemp entitled "Update on the C-8 Blood Sampling Program"	no further information identified	C-8	no further information identified	3825-26-1	Memorandum	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-051 3447	19870609	Table entitled "C-8 Trend in Blood"	no further information identified	C-8	no further information identified	3825-26-1	Table	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-052 3448	19870610	Table entitled "WW C-8 Blood Analyses (Non-Fluorocarbon Exposure)"	no further information identified	C-8	no further information identified	3825-26-1	Table	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-053 3449	19870806	Hand-drawn graphs Blood C-8 Level Change vs. Time	no further information identified	C-8	no further information identified	3825-26-1	Graph	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-054 3450	19890614	Memo from R. D. Lanyon to H. A. Smith et al entitled "C-8 Blood Data"	no further information identified	C-8	no further information identified	3825-26-1	Memorandum	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-055 3451	19900319	Memo from H. A. Smith to J. G. Loschiavo et al entitled "Review of Washington Works C-8 Data Personnel Air Monitoring and Blood Data"	no further information identified	C-8	no further information identified	3825-26-1	Memorandum	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-056 3452	19900400	Report entitled "Review of Washington Works C-8 Data Personnel Air Monitoring and Blood"	no further information identified	C-8	no further information identified	3825-26-1	Report	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-057 3453	19920102	Tables	no further information identified	C-8	no further information identified	3825-26-1	Table	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-058 3454	19940000	Table entitled "1994 C-8 in Blood Results"	no further information identified	C-8	no further information identified	3825-26-1	Table	no further information identified	no further information identified	Washington Works	PFOA in Blood Data

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INDEX NUMBER	DATE	TITLE/DESCRIPTION	REPORT NUMBER	SUBJECT MATERIAL	TRADENAME or CODE	CAS REGISTRY NUMBER	DOCUMENT TYPE	EPA DOCKET	"Bates" NUMBER	SITE	CATEGORY
035-059 3455	19970617	E-mail from Anthony J. Playtis to Younger L. Power entitled "1997 Voluntary C-8 Blood Testing"	no further information identified	C-8	no further information identified	3825-26-1	Email	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-060 3456	19971103	Report by A. J. Playtis entitled "Results of the 1995 Study of C-8 Blood Levels"	no further information identified	C-8	no further information identified	3825-26-1	Report	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-061 3457	20000802	E-mail from Anthony J. Playtis to Robbin Banerjee et all entitled "Preliminary C-8 Blood Results for Washington Works"	no further information identified	C-8	no further information identified	3825-26-1	Email	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-062 3458	20000808	Memo from Anthony J. Playtis to Gary W. Jepson entitled "Pensioner Blood Data"	no further information identified	C-8	no further information identified	3825-26-1	Email	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-063 3459	20001117	Presentation entitled "Washington Works Blood Data Summary" by R. F. Pinchot	no further information identified	APFO	no further information identified	3825-26-1	Presentation	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-064 3460	20041120	Summaries of blood data by year and spreadsheets containing raw data	no further information identified	Perfluorooctanoic Acid	no further information identified	335-67-1	Table	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-065 3461	undated	Table entitled "WW APFO in Blood, 1985 and 1984"	no further information identified	APFO	no further information identified	3825-26-1	Table	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-066 3462	undated	Title entitled "Half Life Results from Pensioners"	no further information identified	C-8	no further information identified	3825-26-1	Table	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-067 3463	undated	Table entitled "WW APFO in Blood, 1989-90"	no further information identified	APFO	no further information identified	3825-26-1	Table	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-068 3464	undated	Table entitled "Average for Job"	no further information identified	APFO	no further information identified	3825-26-1	Table	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-069 3465	undated	Series of tables, 10 pages	no further information identified	C-8	no further information identified	3825-26-1	Table	no further information identified	no further information identified	Washington Works	PFOA in Blood Data
035-070 3466	19870324	Kinetics of Somption and Elimination of Fluorinated Surfactants in Blood	JL-87-5	Poly(difluoromethylene),alpha-fluoro-omega-(2-sulfoethyl)-	[CBI]	80010-37-3	Report	no further information identified	no further information identified	no further information identified	Telomers Blood Data General
035-071 3467	undated	Organic Fluorocompounds in Blood	no further information identified	Organic Fluorocompounds	no further information identified	no further information identified	Memorandum	no further information identified	no further information identified	no further information identified	Telomers Blood Data General
035-072 3468	19790315	Letter from Sidney Pell to P. G. Gilby entitled "Chambers Works Fluorosurfactant Study"	no further information identified	Fluorine	no further information identified	7782-41-4	Correspondence	no further information identified	no further information identified	Chambers Works	Telomers Blood Data

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INDEX NUMBER	DATE	TITLE/DESCRIPTION	REPORT NUMBER	SUBJECT MATERIAL	TRADENAME or CODE	CAS REGISTRY NUMBER	DOCUMENT TYPE	EPA DOCKET	"Bates" NUMBER	SITE	CATEGORY
035-073 3469	19790518	Chambers Works Fluorochemicals in Blood Study	no further information identified	Fluorine	no further information identified	7782-41-4	Study	no further information identified	no further information identified	Chambers Works	Telomers Blood Data
035-074 3470	19990305	E-mail from Barbara J. Dawson to Carol S. Lyell entitled "1978-79 Chambers Works Organic Fluorine in Blood Monitoring Program	no further information identified	Fluorine	no further information identified	7782-41-4	Email	no further information identified	no further information identified	Chambers Works	Telomers Blood Data
035-075 3471	20000321	E-mail from Susan S. Mileti to Gerald L. Kennedy and Stephen H. Korzeniowski entitled "CW blood monitoring C-8 & total F"	no further information identified	Fluorine	no further information identified	7782-41-4	Email	no further information identified	no further information identified	Chambers Works	Telomers Blood Data
035-075 347.	20000321	E-mail from Susan S. Mileti to Gerald L. Kennedy and Stephen H. Korzeniowski entitled "CW blood monitoring C-8 & total F"	no further information identified	C-8	no further information identified	3825-26-1	Email	no further information identified	no further information identified	Chambers Works	Telomers Blood Data
035-076 3472	20011001	Worker Monitoring Summary	no further information identified	Fluorine	no further information identified	7782-41-4	Abstract	no further information identified	no further information identified	Chambers Works	Telomers Blood Data
035-077 3473	20041209	Chambers Works Telomer Summary	no further information identified	PFOA	no further information identified	335-67-1	Table	no further information identified	no further information identified	Chambers Works	Telomers Blood Data
035-078 3474	20041207	First Chemical Company Pascagoula, MS - Baseline Monitoring December 2003	no further information identified	PFOA	no further information identified	335-67-1	Table	no further information identified	no further information identified	Pascagoula	Telomers Blood Data
035-079 3475	20020530	Telomeres fluores Dosages sanguins	no further information identified	PFOA	no further information identified	335-67-1	Presentation	no further information identified	no further information identified	Villers Saint Paul	Telomers Blood Data
035-080 3476	20030327	E-mail from Jim E. Pesek to Korzeniewski, Rickard and Masse entitled "Blood Monitoring at Villers Saint Paul	no further information identified	PFOA	no further information identified	335-67-1	Email	no further information identified	no further information identified	Villers Saint Paul	Telomers Blood Data

Fluoropolymers Laboratory Analysis Information Retrieval

Volume 36

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VOL	TAB	DATE	DESCRIPTION	CATEGORY
36	FLAIR Documents	11/09/04	Flair - Work and Medical Histories for All Employees and All Years	FLAIR Blood Monitoring

AR226-3397

23pp

AR226 - 3397

BLOOD

Determination of Perfluorooctanoic Acid

Gas Chromatographic Method

I. Scope and Applications

This is a method for the determination of perfluorooctanoic acid (C_8) and its salts in blood. Approximately 1 g of sample is required for measurement of concentrations down to 0.01 µg/g.

The method has been evaluated for analysis of human and rat whole blood, but preliminary experiments indicate that it could also be used for serum. A similar procedure can be used for the analysis of aqueous solutions (as from air impingers), and a modified method used for other solutions and solid samples.

II. Principle (See Note 1.)

The water is removed from sample aliquots by freeze-drying (lyophilization) to permit derivatization. Addition of methanolic HCl to the dried residue, along with perfluorodecanoic acid (C_{10}) internal standard, converts the acids, which are not amenable to GC analysis, to more volatile methyl esters. These are extracted from the reaction mixture into hexane solution for GC analysis. An electron capture detector (ECD) is used because of its sensitivity and selectivity, with either a packed or a capillary column.

$$C_7F_{15}COO^-M^+ + CH_3OH \xrightarrow{3\%\ HCl} C_7F_{15}COOCH_3 + MOH$$

$$M^+ = NH_4^+,\ Na^+,\ H^+$$

III. Interferences

As in any GC analysis, compounds with the same retention time as the compound of interest will not be distinguished from it. These can include impurities present in the reagents or other components in the samples themselves.

Interfering peaks from solvents, derivatizing reagent, etc., are not generally observed in this laboratory with the reagents specified below (See Note 2), but each new batch should be checked and a blank included in every analysis. A small peak at the C_8 ester position is found in reagent blanks containing perfluorodecanoic acid internal standard, probably from C_8 present as an impurity in that material. This will give an intercept slightly greater than zero in the calibration plot, but will be a significant contribution to the C_8 peak area only at the lowest concentrations (about 1/3 of the total for 0.01 µg/g C_8, when about 1 µg/g C_{10} is added).

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A very small peak at that position has also been found in some "blank blood" samples, as shown in the example in Figure 2a. Whether this represents a trace of C_8 (about 0.001 - 0.005 µg/g) or some other component of the blood would be difficult to determine at this low concentration and with the limited number of samples examined to date.

IV. Sensitivity, Precision, and Accuracy

The method has been used over the concentration range 0.01-150 µg/g C_8. Above 10-20 µg/g, however, interferences with the C_{10} internal standard are generally encountered so that some modification must be made for analyses at higher concentrations (See Note 15). Due to the relatively narrow linear range of the ECD, the calibration curve must always cover the region of interest for quantification.

From the data available at this time, precision is estimated to be ± 10% relative. Recovery of spikes is quantitative within this uncertainty when calculated relative to the C_{10} internal standard, although absolute recovery is affected by the presence of dried blood solids (See Note 3).

Accuracy will also be affected by the choice of C_8 standard (particularly when the packed column analysis is used), which should correspond to the fluorosurfactant composition of the samples as nearly as possible (See Note 4).

V. Apparatus

Instruments and equipment used in this laboratory are specified here; equivalent apparatus can be substituted.

1. Gas Chromatograph and Supplies - For packed column analysis. (See Appendix 1 for capillary column analysis.)

   Hewlett-Packard 5830 GC with HP 18803 Electron Capture Detector, equipped for on-column injection with glass-packed columns

   10 ft x 2 mm id glass columns (HP configuration 5 with ECD adapter), packed with 10% OV-210 on 70/80 mesh Chromosorb W.AW.DMCS. and conditioned at 200°C

   Hamilton 701N 10 µL syringe

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2. Lyophilizer

Labconco No. 75352 bench-top freeze dryer (12-port, dry ice cooled)

Labconco No. 75406 (150 mL) or No. 75408 (300 mL) Fast-Freeze flasks, with No. 75476 stainless steel adapters

Vacuum pump with auxiliary cold trap

McLeod gage or electronic vacuum gage reading in the 5-0.005 torr range

3. Thermostated Reaction Block

Pierce No. 18800 Reacti-Therm Heating Module, with Reacti-Block to hold 2-dram vials and thermometer (Block C, No. 18804, has 12 holes, but they must be enlarged to about 19 mm to accommodate the 2-dram vials. Block B, No. 18802, can be used as is, but will hold only 9 vials and provides poorer thermal contact.) Lab-Line Multi-Blok Heaters can be used with the same blocks, and will hold 2-6 in a single unit.

4. Vials and Septum Caps

Wheaton No. 224884 or Pierce No. 13028 2-dram (about 7 mL) screw cap septum vials (borosilicate glass)

Pierce No. 12713 TEFLON-silicone septa and No. 13216 open-top screw caps

5. Pipets and Dispensers

Gilson P200 Pipetman variable volume micropipet for quantitative delivery of 20-200 µL aliquots

1, 2, and 5 mL volumetric pipets for measuring sample and reagent aliquots. (Brinkman Dispensette bottle-top dispensers are a great convenience for repetitive delivery of solvents.)

6. Disposable hypodermic syringes, 1-3 mL, if blood samples are to be taken from closed "Vacutainers".

7. Volumetric flasks, 10, 25, and 50 mL

8. Branson B-220 ultrasonic cleaner (See Note 5.)

9. Analytical balance

10. Common laboratory equipment (including a refrigerator for storage of samples)

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VI. Reagents

1. C_8 standards: Perfluoro-n-octanoic Acid (PCR Research Chemicals), FC-143 ammonium perfluorooctanoate (3M), or other material in use in the area to be monitored (See Note 4.)

2. Perfluorodecanoic acid (PCR Research Chemicals)

3. Methanol (Fisher HPLC (A-452) or Fisher Certified ACS (A-412)) (See Note 2.)

4. Derivatization reagent, 3% HCl in methanol, prepared from Applied Science No. 18053 Instant Methanolic HCl Kit, but substituting Fisher HPLC or ACS methanol for the Lipopure methanol provided (See Note 2). The reagent should be stored in the refrigerator, and can be kept for about 1 month.

5. Hexane, Phillips Spectrograde or Applied Science Lipopure (See Note 2.)

6. Water, distilled or deionized

7. "Blank" Blood, to spike for standards. Heparinized "Vacutainer" blood collection tubes (B-D No. 6480) have generally been used for this, as well as for samples. Vacutainers containing liquid EDTA anticoagulant can also be used.

   NOTE: All blood samples must be stored under refrigeration.

8. Perfluorodecanoic acid (C_{10}) standard solution in methanol (See Note 6.)

   Prepare a stock solution and sequential dilutions as follows:

Solution	Preparation	$[C_{10}]$, µg/mL	[F] µg/mL
I	Weigh (to 0.1 mg) about 25 mg perfluorodecanoic acid into a vial. Add 10 mL methanol and shake to dissolve. (Solvent volume can be adjusted as needed to correspond to the actual sample wt.)	2500	1755
II	Dilute 2 mL I to 50 mL in methanol.	100	70.2
III	Dilute 2 mL II to 10 mL in methanol	20.0	14.0

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9. Perfluorooctanoic acid (C_8) standard solution in water (See Note 6.)

Perfluorooctanoic acid is only sparingly soluble in water, and dissolves very slowly. At least 1-2 hr shaking is required at this concentration (about 2 mg/mL), and it is best to prepare the stock solution one day in advance of the dilutions. Acid concentration can be checked by titration.

Concentrations will vary, but solutions are needed from which at least four spiked blood standards can be prepared to cover the range of interest. For the example shown in the chromatograms and calculations below (0.01-0.9 µg/mL), a stock solution and sequential dilutions would be prepared as follows:

Solution	Preparation	[C_8], µg/mL	[F], µg/mL
I	Weigh (to 0.1 mg) about 45 mg perfluorooctanoic acid into a vial. Add 20 mL distilled water and shake to dissolve. (Solvent volume can be adjusted as needed.)	2200 (for 44 mg sample)	1514
II	Dilute 3 mL I to 50 mL in H_2O.	132	90.8
III	Dilute 5 mL II to 25 mL in H_2O.	26.4	18.2
IV	Dilute 2 mL II to 50 mL in H_2O.	5.28	3.63
V	Dilute 3 mL IV to 25 mL in H_2O.	0.634	0.436

VII. Operating Conditions

VIII. Safety and Health Precautions

Human blood should be considered potentially infectious, and the Laboratory Guidelines (See Reference 1) for handling, storage, and disposal of samples should be followed.

The 3M Company has found in preliminary studies that C_8 caused birth defects when fed to rats in a laboratory experiment. Female employees of childbearing capability should not engage in any portion of this procedure which offers significant chance for exposure. Although no health problems are known for workers exposed to C_8, it has been found in blood samples and may be very slowly eliminated from the body (See Reference 2). Standard laboratory safety practices for handling toxic, embryotoxic, etc., materials and for corrosives should be used in working with these perfluorinated acids and their solutions.

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VIII. Safety and Health Precautions (Cont'd)

The electron capture detector contains a radioactive source (^{63}Ni), and the manufacturer's instructions for safe operation must be observed.

Care should be taken to avoid contact with the low-temperature baths used for freeze-drying.

IX. Procedure

A. Preparation of Blood Samples and Spiked Standards for Analysis (See Note 7.)

All blood samples should be well shaken before taking aliquots to insure a uniform distribution of cells and plasma.

1. Spiked standards

For each standard to be prepared, and for one or more blanks, pipet a 1 mL aliquot of "blank" blood into a 2-dram vial. Spike each with C_8 standard solution to give the range of concentrations required, as shown in the following example:

Spike	[C_8], µg/mL blood	[F], µg/mL blood
33 µL 26.4 µg/mL C_8 in water	0.871	0.600
110 µL 5.28 µg/mL C_8 in water	0.581	0.400
69 "	0.364	0.251
41 "	0.216	0.149
110 µL 0.634 µg/mL C_8 in water	0.0697	0.0480
16 "	0.010	0.0070
Blank (no spike)	0	0

Mix gently, keeping the solution in the bottom of the vial, and sonicate for about 2 min for additional mixing (See Note 5). Store in the refrigerator until needed (See Note 8).

2. Samples

If the sample volume is sufficient, prepare in duplicate.

For each sample, pipet a 1 mL aliquot into a tared 2-dram vial and weigh to 0.1 mg. (Aliquots can also be taken with a disposable syringe, if it is felt preferable not to open the containers).

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B. Freeze-Drying

1. A schematic diagram of the freeze-drying apparatus is shown in Figure 1. Each of the 12 ports has a separate valve so that flasks can be attached or removed while the system is under vacuum. The apparatus should be pumped down to an acceptable vacuum (See Note 9) and the cold traps filled before the drying flasks are attached.

2. Freeze the samples before placing them under vacuum to prevent bumping. To reduce the chance of contamination or sample loss, cover each vial with a light filter beforehand; a small piece of "Kimwipe" held in place with a rubber band works well. Freeze the solution in each (See Note 10) and keep the vials at dry ice temperature until all of them are ready.

3. Place up to four vials in each drying flask and attach to the drying chamber. The pressure should drop below 0.5 torr again within a few minutes if no leaks are present, and the samples should remain frozen as sublimation takes place. Allow them to dry for about 4 hr (See Note 11).

C. Derivatization

1. To the dried residue in each vial, add 2 mL methanolic HCl and 50 µL C_{10} standard solution (about 20 µg/mL in methanol). Prepare a reagent blank similarly, using an empty vial. Close with a septum screw cap and shake well. Sonicate for about 2 min (See Note 5) and shake again.

2. Thermostat for 1 hr at 65°C, then allow the vials to cool to room temperature and stand overnight (See Note 12).

3. Add 2 mL each of hexane and distilled water and shake for about 2 min.

4. After the phases separate, the upper hexane layer can be sampled directly for GC analysis (See Note 13). The solutions are stable in this form for at least several days, although hexane will gradually evaporate after the septum has been pierced.

D. GC Analysis - Packed Column. See Appendix I for capillary column analysis.

1. GC Conditions - Instrument and column as shown in V, Apparatus.

Temperatures:	Injection port	200°C
	Detector	325°C
	Column oven	100°C, isothermal

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Carrier gas: 90% argon/10% methane (or nitrogen if recommended for the instrument) flow about 30 mL/min

Injection Volume: 2 µL

Sensitivity: Attenuation as needed to keep peak height measurable, 2^5-2^{13} on HP 5830.

Run time: 11-25 min, depending on sensitivity (See Note 14.)

After installing the column and establishing the conditions above, check the ECD base frequency and noise level according to the manufacturer's instructions, to insure that they are stable and within acceptable limits.

2. Run each solution twice (or run duplicates once each), bracketing samples with standards of similar concentration in the second series of injections.

   Representative chromatograms are shown in Figure 2 for blanks, standards and samples. Measure either peak height or peak area.

   As noted above, the calibration curve must cover the concentration range of the samples. If some samples are found to fall above the range of prepared standards, the hexane solution can be diluted with that from a blank (e.g., 100 µL + 400 µL for 5X dilution) to reduce the C_8 concentration without changing that of the internal standard. This type of dilution can also be used if peaks interfering with the internal standard are observed at high C_8 concentrations in either sample or standard preparations (See Note 15).

X. Calculations (See Note 16.)

1. Normalized C_8 Peak Values

   A tabulation of peak heights for analysis of a series of standards (prepared as above) and samples as shown in Figure 3a.

   To correct for any variations in injection volume, reagent volumes, etc., the raw C_8 peak heights (or areas) are first normalized relative to the internal standard average:

$$C_8 \text{ (corrected)} = C_8 \times \frac{C_{10} \text{ (average)}}{C_{10}}$$

   Calculation of the C_{10} average also provides a measure of the precision in sample preparation and GC analysis.

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2. Calibration Plot

A calibration curve obtained by plotting corrected C_8 peak height vs concentration of the spiked standards is shown in Figure 3b.

In this case, straight lines can be fitted to sets of points at higher (0.61-0.15 μg/mL) and lower (0.15-0 μg/mL) concentrations, and the slopes and intercepts calculated by linear least squares analysis.

In some plots no really linear region may be found, and a smooth curve should be drawn through the data points.

3. Calculation of Sample Concentrations

Using the corrected C_8 peak heights (or areas) for the samples, corresponding values of μg F/sample can be calculated from the LLS equations (as in Figure 3) or can be read directly from the calibration curve.

Divide each value by the sample weight (in grams) to obtain g F/g blood, and average the results for duplicate runs or duplicate preparations. Report as μg F/g blood (See Note 6).

XI. Calibration (See Under X, Calculations.)

XII. Notes

1. Initial method development was based on a procedure for determination of perfluorooctanoic acid in serum or plasma recently published by 3M (See Reference 3). In that method, C_8 is extracted from acidified serum into hexane/ether, the solution concentrated by evaporation, and diazomethane added for derivatization. With the lyophilization procedure described here, sample handling, time, and material required are reduced, and the use of diazomethane is eliminated. However, concentration of C_8 from a large volume of sample as in an extraction, is not possible. A sample preparation procedure similar to that in the 3M method has been used for aqueous solutions in this laboratory and can be followed by the same methanolic HCl derivatization and GC analysis as lyophilization. The extraction has not been tested with whole blood in either method, however.

GC analysis was initially done with a packed column (as in the 3M method but with a different stationary phase). A capillary column has also been used recently for better resolution of the branched C_8 isomers, and modifications for that analysis are given in Appendix I.

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2. The solvents specified in Section VI were found preferable to several tried for this analysis, but others may also be satisfactory. Even with the same reagents, the appearance of the blank may depend on the condition of the detector. With the ECD used here, contamination results in a significant decrease in selectivity and increased reagent interference.

3. Recovery was determined by spiking blood, water, and methanol solutions at equivalent concentrations, obtaining the response factor for C_8 relative to C_{10} in GC analysis of the water and methanol spikes, and using this factor to calculate the C_8 concentration in the blood spikes. Average recovery (C_8 found/added) was 100 ± 5% for 18 samples of human blood spiked with 0.014-46 µg F/mL (FC-143 or perfluoro-n-octanoic acid) and for 7 samples of rat blood spiked with 0.007-67 µg F/mL. Absolute C_8 and C_{10} peak heights were about 15-20% lower in the presence of dried solids from 1 g blood, however, so that a corresponding error would result from external standard calibration against aqueous solutions.

   The question of whether recovery of spikes provides an accurate measure of recovery of the same material from samples should also be considered, particularly with a complicated substrate such as blood. Agreement between the results of this analysis and those of Wickbold Torch analysis for organic fluorine in a series of test samples seems to indicate that the spikes are a reasonable model for samples.

4. The FC-143 samples examined to date all appear to be a mixture of about 70-75% straight-chain material with several branched isomers present at about 1-10% (determined by F-19 NMR, capillary GC, and GC/MS). In contrast, commercial perfluoro-n-octanoic acid (PCR) contains about 95% straight chain C_8 with about 4% $(CF_3)_2CF(CF_2)_4COOH$ and traces of the other isomers. As shown in the chromatograms in Figures 2c and 2d, in the packed column GC analysis, only one of these is really separated from the main peak (small peak at 3.7 min) while others are visible as a shoulder following it. Chromatograms of samples and standards obtained using the capillary column analysis are shown in Figure 4 (Appendix I); under those conditions, at least partial resolution of four isomers from the main peak can be obtained.

   Since ECD response appears to be higher for the isomers than for the straight-chain ester (by a factor of 2 or more), the total area/concentration ratio also becomes higher as their percentage increases. In the packed column analysis, the response factor calculated for C_8 relative to C_{10} is about 30-40% higher for FC-143 standards than for perfluoro-n-octanoic acid standards, so that it becomes very important to use the one most similar to the samples to be analyzed. Although small variations in isomer distribution can be seen in human blood samples, all of those examined to date resemble perfluoro-n-octanoic acid much more than FC-143, and it has been an appropriate standard

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XII. Notes (Cont'd)

4. (Cont'd)

for quantification within the uncertainty of the method. In a series of rat blood samples, however, considerable variation in distribution was observed. As seen from the chromatograms in Figure 4, neither standard would have been a good approximation to some samples, and analyses were done with the capillary column.

5. Gentle sonication (with the vials immersed about half-way in the water bath of a sonic cleaner) has been used to aid in mixing of spikes and in promoting contact of derivatizing reagent with the dried blood solids. Additional experiments are planned to determine whether this step is necessary or can be eliminated.

6. Since results that are to be compared with nonspecific analyses for total organic fluorine must be expressed as fluorine rather than as C_8, both concentrations are given for the standard solutions. Values for percent fluorine used in the conversion are: perfluorooctanoic acid, 68.82%, ammonium perfluorooctanoate, 66.10%, perfluorodecanoic acid, 70.22%.

7. An aliquot volume of 1 mL is generally used for both samples and standards, but it can be reduced to 0.5 mL when concentrations are expected to be relatively high.

   Coagulation is generally a problem with rat blood samples kept for more than a week or two before analysis. When it is no longer a homogeneous liquid, the entire sample must be lyophilized, mixed well, and portions of the dried powder weighed out for analysis. The exact ratio of dry to liquid weight must be determined for each sample, but is about 0.2, so that 0.2 g powder will be comparable to 1 mL liquid. This procedure greatly increases the time required for sample handling and the probability for error in the weight, and it should be avoided if possible.

8. Spikes prepared for method development have been allowed to stand at least overnight before analysis, but a period of a few hours appears to give equivalent results.

9. For this freeze-drying application, pressures less than 0.5 torr seem to be satisfactory, although 0.025-0.05 torr may be achieved. Readings will also depend on the type of gage used, since the McLeod gage does not read the pressure of water vapor as electronic gages do.

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10. A small dry ice/acetone bath or the center cold well of the drying chamber can be used for rapid freezing of the solutions in the bottom of the vials. As noted in Section VIII, care must be taken to avoid contact with the cold bath.

11. A 4-hr drying time has been adopted for preparation of blood samples by comparison with 1 mL water samples, where drying can be monitored by disappearance of the ice. Experiments with spiked blood samples indicate that longer drying times (8-15 hr) can also be used without loss of C_8.

12. Derivatization mixtures from aqueous samples can be partitioned with hexane/water immediately after cooling. In the presence of dried blood solids, however, additional time for equilibration of the C8 and C_{10} esters seems to be necessary. After standing overnight, peak areas for both C_8 and C_{10} are lower than in reaction mixtures prepared from aqueous or methanolic standards, but the relative response factors are equivalent (See Note 3). Preliminary experiments indicate that it might be possible to eliminate the overnight equilibration by spiking with aqueous C_{10} before lyophilization, rather than with methanolic C_{10} after.

13. Although a clear hexane layer is obtained after standing for about 1/4-1/2 hr, the solution has a relatively dark rust color and undoubtedly contains nonvolatile or high-boiling impurities. In the packed column analysis, these are injected onto the column head; and at the end of the day, the oven should be programmed to 180°C and held for several hours to reduce build-up. No deterioration of performance was observed in a column used for several weeks of analyses, but it may prove preferable to adopt flash vaporization with a glass injection port liner which can be changed daily, as in the capillary column analysis.

14. As seen in the chromatograms in Figure 2, some small, broad peaks can appear late in the run. These appear to come from the C_{10} standard and might be eliminated in purified material; others seem to be characteristic of older blood samples. At the high sensitivity used for low C_8 concentrations, these can interfere with the following run and must be allowed to elute before the next injection.

15. Several minor components are present in both the perfluoro-n-octanoic acid and FC-143 standards which elute near the C_{10} internal standard under these GC conditions and can interfere with quantification. Similar peaks are also often observed in samples at higher concentrations. With the C_{10} concentration generally added (about 1 µg/g), this seems to occur above about 20 ppm C_8 in the capillary column analysis and about 10 µg/g with the packed column. In some cases, an obvious shoulder can be observed on the C_{10} peak, varying in size with the C_8 concentration. In others, an unresolved peak may be indicated by an unusual change in C_{10} peak size, but is only seen if a sample is prepared without added internal standard. Depending on the type of analysis to be done, various techniques can be used for quantification under these conditions.

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(a) Standards can be prepared only up to about 10 μg/g, and any samples found to be above this range diluted and run again, as described in IX, Procedure, Part D.

(b) If only relatively high concentrations are of interest, the C_{10} concentration can be increased and/or the sample size decreased so that the interference becomes negligible.

(c) With the increased resolution of the capillary column, components of the perfluoro-n-octanoic acid standard can be resolved from the C_{10} and the problem eliminated for standards. Samples must still be examined for interference, however.

(d) The calibration curve can be used for an external standard calculation, with uncorrected C_8 peak areas or heights. While good reproducibility is possible with care in measuring the injection and reagent volumes, it is obviously more critical here than in an internal standard calculation and must be checked regularly at each point.

16. From the calibration plot in Figure 3, it can be seen that the ECD response is not linear with concentration over the entire range. Linear plots may be obtained in some cases, but they still have concentration-dependent response factors. The calculations described here thus make use of a calibration curve, in which the internal standard is used to normalize raw peak values before plotting. For an ECD which shows a more linear response and constant relative response factors, calculations could be done by a general internal standard procedure instead. (A calibration plot of this sort has been observed with a Varian 3700 GC under similar conditions).

XIII. References

1. "Experimental Station Rules and Procedures for Human and Other Primate Blood and Blood Products", 3/80, Safety Office, Experimental Station.

2. F. A. Uoel, S. D. Sorenson, and D. E. Roach, "Health Status of Plant Workers Exposed to Fluorochemicals - A Preliminary Report" Am. Ind. Hygl Assoc. J. 41, 584 (1980).

3. J. Belisle and D. F. Hagen, "A Method for Determination of Perfluoro-octanoic Acid in Blood and other Biological Samples", Anal. Biochem. 101, 369 (1980).

[4. [redacted]]

Origin: Experimental Station
Prepared by: S. S. Stafford Approved by: L. J. Papa
Approved by Laboratory Methods Committee, 9 Nov 81

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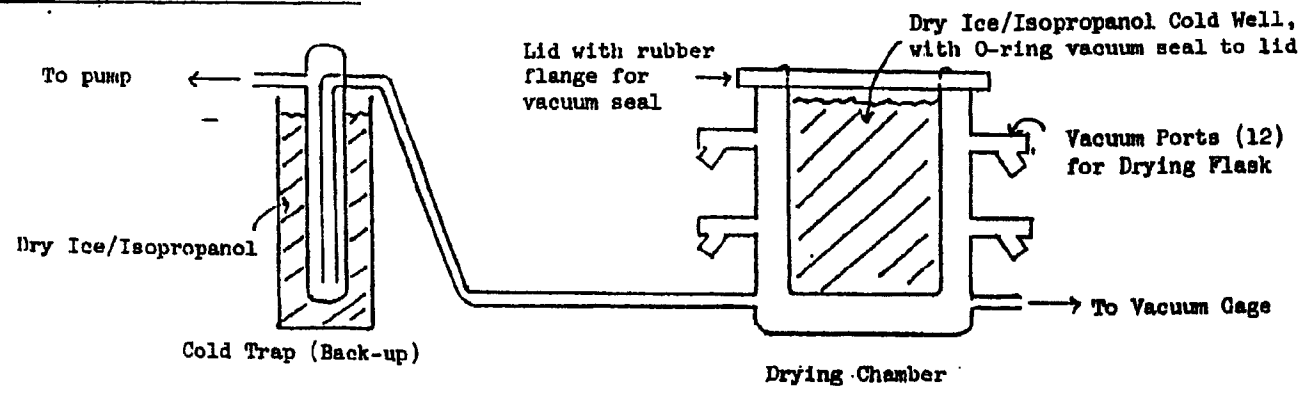
FIGURE 1 - APPARATUS FOR FREEZE-DRYING SAMPLES

(a) Drying Chamber and Vacuum Line



(b) Vacuum Port, Drying Flask, and Samples

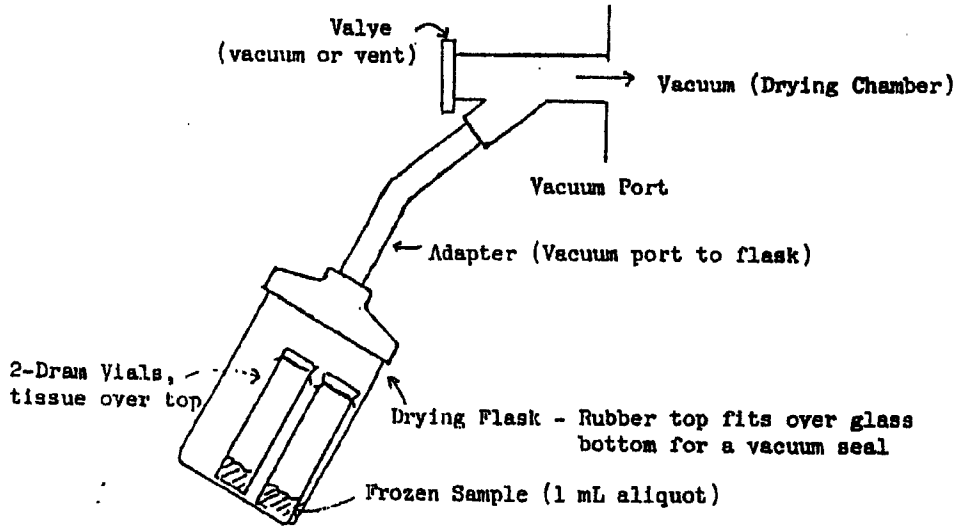


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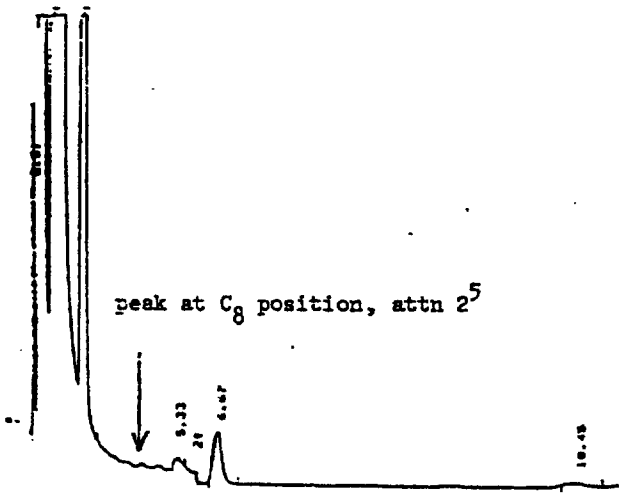
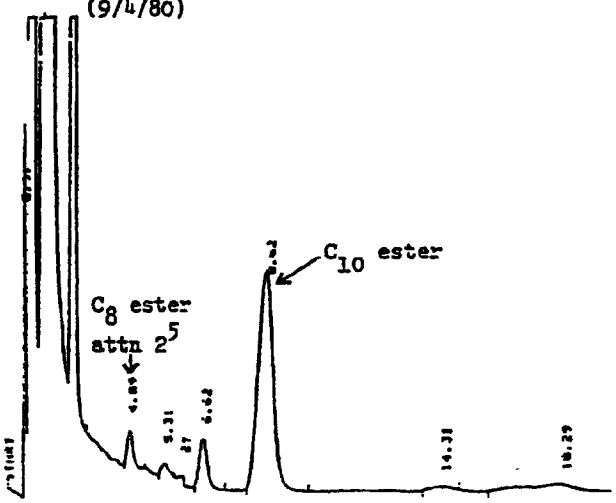
FIGURE 2 - CHROMATOGRAMS FOR C_8 DETERMINATION, PACKED COLUMN ANALYSIS

GC conditions as on p. 8. Attenuation as noted for 0-6 min, 2^7 after 6 minutes. Chart speed 1 cm/min. Retention time (minutes) indicated by each peak.

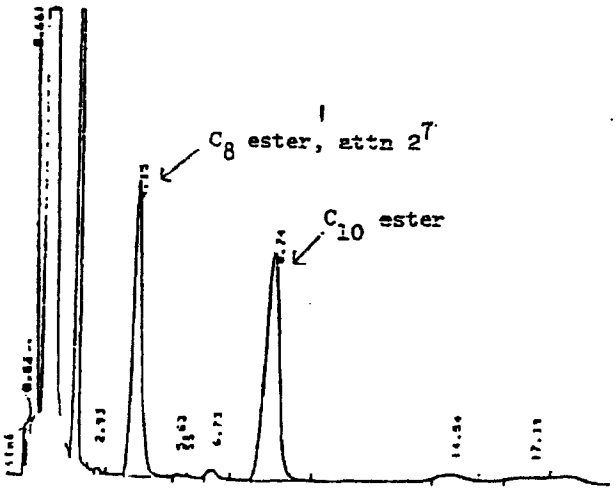
(a) Blank blood, no C_8 spike or C_{10} standard added (9/4/80)



(b) Standard, blood spiked with 0.01 µg/mL perfluoro-n-octanoic acid (0.007 µg F/mL) (9/4/80)



(c) Standard, blood spiked with 0.9 µg/mL perfluoro-n-octanoic acid (0.6 µg F/mL) (9/10/80)



(d) Sample E22514-28-1 (9/10/80)

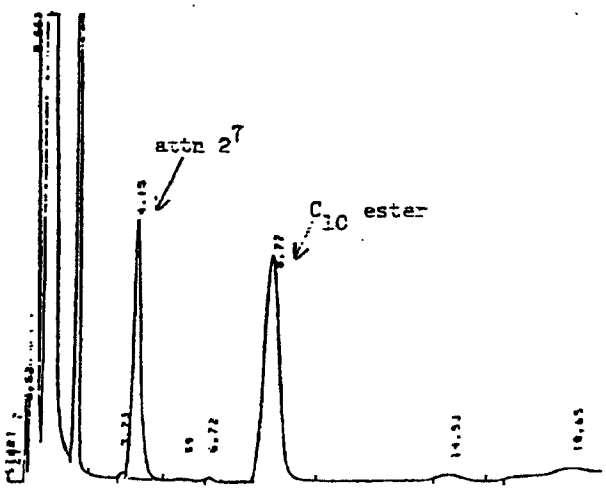


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FIGURE 3 - CALCULATION OF CORRECTED PEAK HEIGHTS AND CALIBRATION PLOT

(a) Peak height values for runs of seven standard and five sample solutions (duplicate runs were made, and shown on the calibration plot, but only one is included in the table).

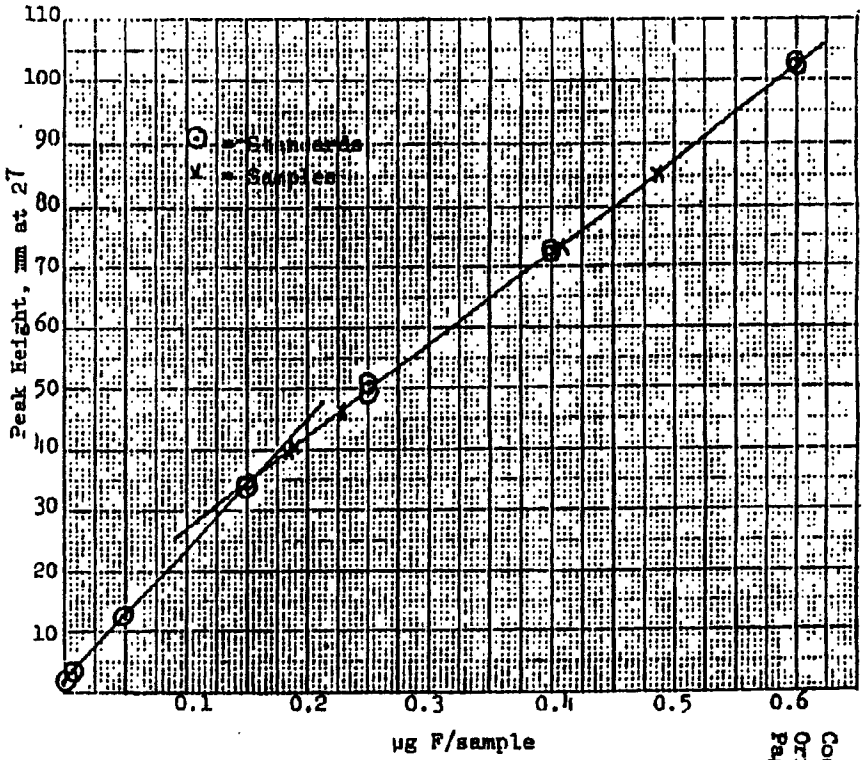
Solution	$[C_8]$, µgF/sample	Run No.	Peak Height, mm at attn 2^7		
			Raw C_8	Raw C_{10}	Corrected $C_8 \times \frac{79}{C_{10}}$
	Added				
Standards	0.601	8	93	76	102
	0.399	6	71.1	78.1	71.9
	0.250	10	49.9	77.5	50.9
	0.149	12	34.1	79.9	33.7
	0.0480	23	12.6	78.2	12.7
	0.0070	4	3.80	81.7	3.67
	Blank + C_{10}	3	1.95	80	1.93
				Avg. (11 values) = 79 ± 3	
	Calculated*				
Samples	0.491	9	87.8	80.8	85.8
	0.409	7	72.5	78.5	73.5
	0.230	5	48.3	82	46.5
	0.191	11	36.5	70.8	40.7
	0.186	20	38.1	75.5	39.9

*Sample concentrations calculated from linear least squares fit,

0.6-0.15 ppm standards (8 points): H = 11.98 + 150.3 [F]

0.15-0 ppm standards (5 points) : H = 2.13 + 214.4 [F]

(b) Calibration plot, corrected C_8 peak height vs. concentration (expressed as fluorine)



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APPENDIX I

Modifications for Capillary GC Analysis

As discussed in the method, a capillary column can be substituted for the original packed column in analyses where separation of the C_8 isomers is necessary for quantification, or where determination of the isomer distribution is of interest. Chromatograms obtained with the column and conditions currently in use are shown in Figure 4. A wide-bore WCOT is used to permit large injections (1-3 µL, as with the packed column) for detection of low concentrations although the efficiency is probably less than that of a lower capacity column. The major isomer peaks are generally resolved well enough for quantification, however, or at least to indicate whether a significant peak is present (as in Figures 4c and d). Comparison of these chromatograms with those in Figure 2 shows that the analysis time is presently longer than with the packed column; this may be reduced by further column modifications.

Preparation of samples and standards is the same for both analyses. Modifications needed in apparatus, GC conditions, and calculations for the capillary analysis are as follows:

1. Apparatus (V)

   HP5830 GC with HP18803 Electron Capture Detector, equipped for splitless injection with glass capillary columns. A flame ionization detector should also be available on this or another capillary instrument.

   Glass injection port liners (inserts) for use with the capillary system in splitless mode.

   Silanized glass wool for packing injection port liners.

   Glass WCOT column, 50 m x 0.5 mm, OV-210 (high load). (The column currently in use is a custom-coated column from Alltech Associates. It can also be specially ordered from Quadrex or Chrompack, but is not presently available as a stock column.)

2. GC Analysis (IX, Procedure, Part D)

   Instrument and column as above; straighten the column ends, recoat them with FFAP in CH_2Cl_2, and install the column according to the manufacturer's instructions.

   Before inserting the glass injection port liner, pack it loosely with about 1 cm silanized glass wool. This should be positioned just below the point of injection, to prevent nonvolatile sample components from reaching the column.

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GC Conditions:

Temperatures:	Injection port	200°C
	Detector	325°C
	Column oven programs	(a) 15 min 55°C, 8°/min to 130°C, 5 min 130°C
		(b) 10 min 60°C, 2°/min to 76°C then 6°/min to 120°C, 6 min 120°C

Carrier and make-up gas: 90% argon/10% methane
column pressure 3 psig, about 2.7 mL/min flow at 100°C
make-up about 26 mL/min (total flow about 30 mL/min)
splitter about 100 mL/min

Injection volume: 2 µL, splitless injection with 60 sec hold before opening splitter vent

Sensitivity: Attenuation as needed to keep peak height measurable 2^5-2^{13} on HP5830

Run time: About 30 min (depending on program) plus cool-down.

Temperature program and column flow rate will vary with the condition of the column, instrument configuration, carrier gas, etc., and must be chosen and modified as needed to maintain adequate resolution. Column oven program (a) was used for the chromatograms in Figure 4; program (b) and similar ones have also been used.

After installing the column and establishing the conditions above, check the ECD base frequency and noise level according to the manufacturer's instructions to insure that they are stable and within acceptable limits. Base frequency should also be checked before each day's operation.

Maintenance of a clean system is especially important for temperature-programmed ECD analyses at high sensitivity. A clean injection port liner and new septum (low-bleed) should be installed at the end of each day, and the column oven temperature raised to 130°C (or the maximum program temperature) overnight and when the instrument is not in use.

3. Calculations (X)

The calculations are done in two parts, first determining the concentration of the main component, then adding a percentage correction for the secondary isomers.

(a) Concentration of perfluoro-n-octanoate

Calculation of normalized C_8 peak values, preparation of the calibration curve, and use of it and the sample weights to calculate µg/g for each

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sample are done as in the original method. Since only the area of the main peak is used, however, the concentrations of the standards must first be corrected to correspond to it rather than to the total C_8 concentration. For the perfluoro-n-octanoic acid standard used in this laboratory, the concentration of straight-chain acid is taken to be 95% of the total (See Note 4 above).

For some samples, such as the one shown in Figure 4d, the isomer peak just ahead of the main peak may not be large enough to be resolved but still makes a significant contribution to the total. Peak height rather than area can be used to minimize the error in quantification of the main peak.

(b) Correction for secondary components

(1) Relative response factors

As discussed in Note 4 above, ECD response for the branched isomers is higher than that for the straight-chain ester, so that relative response factors must be determined in order to calculate their concentrations. Since FID response appears to be more nearly equal for all of the isomers, the factors can be estimated by comparing peak area percent values for standards analyzed on the same column by the two different detectors.

Differences in carrier gas, reagent interference, and relative peak sizes make it difficult to reproduce the chromatography exactly, but conditions should be chosen to make the analyses as similar as possible. Calculate average area percent values by both detectors for the groups of five C_8 isomer peaks, then use the ratios to determine ECD response factors relative to the main peak, as in the following example for an FC-143 standard:

	Peak Number, 14.95-17.22 min in Figure 4b				
	#1	#2	#3 (main peak)	#4	#5
ECD area percent (average of several runs)	7.38	11.94	51.76	10.02	18.91
FID area percent (average of several runs)	3.55	4.38	72.88	8.45	10.73
$F_i' = \left(\frac{A_i}{A_{main}}\right)_{ECD} \times \left(\frac{A_{main}}{A_i}\right)_{FID}$	2.93	3.84	1.00	1.67	2.48

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For perfluoro-n-octanoic acid standards (Figure 4a) the only measurable isomer peak is #5. The factor calculated for it generally differs somewhat from that for FC-143 standards, as might be expected from the incomplete resolution and different contributions from neighboring peaks. For samples ranging in type between the two standards, the average factor is usually taken.

(2) Percent correction for total concentration

For each sample run, use the peak areas and response factors to calculate the concentration of isomer peaks relative to the main peak as in the following example (peak numbering as in the factor calculation above):

Figure 4e; Sample 80-68609, Run #21, 12/30/80
Main Component Concentration 7.63 µg/g F

Peak No.	F_i'	Peak Area (integrator units)	% of main peak $=\left(\frac{A_i}{A_{main}}\right)\times\left(\frac{10^2}{F_i'}\right)$	
1	2.93	83 560	4.80	Total % correction = 24.1
2	3.84	70 460	3.09*	
3	1.00 (main peak)	59 4000	(100)	7.63 x 1.241 = 9.5 ppm F total
4	1.67	32 430	3.27**	
5	2.73	20 9300	12.91	

*Peak #2 is frequently visible as a shoulder, but not resolved sufficiently for quantitative measurement. Depending on the size, the correction may be considered insignificant or can be estimated by comparison with the other isomers.

**This value is probably too high, by comparison with peaks #1 and #3 in the chromatogram in Figure 4e. Since the correction is only a few percent, however, the effect on the total concentration will not be appreciable.

These calculations clearly involve many approximations, especially for samples unlike either of the standards in isomer distribution. Determination of the isomer concentrations is difficult in those cases, since the "response factors" for a group of poorly resolved peaks will be influenced by the relative sizes and contributions from each other as well as by detector response. For peaks #2 and #4 in particular, the individual values must be considered estimates only. Since the contribution of each isomer to the

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total concentration is usually small, however, the overall uncertainty will probably still be less than if the composite peak were used and no correction is made for differences in composition. In most of the blood samples examined to date, the composition has appeared similar to that of perfluoro-n-octanoic acid (See Note 4), so that the isomer correction is small and calculated for the well-resolved peaks 1 and 4. For those samples, the packed column analysis should give equivalent results (within the uncertainty of the method), but the capillary analysis has the advantage of verifying that a significant error has not been introduced by undetected isomer peaks.

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/30/80
conditions as on p.18
mperature program:
c 55°C, 8°/min → 130°C,
130°C

art speed 1 cm/min

tenuation 2^{10} for 20 min,
after

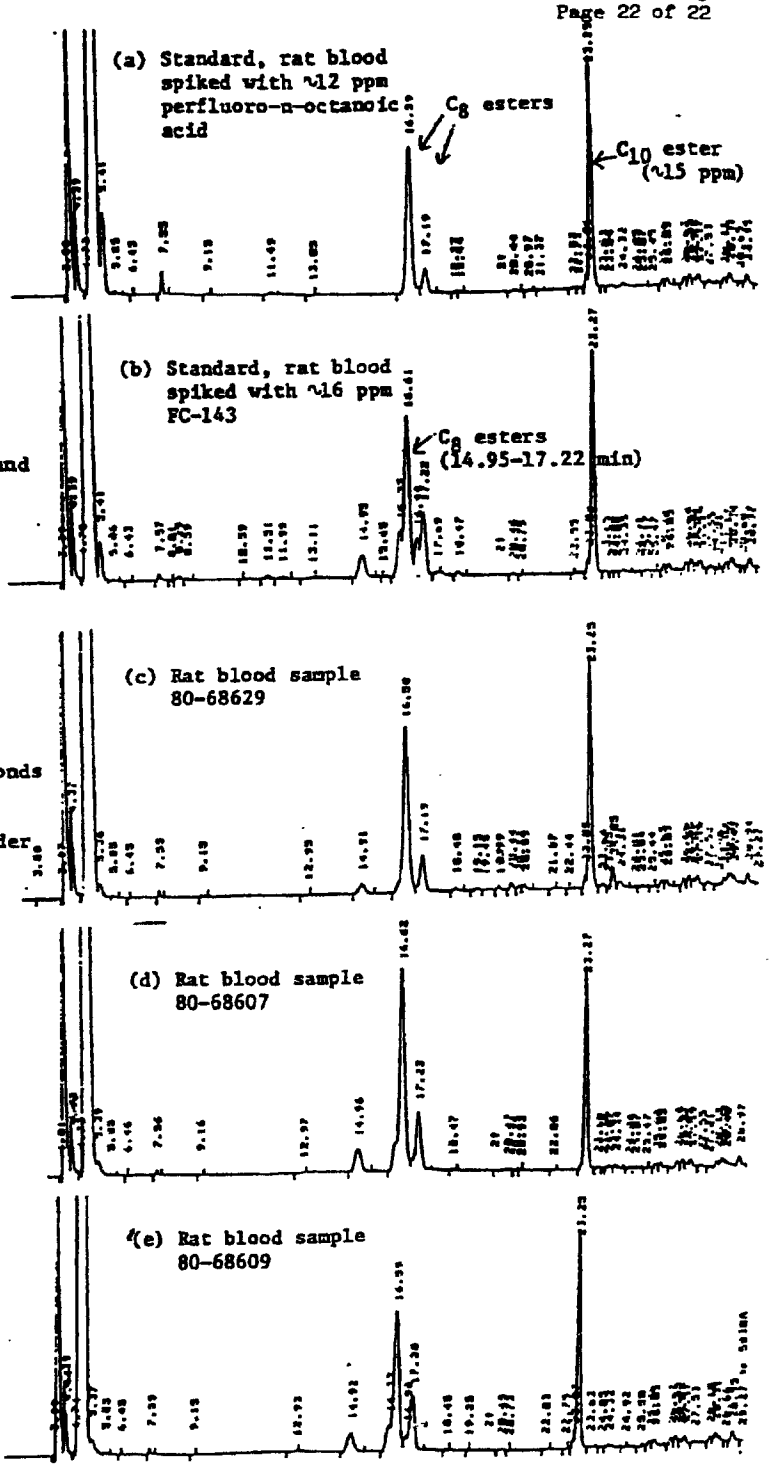
thyl perfluoro-n-octanoate
pears at 16.6 min, branched
omers at 14.9, 16.3, 17.0, and
.2 minutes.

r comparison with the
matograms in Figure 2
ed column analysis):

e peak at 14.9 min corresponds
that at 3.7 min

e peak at 16.3 min lies under
e main peak

e peaks at 17 and 17.2 min
pear as a shoulder on the
ck of the main peak



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FOR DUPONT
USE ONLY

To: file
From: R.A. Brandenburg

Dordrecht, 16-7-1998

Analysis of C-8 in blood, status of interlab comparison

Introduction
In december 1997 Dordrecht Works has taken blood samples of the Teflon E-shift workers to be analyzed for C-8 content. For reasons of cost effectiveness and convenience the samples were brought to Shell VGW-lab in Pernis, but a duplicate of every other sample was also sent to National Medical Services lab, who is performing C-8 in blood analyses for Parkersburg for many years.

Summary
The differences between the two labs were unacceptably high: especially in the high numbers Shell VGW gave a result 2 - 3 times higher than NMS. We have been communicating with both labs, and Shell has done a lot of tests to see what could be the reason of the differences.
At this time Shell reports results similar to NMS, with the exception of one sample, where there is a factor 10 difference. We have agreed to resample the person who gave this blood and have it analyzed by both labs. NMS will also investigate the data on their file, to see if anything strange was the matter with this particular sample. It was agreed that this one resample is free of charge.

Discussion
One important difference is that NMS prepares the sample by freeze drying, followed by esterification, while Shell VGW has no ready access to a freeze dryer, so they use an extraction method. The extraction solvent is evaporated, and the sample is esterified and injected on a GC-MS system.
The first extraction was with hexane, but this gave a recovery of only 10 - 15 %. Addition of hexane to acidified old blood gave lumps and looked unreliable, although with fresh acidified blood there was no visual problem. Extraction with ethyl acetate gave a clear extract both with old and fresh blood, and a recovery of 50 %.

We came to some other interesting conclusions which may interest others who are working in this field [redacted]

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1. They started with the use of C-10 as an internal standard, but changed to C-9 when they heard that C-10 contains C-8 as an impurity. However, during the investigation it turned out that most blood samples also contained C-9 before adding internal standard. We confirmed that Dordrecht Teflon workers have been exposed to C-9. This caused a significant error in the analysis.
NMS uses C-10 as an internal standard, at such a low level that C-8 impurity is insignificant.

2. Bloodsamples also contain small amounts of C-10. This must be because C-10 is an impurity in C-8, so if workers are exposed to C-8, they are also exposed to C-10.
So this gives an error if C-10 is used as an internal standard at low levels, and the workers have high levels of C-8..

3. Extraction recovery of C-9 is 70 % vs C-8 50 %. This means that you cannot extract more than once, for the ratio C-8/C-9 will change with every extraction step.
A similar phenomenon is expected for C-10.

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2nd Draft Trip Report

Visit to National Medical Services Laboratory (NMS)

Monday, January 29, 2001

Mary A. Kaiser, Ph.D.
DuPont Corporate Center for Analytical Sciences

Summary

At the request of Barbara Dawson (DuPont DCSE), on January 29, 2001, Daryl Cobranchi and I visited National Medical Services Laboratory in Willow Grove, Pennsylvania, to review their data and procedures for the determination of perfluorooctanoic acid (PFOA) in blood samples taken in 1999 and 2000. After a discussion of the data and procedures with two of the scientists involved in recent data collection, we concluded that the concentrations reported for samples 386340-386389 and 452284-452329 were below the level of quantitation. The reported numbers are also not meaningful since the calculated values were significantly below the level of the lowest standard that the laboratory had run. We requested that NMS run lower concentration standards in the future and that they look at some common interferences to ensure that there was not a problem with coeluting peaks.

Detailed Report

National Medical Services (NMS) is a full-service, independent laboratory featuring a rather comprehensive schedule of analytical and consultative services in therapeutic drug monitoring, environmental / occupational toxicology, forensic toxicology, criminalistics and research &development. They work almost entirely with biological samples such as blood, urine, hair, serum, and plasma. They are accredited or licensed by 16 agencies such as the DEA, Pennsylvania Department of Health, and the College of American Pathologists. NMS is involved in ongoing proficiency testing with a number of these agencies. In May, 1999, Sue Mileti (DCSE), Barbara Larsen (CRD, CCAS), Barbara Dawson, and I visited NMS to see if they had the resources to do some additional development work for DuPont as well as to review the status of the PFOA in blood measurements they had done in the past. We concluded then that they had the resources in place to continue to measure PFOA in blood at the levels that they had measured in the past, but they did not have the personnel to do additional method development.

The NMS method for PFOA in blood is based on a method developed by DuPont in the 1980s. DuPont Polymer Products analytical group (now CCAS) used this method at the Experimental Station to measure PFOA levels in blood of DuPont workers from Washington Works, West Virginia. It involves adding an internal standard of perfluorodecanoic acid and sodium hydroxide to the whole blood, which is then freeze-dried. The acids are then derivitized to their methyl esters with methanolic hydrochloric acid, which is then extracted into hexane. Analysis is done by high-resolution capillary gas chromatography with electron capture detection (ECD) on a Hewlitt-Packard (now Agilent) 5890 gas chromatograph.

On January 29, 2001, Dr. Daryl Cobranchi (Sr. Res. Chem., CRD, CCAS) and I visited NMS to review recent data and procedures for the determination of PFOA in blood samples taken form workers at the DuPont Chambers Work site in Deepwater, New Jersey. Mr. Matthew McMullin, Director of Therapeutic Drug Monitoring and Clinical Toxicology, met us and introduced us to Dr. Laura Madrid, Group Leader for the Environmental Testing Section and Mr. Harry Garcia Flores, Chemist, in Dr. Madrid's group. Dr. Madrid has been head of the section since August 2000. She has a Ph.D. in toxicology. Mr. Flores is a bachelor's level analyst who has been with NMS since May 2000. Due to the short period of time between our request to review the data and our visit to the facility, NMS was not able to produce the raw data and reports on the 1999 samples. Unfortunately the chemist and the supervisor responsible for producing and approving the data and report were no longer with NMS so we were unable to interview them. We decided to concentrate then on a review of the 2000 data and procedures. Mr. Flores noted that he had a problem with linearity of the calibration curve. He also noted that he was uncomfortable reporting numbers lower than the lowest level quality control standard (100 parts per billion, (ppb)). Since all the levels that they reported were well below the 100-ppb level and since the calibration curve was not linear, we concluded that it was inappropriate to report specific numbers for these samples (386340-386389 and 452284-452329). Mr. Flores also pointed out that many of the samples showed high levels of background, making it difficult to ascertain if the peak was really due to PFOA. Since the measurement relies only on retention time and response by the ECD, other materials that come off the chromatographic column at the same time (coeluting peaks) might give a positive response, even if no PFOA were present and would be incorrectly reported as PFOA. We asked if NMS has looked for possible coeluting peaks. They had no recollection of having checked this system for coeluting peaks, so we asked them to check common species they generally found in blood such as nicotine, caffeine, and fatty acids which also might give a positive response to the ECD. We also asked them to give more information on reporting the results so that it would be clearer to us what they might have found.

Recommendations/Path Forward

In addition to looking for coeluting interferences, they will run a 50 ppb standard as part of their usual quality control process. If they see no peaks at the retention time of the methyl ester of PFOA, they will report "not detected". If they see a peak at the right retention time at less than the 50 ppb level (detectable, but not quantifiable), they will report it as "detected but below the level of quantitation" (LOQ). They will estimate the LOQ for each sample set.

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3701 Welsh Road
Willow Grove, PA
19090
[redacted]

National Medical Services

November 9, 2001

Mary Kaiser, Ph.D.
DuPont Central Research & Development
[redacted]
Wilmington, DE 19880-0269
[redacted]

Dear Dr. Kaiser:

We have completed work on the development and validation of a new procedure for the analysis of PFOA in blood. Please find enclosed an updated Test Information Summary Sheet and a summary of our findings. As always, we look forward to and welcome discussion concerning the particulars of this analysis. Specifically we greatly anticipate your comments concerning the proposed methodology change.

Sincerely,

L. Labay

Laura Labay
Group Leader

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PFOA Method Change Proposal
November 4, 2001

Background:

In an attempt to better certain aspects of the method currently in place to test for the presence and amount of perfluorooctanoic acid (PFOA) a new sample preparation procedure was developed and validated.

In brief, an internal standard (perfluorodecanoic acid) is added to the sample and the acids derivatized to their methyl esters utilizing methanolic HCl. All derivatives are then extracted into hexane prior to analysis by GC-ECD. The main advantages of using this new procedure in conjunction with the results of the validation for it are outlined and discussed below.

Reporting Limit:

The reporting limit for this analysis has historically been 10ppb and in this regard it is of importance that this value be consistently achievable. However, during the course of analysis we observed interferences that did not allow us to reproducibly detect this critical 10ppb point. In essence, this point was "buried" in the baseline and as a consequence the reporting limit had to be increased to a greater value. Investigation revealed that this problem was in fact due to one of the reagents that used during the sample preparation part of the procedure. Because purchasing fresh material did not alleviate this problem, it was determined that a new method be developed.

- By using the proposed method the interferences that caused the problem detailed above are no longer present. A reporting limit of 10ppb is consistently obtained (See Figure 1).

Patient Results:

To test the validity of the method 33 patient samples, along with the appropriate quality controls, were analyzed using both types of sample preparation procedures and their results compared.

- With the exception of four patient samples, all results are comparable with values not differing by more than ± 30%.
- The patient samples where this criterion did not hold true were samples where the described interferences were present.

Overall Conclusions:

1. A reporting limit of 10 ppb is consistently obtained.
2. Interferences that were observed and, in some samples, affected accuracy of results are no longer present.
3. Patient results are comparable when analyzed using both methods.
4. The greater ease of sample preparation allows us to handle a higher volume of samples at one time.

NAME OF TEST: PERFLUOROOCTANOIC ACID NMS # 3425

SYNONYMS: PFOA, FC-143 Component, Perfluorocaprylic acid

ANALYTE CLASSIFICATION: Fluorinated Organic Acid

METHOD PRINCIPLE: This test is a quantitative analysis of perfluorooctanoic acid in whole blood and serum specimens. This is achieved by adding an internal standard (perfluorodecanoic acid). The acids are then derivatized to their methyl esters with methanolic HCl, which are then extracted into hexane.

Analysis is by gas chromatography with an electron capture detector on a DB-1701 capillary column.

ALTERNATIVE METHODS: None available

SPECIMEN REQUIREMENTS:

Specimen	Requested Volume	Aliquot Volume	QNS Volume
Blood	4.0 mL	1.0 mL	0.5 mL
Serum	4.0 mL	1.0 mL	0.5 mL
For Tissue & Other Specimen Types, Call Lab.			

SPECIAL HANDLING: Store refrigerated.

REPORTING LIMIT: 10 ng/mL

TAT: Set-up on a by-arrangement basis.

PHARMACOTOXICOLOGIC DATA: Little toxicological data is available on perfluorooctanoic acid. It is known to have a very long elimination half-life.

LIMITATIONS OF METHOD:

1. Quantitative results cannot exceed the highest working standard or be less than the lowest working standard for that run.
2. There are no known interferences for this analysis.

REFERENCES:

1. Belisle, J. and Hagen, D.F., A Method for Determination of Perfluorooctanoic Acid in Blood and Other Biological Samples, Analytical Biochemistry, 101, 369-376 (1980).
2. Ubel, F.A., Sorenson, S.D., and Roach, D.E., Health Status of Plant Workers Exposed to Fluorochemicals - A Preliminary Report, American Industrial Hygiene Association Journal, 41, p. 584 (1980).

Figure 1: Low point (10ppb) on calibration curve using liquid extraction procedure.

P:

Software Version	: 6.1.2.0.1:D19	Date	: 4/16/01 2:48:53 PM
Operator	: lamadrid	Sample Name	: Low Curve: 10 ng/mL
Sample Number	: 053	Study	: Homemade MeOH:HCl
AutoSampler	: NONE	Rack/Vial	: 0/0
Instrument Name	: E03	Channel	: A
Interface Serial #	: 7230910097	A/D mV Range	: 1000
Delay Time	: 0.00 min	End Time	: 21.00 min
Sampling Rate	: 7.1420 pts/s		
Volume Injected	: 1.000000 ul	Area Reject	: 100.000000
Sample Amount	: 1.0000	Dilution Factor	: 1.00
Internal Standard Amount	: 1.0000		
Data Acquisition Time	: 4/12/01 11:42:30 AM	Cycle	: 38

Raw Data File : \\Pe42001\MainLab\Env\E0-3\Data\041101\PFOA\pfoa-041101hgf-038.raw <Modified>
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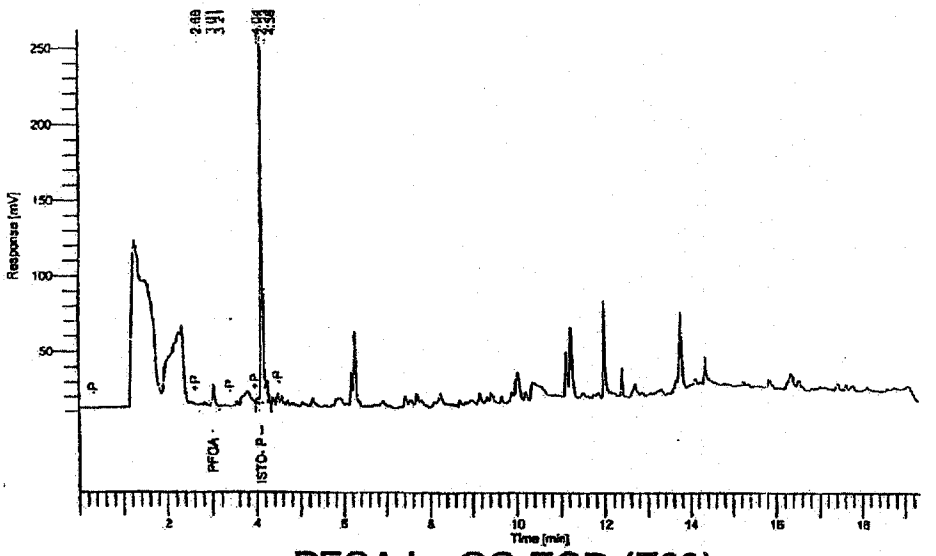


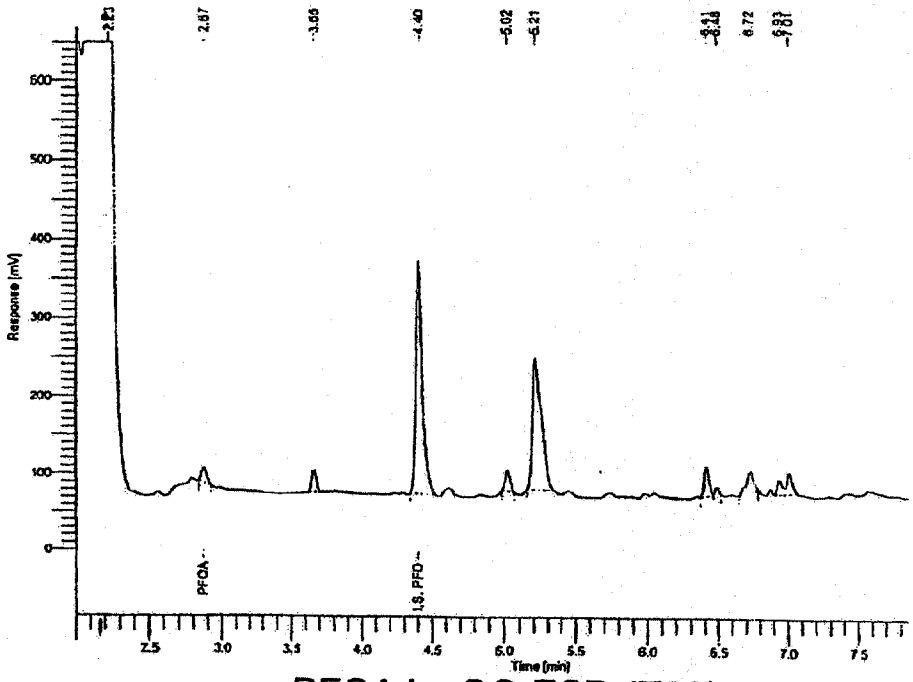
PFOA by GC-ECD (E03)

Peak #	Time [min]	Rel. RT	Area [µV·s]	Height [µV]	Area/Height [s]	ISTD Resp Ratio	Blank Column	Component Name	Concentration ng/mL
3	3.008	0.733	48421	14846	3.262	0.0627		PFOA	9
7	4.105	1.000	636461	236754	2.688	1.0000		ISTD- PFOA	———
			684882	251600		1.0627			9

Figure 2: Freeze Drying Method (Low QC)

Software Version	: 6.1.2.0.1:D19	Date	: 4/15/01 4:15:44 PM
Operator	: hagarcia	Sample Name	: Low QC
Sample Number	: 025	Study	: WL#311904
AutoSampler	: NONE	Rack/Vial	: 0/0
Instrument Name	: E03	Channel	: A
Interface Serial #	: 7230910097	A/D mV Range	: 10000
Delay Time	: 0.00 min	End Time	: 21.00 min
Sampling Rate	: 10.0000 pts/s		
Volume Injected	: 1.000000 mL	Area Reject	: 100.000000
Sample Amount	: 1.0000	Dilution Factor	: 1.00
Internal Standard Amount	: 1.0000		
Data Acquisition Time	: 4/7/01 6:23:55 PM	Cycle	: 25

Raw Data File : \\pe42001\MainLab\Env\E0-3\Data\040701\PFOA-040701HGF-025.raw <Modified>
Result File : \\pe42001\MainLab\Env\E0-3\Data\040701\PFOA-040701HGF-025.rst
Inst Method : \\pe42001\MainLab\Env\E0-3\Methods\PFOA 0-1000 curve-121600 from \\pe42001\MainLab\Env\E0-3\Data\040701\PFOA-040701HGF-025.rst
Proc Method : \\pe42001\MainLab\env\e0-3\data\040701\pfoa 200-4000-040701.mth
Calib Method : \\pe42001\MainLab\env\e0-3\data\040701\pfoa 200-4000-040701.mth
Sequence File : \\pe42001\MainLab\Env\E0-3\Data\040701\PFOA-040701HGF.seq



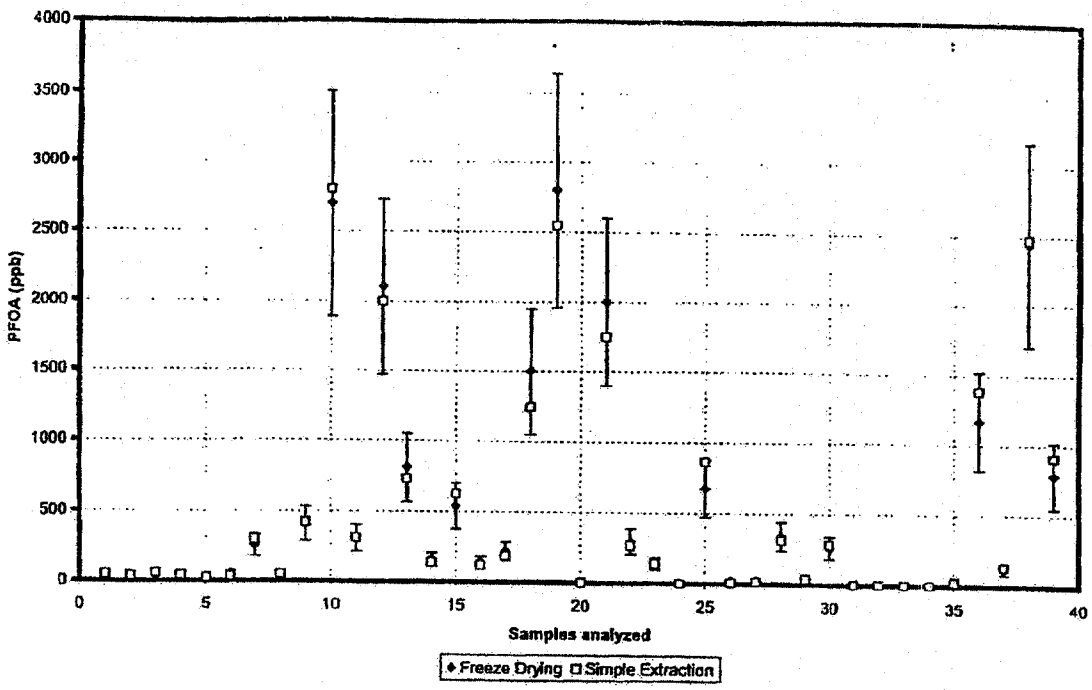
PFOA by GC-ECD (E03)

Peak #	Time [min]	Rel. RT	Area [µV·s]	Height [µV]	Area/Height [s]	ISTD Resp Ratio	Blank Column	Component Name	Concentration ng/mL
2	2.871	0.652	45541	18614	2.447	0.0624		PFOA	34
4	4.401	1.000	909923	298336	3.050	1.0000		I.S. PFDA	
			955464	316950		1.0624			34

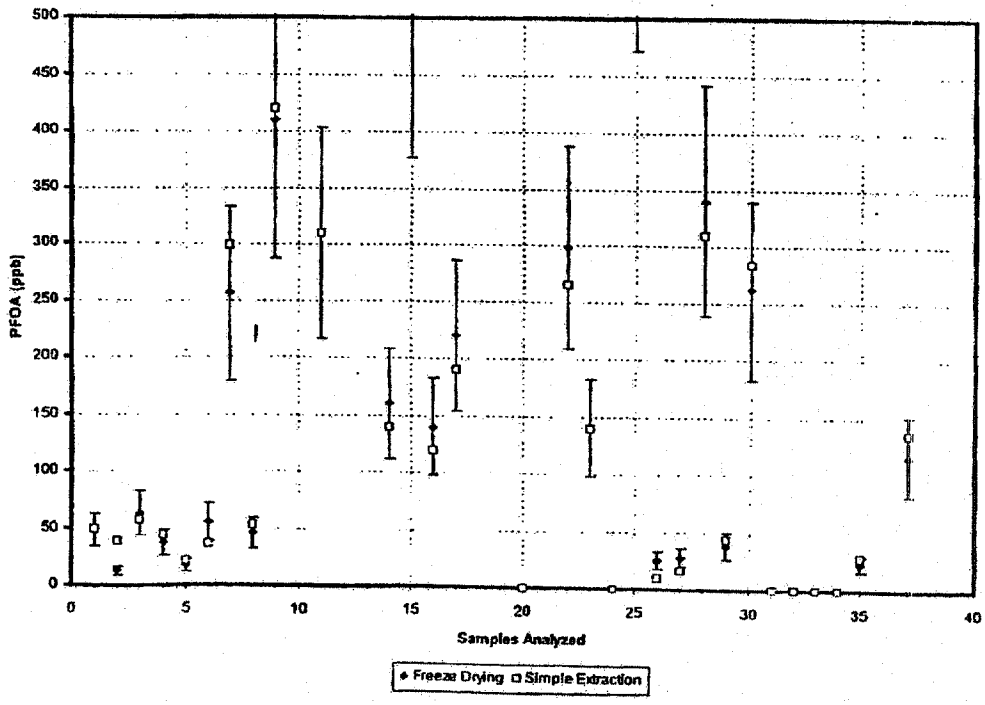
PFOA Method Comparison Freeze Dried Method versus Liquid Extraction Method of Perfluorooctanoate methyl ester from Blood

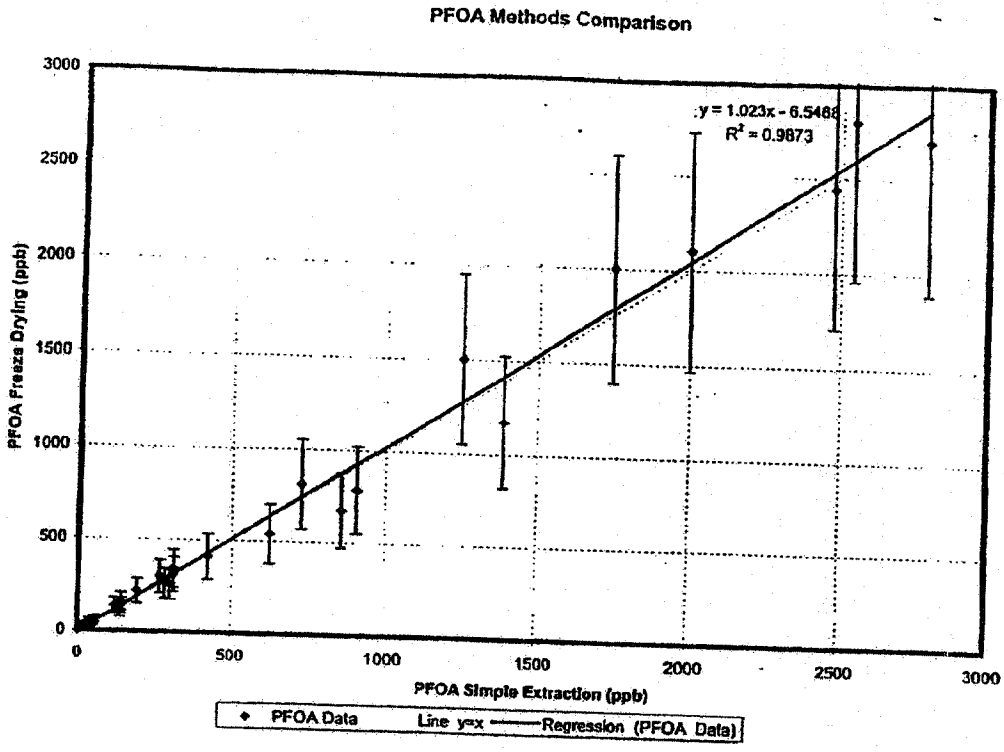
ample umber	Control Number	FreezeDrying PFOA Ht.	ISTD Ht.	ISTD Resp.	ng/mL	Liquid Extraction PFOA Ht.	ISTD Ht.	ISTD Resp.	ng/mL	% diff > +/- 30%
1	Low QC	17222	243073	0.071	48	22049	256135	0.086	49	2
2		8053	247169	0.033	13	20971	281763	0.074	38	98 **
3		21927	252004	0.087	63	27751	291816	0.095	57	10
4		12329	208416	0.059	37	24076	297100	0.081	44	17
5		8168	212227	0.038	18	15910	285704	0.056	22	20
6		21538	274340	0.079	55	21841	303446	0.072	36	42 **
7	Mid-QC	50612	183210	0.276	256	79640	243951	0.326	299	15
8	Low QC	17312	251466	0.069	46	24268	273951	0.089	53	14
9		76733	195603	0.392	410	130769	307048	0.426	420	2
10		71339	253949	0.281	2700	85973	281786	0.305	2800	4
11		71436	226788	0.315	310	101613	300800	0.338	310	0
12		60243	256633	0.235	2100	68749	293512	0.234	2000	5
13		116082	194232	0.598	810	207364	325202	0.638	730	10
14		34108	184427	0.185	160	60516	340561	0.178	140	13
15		39543	247914	0.160	538	28829	291402	0.099	627	15
16		40585	238556	0.170	140	46740	302389	0.155	120	15
17		56678	233943	0.242	220	68624	303009	0.226	190	15
18		45512	255324	0.178	1500	26280	266231	0.099	1249	18
19		63205	218966	0.289	2800	73665	258508	0.285	2543	10
20		2178	216499	0.010	0	5060	310214	0.016	0	N/A
21		49680	220045	0.226	2000	55698	263645	0.211	1752	13
22	Mid-QC	68453	223282	0.307	298	86938	295411	0.294	265	12
23		40573	249224	0.163	140	58153	331323	0.176	140	0
24		3309	236671	0.014	0	7399	321543	0.023	0	N/A
25		47659	248200	0.192	673	228640	323630	0.706	860	24
26		10975	239652	0.046	25	12966	303100	0.043	10	86 **
27		12113	249430	0.049	28	15902	314680	0.051	17	49 **
28		78299	229317	0.341	340	100095	302138	0.331	310	9
29	Low QC	10037	167416	0.060	38	24353	304819	0.080	44	15
30	Mid QC	52963	191978	0.276	261	85457	274960	0.311	283	8
31			139762	0.000	0	7902	298280	0.026	0	N/A
32		3518	198673	0.018	0	9273	281886	0.033	0	N/A
33			153525	0.000	0	10052	303660	0.033	0	N/A
34			149912	0.000	0	7813	326413	0.024	0	N/A
35		7358	168129	0.044	23	21948	343206	0.064	29	23
36		79791	264217	0.302	1169	55987	318673	0.176	1386	17
37		19411	137065	0.142	117	57208	329714	0.174	136	15
38		117280	263930	0.444	2438	90354	323824	0.279	2477	2
39		59401	272670	0.218	784	42979	336052	0.128	909	15
AVG			220457				300294			
SD			37941				24257			
RD (%)			17				8			

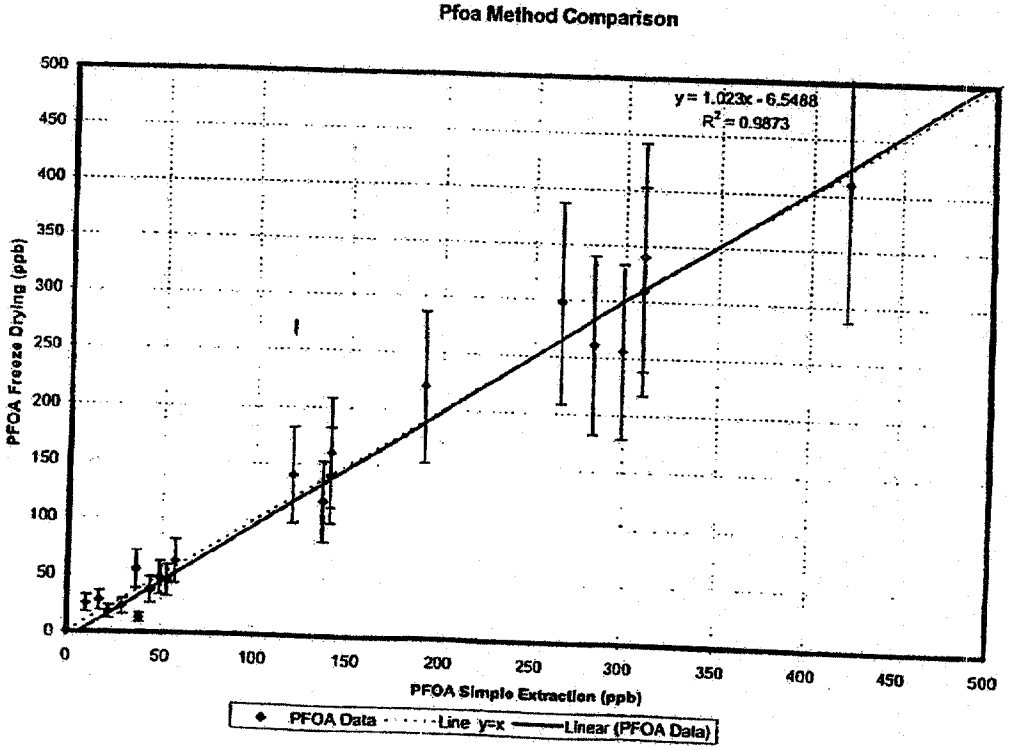
PFOA 30% Error Bars (0-4000 ppb)



PFOA 30% Error Bars (0-500 ppb)




PFOA Methods Comparison
y = 1.023x - 6.5488
R² = 0.9873
PFOA Freeze Drying (ppb)
PFOA Simple Extraction (ppb)
0
500
1000
1500
2000
2500
3000
PFOA Data
Line y=x
Regression (PFOA Data)


Pfoa Method Comparison
y = 1.023x - 6.5488
R² = 0.9873
PFOA Freeze Drying (ppb)
PFOA Simple Extraction (ppb)
0
50
100
150
200
250
300
350
400
450
500
PFOA Data
Line y=x
Linear (PFOA Data)

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Perfluoroctanoic acid in plasma

Author: H-W.Hoppe examiner: Leng

Draft 22/11/01

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1 Basis of the procedure

Perfluoroctanoic acid is extracted with pH 10 as ion pair in tert-butylmethylether and derivatised with benzyl bromide. The determination takes place with GC/MS in the EGG - or NCI mode. Concentrations of interest for industrial medicine and environmental medicine in the plasma can be determined accurately.

2 Devices, chemicals, solutions

2,1 Devices

HP5890 with Split Splitless injection system and autoinjector
HP7673 mass-selective detector e.g. Kodiak 1200 v. Fa. Bear

Heating block with drillings for glass tube
Heatable evaporation block with blower
shaker

centrifuge (3000 - 4000 RPM) vacuum centrifuge (e.g. SpeedVac of SAVANT)
variable adjustable 100 µl and 1 ml pipettes (e.g. of EPPENDORF)
10 µl 100 µl glass syringes (e.g. of Hamilton)
Autosampler
2 ml vials (e.g. of HEWLETT-PACKARD)
10 ml glass vials with cap
20 ml glass vials with ground glass stoppers

2,2 chemicals

tert.Butylmethylether (TBME)
acetone
benzyl bromide Aldrich B17905
pig pool serum
linear Perfluoroctanoic acid
(PFOS) of Aldrich (Cat.Nr. 171468)
Perfluornonanoic acid (PFNS) of Aldrich (Cat.Nr. 394459)

2,3 solutions

-0,25 M carbonate buffers pH 10 beginning: 4.2 g NaHCO3 (Merck 106329) and 14.3 g Na2CO3 Decahydrate (Merck 106391) with water ad 200 ml solve
- 20 % (0.77 M) Tetrabutylammoniumhydroxide (TBA) in water of Merck (Kat.Nr. 818759)
- 0,5 M Tetrabutylammoniumhydroxide (TBA) in water beginning: 65 ml 20 % TBA + 35 ml water mix

2,3 comparison standards

2,3,1 initial solutions

Perfluoroctanoic acid (PFOA): Weigh 25 mg PFOA and with acetone add 25 ml exactly. End concentration: 1 mg/ml.

Perfluornonananoic acid (PFNA): Weigh and with acetone add 25 ml exactly. Final concentration 1 mg/ml.

2,3,2 Perfluoroctanoic acid dilution 1

In 10 ml measuring flasks an acetone , add 500 µl PFOA initial solution (1 mg/ml). With acetone fill to the mark. Final concentration: 50 µg/ml.

2,3,3 Perfluoroctanoic acid, dilution 2

In 10 ml measuring flasks add, to 100 µl PFOA dilution 2 (50 µg/ml) Fill to the mark with acetone.
Final concentration 0.5 µg/ml.

2,3,4 Perfluornonanoic acid dilution 1 (internal standard)

In 10 ml measuring flasks take 10 µl PFNA initial solution (1 mg/ml). With acetone fill to the mark. Final concentration: 1 µg/mL

2,3,5 calibration standards

PFOA solutions are made by dilution with pig plasma calibration standards, which contain PFOA concentrations between 5000 and 5 µg/l.

Pipetting pattern

Volume of the PFOA dilution 1 (50 µg/ml) volume of the PFOA dilution 2 (0.5 µg/ml) pig plasma concentration in the comparison standard µl µl ml µg/l

µg/l = ppb

50 µl -- 0.5 5000 25 µl -- 0.5 2500 5 µl -- 0.5,500 -- 100 µl 0.5,100 -- 50 µL 0.5 50 -- 10 µL 0.5 10 -- 5 µL 0.5 5 -- -- 0.5 0

For questions according to industrial medicine it is sufficient to set calibration standards within the range 100 to 5000 µg/l. For measurements within the environmental medical purposes, standards are necessary within the range of 5 to at least 100 µg/l.

3 Sampling and sample preparation

3,1 Sampling and sample preparation

Sampling:

Blood withdrawal e.g. by means of EDTA - Sarsted Monovette. The plasma production can be accelerated by centrifugation. The blood withdrawal system should have been examined before use for zero blanks.

Execution:

1. The beginnings for samples and calibration standards take place in 10-ml-Gewinde-Roehrchen 2nd standard internal on 0,5 ml plasma 50 µl (PFNA Verd. 2) and 2 ml 0,25-M-Carbonate-Buffer(pH 10) gives and examines (with indicator paper) 3rd 1 ml 0,5-M-TBA-Loesung and 3 to pH value each ml TBME in addition-gives; then approx. 60 min intensively mixes (over head shakers, e.g. HEIDOLPH) 4th following centrifugation 5th 1.7 ml clear TBME excerpt into a Autosampler ampule transfers and

with approx. 35 C under air flow to dry ones restricts (is uncritical)
6. the arrears in 100 µl acetone takes up to put 20 µl benzyl bromide the solution to point-in-corrodes transfers and zudeckeln. Then approx. 45 min on approx. 75 C heat up.

(when investigations according to industrial medicine the derivatization can be accomplished alternatively in 500 µl acetone.)
7. Measurement in the EI mode or NCI mode

4 Conditions of work by gas chromatography

Detector: KODIAK 1200 (EI mode) gas chromatograph: HP 5890 II capillary column: RTX 5; -30 m, 0,25 mm I.D. x 0,5 µm film Taegergas: Helium 4,6 form: 11 psi temperature program: 1 min with 70 oC, then with 10 oC/min on 140 oC, with 30 C/min on 290 C and 2 min bake. Injector: Split splitless with 250 oC evaporator tubes: 2 mm I.D., task of sample deactivates: 2 µl Splitless time: 1 min transfer LINE: 280 oC electron collision ionization: 70 eV

EI MS conditions masses for PFOA: m/z 504 and 505 (Qualifier) masses for PFNA: m/z 554

NCI MSMS conditions: PFOA: Decomposition of m/z 413 after 369 PFNA: Decomposition from m/z 463 to 419 CI gas: Methane; Pouring jerk: 6.5 torr collision gas: Argon; 1.2 mTorr collision energy: 10 V

4 Analytic regulation

2µl is injected in each case in the GC.
Usually single injections are sufficient. If the measured values lie outside of the linearity of the calibration curve, then the samples are diluted and again regenerated. In each series a quality inspection sample is analyzed.

6 Calibration

For the production of a calibration curve comparison standards are set in pig plasma in accordance with the pipetting pattern in section 2,3,5 and regenerated as for plasma samples in section 3 described and analyzed according to section 4 by gas chromatography.

7 Computation of the results of analysis
On the basis the calibration curve, the associated concentration in the blood is determined.

8 Standardisation and quality assurance

For quality assurance will proceed, as in the TRgA 410 of the dangerous material regulation planned. With the individual analyses, precision and accuracy controls are analyzed.

9 Evaluation of the procedure

9,1 precision

For the determination of the precision doped pig plasma was examined. Measurements in the EI mode.

Spiking n Precision Precision mg/l into the series From day tons day VK (%) VK (%) 10 15 -- 8,2.5 10 4.77 -- 0.5 10 3.29 -- 0.1 10 5.00 --

9,2 accuracy

The correctness of the procedure was examined by regaining experiments with doped individual Human plasma proben. Measurements in the EI mode.

Spiking n Recovery guesses mg/l Mean (rank)

10 10 97 (89,1-107) 2.5 10 98.1 (78-107) 0.5 10 99 (80-110) 0.05 10 93 (78-116)

Selectivity comparison. Measurement of PFOA in the plasma vocationally not more exposed with EI-MS and NCI MSMS.

Person EI-GCMS NCI MSMS µg/l µg/l 1,9.6 10.8 2 5.4,6.6 3 3 3.5 4 4.3,4.8 5 3.5 5 6 2 3.1 7 3'1,5.1 8 5.2 7 9 3 3.7 10 4.8,5.4 blank 0.5,0,6

9,3 Detection limits

Under the indicated conditions of work and under taking a signal-to-noise ratio as a basis of 3:1 the detection limits for PFOA amount to 3 µg/l. in the EI mode. In the NCI MSMS mode is given the NWG at present by a blank value at a value of approx. 0.5 - to 1 µg/l. Those extrapolates detection limit amounts to approx. 0.2 µg/l.

9,4 Influences of noise

PFOA of test empties values at a value of approx. 0.5-1 were observed

µg/l. The causes are not finally clarified yet. The pig plasma used for calibration purposes is unloaded (PFOA < 1 µg/l) and from the blood withdrawal system no PFOA is set free.

Adsorption at Glass - or or plastic materials one did not observe.

10 Discussion of the method

The available GC-MS method been based on the procedure of M. Hanhijaervi et aluminium (1) for the quantification of PFOA by means of extraktive alkylation. From this the acid anion is extracted after integration with Tetrabutylammoniumhydroxide (TBA) as ion pair from the plasma and derivatised afterwards to the benzyl ester.

Already of M. Hanhijaervi et the aluminium (1) optimized buffer and TBA concentrations was invariably taken over. By the change of ethyl acetate against tert. Butylmethylether (TBME) as extracting agents the extraction temperature of 50 C could on ambient temperature be lowered and the evaporation of the excerpt to dry ones before the Derivatisierungsschritt be substantially accelerated.

After derivatisation with benzyl bromide in acetone the reaction mixture without further cleaning is chromatographed by means of GC-MS on a RTX5 30 m x 0.25 mm x 0.5 µm film thickness. GC columns with thinner film, e.g. HP5-MS 30 m x 0.25 mm x 0.25 µm, could be alternatively used. However the measuring solution had to be diluted of 0,1 to 0,5 ml, since in the more concentrated solution the benzyl bromide remainders unfavorably affected the peak form of PFOA with splitless injection (overloading the column).

Detection can take place with a MSD in the EGG or NCI mode (see spectra). If highest sensitivity is required, NCI GCMS or NCI GCMSMS is recommendable. The detection limit for NCI GCMS is given at present however by a test empties value in Hoehhe of approx. 0.5 µg/l. A parallel measurement with EI-GCMS and NCI GCMSMS at 10 did not load vocationally show that also with EGG-OFFICE-MS environmental medically relevant concentrations can be obtained at present sensitively and selectively. The determined PFOA of plasma results (2 - 11 ppb, n=10) is appropriate for a current HPLC MSMS study (Lit 2) in the lower range of values (< 5 to 35.2 ppb, n = 65).

During specific working place loading PFOA plasma concentrations within the lower ppm range were determined.

The procedure is uncomplicated, very sensitive and durable. The procedure characteristic data is good as very to designate. The procedure works is extended further to other fluoridated carbonic acids e.g. Perfluorheptane -, Perfuornonane and Perfluordecane acids. Likewise meaning Perfluoroctansulfononic acid can be determined however only by means of HPLC-MS (2).

Literature

1) M.Ylinen, H.Hanhijaervi et aluminium: Quantitative office determination OF Perfluorooctanic Acid as the benzyle ester in plasma and Urine. Arch.Environ.Contam.Toxicol. 14, 713-717 (1985)

2) K. J. Hansen et aluminium: Compound Specific, quantitative Characterization OF Organic Fluorochemicals in Biological Matrices. Environmental Science & Technology 35, 766-770 (2001)

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AR226-3402

TRIP REPORT: National Medical Services Laboratory (NMS), Willow Grove, Pennsylvania
Tuesday, January 29, 2002

Mary A. Kaiser, Ph.D.
DuPont Corporate Center for Analytical Sciences
Central Research & Development
E302/117B

Meeting Participants from NMS: Laura Labay (supervisor), Harry Garcia-Flores (analyst), Bob Klinger (QA manager), and Paul Delany (former analyst)

Summary: The probable reason for some of the differences in the levels of perfluorooctanoic acid (PFOA) in blood from 2000 to 2001 is the use of a new and improved analytical method for the 2001 samples.

Dr. Daryl Cobranchi, DuPont CR&D CCAS, and I visited NMS to determine why some blood PFOA levels from 2000 and 2001 did not agree, although the same laboratory ran them. The samples were taken from individuals at the DuPont Washington Works facility in West Virginia. The data below show that the results from 2000 for some of the same individuals are generally significantly lower than the results from 2000.

Job Description	2001		2000	
Granular Polykettle Operator	3.7	776395	8.5	495972
	3.7	776394	9.0	495964
	0.76	776413	1.7	495935
	2.9	776419	6.2	495955
	1.4	776388		
	0.55	776412		
	0.91	776415	0.80	495917
Fine Powder/Dispersion Autoclave Operator	2.9	776408	4.7	495925
	1.2	776406		
	1.9	776405		
	2.6	776397		
	1.9	776398	4.3	495946
	0.79	776399		
	1.9	776407	4.9	495916
	1.1	776411	2.4	495947
	0.49	776409		
Other DuPont Employees	1.1	776403	2.8	495941
	0.22	776396		
	0.39	776410	0.33	495906
	0.14	776401	0.22	495950
	0.33	776404		
	0.07	776414		
	0.45	776400		
	0.76	776413		
	0.60	776423		
	0.12	776416		
	0.23	776417		
	1.5	776421		
	1.3	776420		

	1.6	776422
ONYX Employees (* = PSA)	2.2	776392
	1.3	776393
	0.48	776386
	2.5	776391
	0.66	776387
	0.26	776389
	0.71	776385
	1.2*	776402

The most probable reason for the difference in the reported levels in the two sample sets is that NMS introduced a new method of sample preparation for our 2001 samples. The two methods (old and new) are described below.

Old Method
Perfluorooctanoic Acid (Freeze-drying)
Method#3425
Effective date: 12/92

New Method
Perfluorooctanoic Acid (w/out Freeze drying)
Method#3425
Effective date: November 1, 2001

The method was changed to reduce the interferences from the acetyl chloride peak impurity from the kit used in the old analysis. The interfering peak came immediately before the PFOA (methyl ester) peak, sometimes making the peak integration so difficult that the analyst had to manually integrate the PFOA peak. Because of the interference, the laboratory often could not reproducibly detect PFOA at the 10 ppb (10 ng/mL) reporting limit. In the new method the analyst makes up methylation reagent from high-performance liquid chromatographic grade methanol and concentrated (37%) hydrochloric acid. The data show that there is no interfering peak. The new method does a better job homogenizing the blood so that one can more easily extract a representative sample for gas chromatographic analysis with an electron-capture detector. The new method also uses less extraction solvent, improving the dilution factor fourfold.

A comparison of the two methods is given below:

New Method	Old Method
whole blood	whole blood
GC/ECD	GC/ECD
PFDA* internal standard	PFDA internal standard
5890 GC	6890 GC
HPLC-grade methanol/37% HCl	Alltech instant methanolic kit
0.5 mL hexane	2.0 mL hexane
no freeze drying	freeze drying
no NaOH	NaOH
no sonication	sonicate for 30 minutes
no water added	1 mL of water added
65-75% completeness of methylation (estimate)	100% completeness (estimate)

*perflurodecanoic acid (PFDA)

Overall, the new method seems to be more precise with better recoveries of spikes, especially at the lower levels.

A characteristic of the new method is lower % methylation reaction completion, although this is somewhat compensated for with the PFDA internal standard. Both the old and the new method use PFDA, which has measurable amounts of PFOA as an impurity. Retention of the PFOA methyl ester peak could be improved in both methods, perhaps by using a pefluorinated stationary phase. Both methods use the electron capture detector, which is not specific for PFOA (other compounds could co-elute causing an enhanced peak and higher reporting levels from what is actually present in the sample). This is especially important since the retention time is so short. Analytes with short retention times have increased probability of coelution with another material.

Conclusion: The NMS new method is an improvement over the old method. The 2001 results are more reliable than the 2000 results for our two sample sets. The determination could be improved by increasing both the sensitivity (10 ng/mL reporting level) and specificity.

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Site Manual for DuPont PFOA Screening

This site manual contains instructions and forms to support collecting, processing, and shipping clinical samples for the DuPont PFOA quarterly screening project.

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Sample Collection Supplies	2
Sample Processing Procedures	3
Sample Processing for the PFOA Assay	*3*
Packing and Shipping Frozen Samples	5
PFOA Sample Collection Record	6
Sample Collection Supply Reorder Form	7
Shipping Notification Form	8

Advion BioSciences contact:

Mr. David Hardwick
Director of Laboratory Operations
Advion BioSciences, Inc.
15 Catherwood Road
Ithaca, NY 14850

Phone: [redacted]
Fax: [redacted]
email: [redacted]

Company Sanitized. Does not contain TSCA CBI

Sample Collection Supplies

Sample collection supplies, sufficient for 24 subjects, are provided for each PFOA screening session. Supplies are labeled with the company name, study identification, and the expected month and year of screening. Because PFOA can be present in very low levels on some of the supplies, all supplies are tested at Advion before shipment. To minimize the possibility of extraneous contamination, please use only the materials supplied and discard unused supplies after each screening session.

Supplies include:

1. Tubes
Tubes are provided for collecting samples for PFOA analysis. Blood from the patient is drawn into red-top Vacutainer® tubes. Processed samples are transferred into polypropylene tubes. Each tube has an area to apply a label.

2. Labels
Blue paper labels are to be applied to the red-top Vacutainer tubes.
White nylon barcode labels are to be applied to the 12 x 75 mm screw-cap polypropylene sample tubes and have an area to write the subject ID, collection time, and collection date.

3. Needles
Needles are included for drawing blood. Needles are pre-tested by lot to determine their acceptability for use in this project.

4. Needle Holders
Needle holders are provided for sample collection.

5. Transfer Pipettes
Polypropylene transfer pipettes are provided to transfer the processed serum into the screw-cap sample tubes. Transfer pipettes are pre-tested by lot to determine their acceptability for use in this project

6. Plastic Bags
Large and small zip-lock bags are provided to protect tubes and Sample Collection Records from leakage during transport back to Advion.

7. Site Manual
This Site Manual is included with your Sample Collection Supplies. Make copies of the Sample Collection Record (page 6) as needed for each day that samples are drawn.

IMPORTANT:
When all subjects have been recruited and blood samples collected, discard all remaining supplies. New supplies will be shipped for the subsequent screening session.

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Sample Processing Procedures

During each screening session, samples will be collected for PFOA analysis. Please use the procedure listed below for sample processing.

Sample Processing for the PFOA Assay

Equipment and Supplies Required

- 4-mL (red-top) glass Vacutainer® blood collection tubes (supplied)
- 21-gauge needles (supplied)
- Needle holders (supplied)
- Polypropylene tubes (12 x 75 mm) with caps (supplied)
- Centrifuge
- Transfer pipettes (supplied)
- –20 ± 10 °C freezer
- Labels (supplied)

[redacted]

Procedures

1. Draw blood into a 4-mL (red-top) glass Vacutainer® blood collection tube using the 21-gauge needles supplied. Label the Vacutainer® with the **blue paper label** provided.
2. Allow blood to clot for 15 minutes (or until thoroughly clotted) at room temperature.
3. Centrifuge the blood sample for 15 minutes at 3000 rpm.
4. Remove the serum using the transfer pipettes provided and transfer the serum into a 12 x 75 mm polypropylene tube. Cap the tube tightly.
5. Label the sample with the **white nylon barcode label** provided. Write the patient ID, date, and time on the label using a Sharpie® permanent marker. Do not use ballpoint pen.

[redacted]

Example of PFOA sample label

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(Continued) Sample Processing for the PFOA Assay

6. Enter the **last five digits of the barcode** that appears on the white nylon label on the PFOA Sample Collection Record (page 6). Enter **the date and 24-hour clock time of sampling** on the same page.

7. **Freeze immediately at –20 °C**. Please hold samples at –20 °C and ship all accumulated samples at the end of each visit. If additional shipments are required, please contact Advion in advance.

8. When ready, **ship the sample set** overnight on dry ice to Advion BioSciences. See Shipping Instructions for more details.

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Packing and Shipping Frozen Samples

Prior to shipping the first set of samples call the courier (**FedEx**) to set up an account, if this has not been done previously. This will facilitate scheduling pick-ups even though your account will not be billed for the transportation of the samples. Request information on local service schedules and the latest time of day to arrange for pick-up.

Important: Please hold samples at –20 °C and ship all accumulated samples at the end of each screening session. If additional shipments are required, please contact Advion in advance.

Ship samples to Advion BioSciences via FedEx overnight delivery. Your supplies include shipping Airbills pre-addressed to Advion BioSciences. Please write in your address and shipping information.

Samples should be shipped on Monday, Tuesday, or Wednesday, only.

Package the frozen, processed samples as follows:

1. Put all samples in a zip-lock bag.
2. Place a copy of all applicable Sample Collection Records in a second large zip-lock bag.
3. Place the zip-lock bags containing the frozen samples and the Sample Collection Records in the insulated shipping container provided by Advion.
4. Pack the samples with at least 10 pounds of dry ice and replace the foam lid.
5. Seal the shipping box securely.
6. Complete the FedEx Airbill and place the "Dry Ice" sticker on the box. Fill in the amount of dry ice in kg (10 lbs = 4.5 kg).
7. Telephone your local FedEx service to arrange for pickup.
8. When the agent arrives, sign the Airbill and keep the sender's copy. Maintain your copy, as this begins the audit trail that documents the shipping process.
9. Complete the Shipping Notification Form and fax the form to Advion BioSciences.

Nationally observed holidays may cause shipment delivery delays. Contact Advion BioSciences for holiday pick-up and delivery schedules.

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PFOA Sample Collection Record

Study: PFOA Screening	Site No.:	Date of Sampling: Day Month Year

PFOA Sample Collection:

Subject Initials	24-HOUR CLOCK TIME (HH:MM)	BARCODE (enter last five digits)	COMMENTS)
	:	4140042	
	:	4140042	
	:	4140042	
	:	4140042	
	:	4140042	
	:	4140042	
	:	4140042	
	:	4140042	
	:	4140042	
	:	4140042	
	:	4140042	
	:	4140042	

Comments:

Date:	Samples Collected by:

Make copies as needed for different sampling days and additional subjects.

Once completed, please make a copy of this form. Send one copy with the set of samples when shipped. Retain originals.

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Sample Collection Supply Reorder Form

Please use this form to reorder sample collection kits from Advion BioSciences.

Instructions:

1. Complete the reorder form.
2. Fax to the attention of [redacted]
3. Orders may also be phoned in to [redacted]

Requested By: _____

Study #: PFOA Screening

Date Requested: _____

Investigator's Name: _____

Telephone Number: _____

Date Supplies Needed: _____

ALL INFORMATION ABOVE IS REQUIRED TO COMPLETE ORDER

Additional Supplies

Supplies	Quantity Needed
4-mL red-top Vacutainer® tubes	_____
21 Gauge Needles	_____
Needle Holders	_____
Transfer Pipettes	_____
Blue paper Vacutainer® labels	_____
Barcoded Sample Labels*	_____
FedEx Airbills	_____
Dry Ice Shipping Labels	_____
Shipping Containers	_____

*Please contact Advion to discuss details.

Please allow 5 to 7 days for delivery of kits and supplies.

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15 Catherwood Road, Ithaca, NY 14850 [redacted]

Shipping Notification Form

When shipping samples, please complete this form and return by fax to Advion BioSciences at **607-266-0749**.

FAX TRANSMISSION COVER SHEET

TO: **NAME:** [redacted]e]
COMPANY: Advion BioSciences
PHONE: [redacted]
FAX: [redacted]

TOTAL PAGES TRANSMITTED INCLUDING COVER:

FROM:

Investigator's Name: _____
Site Number: _____
Location/Address: _____

Telephone Number: _____
Fax Number: _____
Compound or Project: PFOA Screening
Ship Date: _____
FedEx Tracking Number(s): _____
Number of Shipping Containers: _____
Number of Samples Shipped: _____
Contact at Shipping Site: _____
Email Address: _____

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RECYCLED

AR226-3404

METHOD VALIDATION REPORT

TITLE: Method Validation for the Quantitation of Ammonium Perfluorooctanoate (APFO), Measured as the Perfluorooctanoate Anion (PFOA, 0.05 to 10 µg/mL Concentration Range), in Human Serum by Turbo Ion Spray LC/MS/MS

DATE: 12 July 2002

CERTIFIED COPY OF ORIGINAL	
Initials	Date
[illegible]	16 July 2002

REPORT: 02120VDJA_DU.DOC

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NUMBER OF PAGES: 54

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AUTHORS: David J. Anderson, M.S.
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TITLE: **Method Validation for the Quantitation of Ammonium Perfluorooctanoate (APFO), Measured as the Perfluorooctanoate Anion (PFOA, 0.05 to 10 µg/mL Concentration Range), in Human Serum by Turbo Ion Spray LC/MS/MS**

ABSTRACT

A sensitive, selective, accurate, and reproducible analytical method was developed by Advion BioSciences, Inc., Ithaca, New York to quantitate ammonium perfluorooctanoate (APFO), measured as the perfluorooctanoate anion (PFOA), in human serum samples. PFOA and its internal standard (IS) were isolated from human serum samples (25 µL) by a liquid-liquid extraction procedure. An aliquot of the organic layer from each sample was evaporated to dryness, reconstituted and analyzed by turbo ion spray liquid chromatography/tandem mass spectrometry (LC/MS/MS) in the negative ion mode. The assay demonstrated a lower limit of quantitation of 0.05 µg/mL for PFOA. The calibration curve range was quadratic from 0.05 µg/mL to 10 µg/mL for PFOA. The coefficients of determination (r^2) of the calibration curves were ≥0.9950 for PFOA.

Precision and accuracy quality control (QC) samples were prepared at concentrations of 0.15, 3, and 8 µg/mL PFOA. The intra- and inter-assay precision (CV) results calculated from QC samples ranged from 2.07 to 7.70% for PFOA. The intra- and inter-assay accuracy (RE) calculated from QC samples ranged from –12.3 to 9.00% for PFOA.

The results for PFOA were reproducible upon reinjection of prepared samples after storage for up to 65 hours at room temperature. The extraction recovery of PFOA and the IS from human serum were 81.8 and 90.9%, respectively. The matrix effect

on the ionization of PFOA and the IS was an enhancement of 1.62 and 8.07%, respectively.

SIGNATURE PAGE

TITLE: Method Validation for the Quantitation of Ammonium Perfluorooctanoate (APFO), Measured as the Perfluorooctanoate Anion (PFOA, 0.05 to 10 µg/mL Concentration Range), in Human Serum by Turbo Ion Spray LC/MS/MS

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12 JUL 02
Date

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DuPont Corporate Center for Analytical Sciences

16 July 2002
Date

QAU STATEMENT

Periodic audits of the method validation for the quantitation of APFO, measured as PFOA, in human serum were conducted by the Quality Assurance Unit of Advion BioSciences, Inc. (Advion).

The study was inspected on the following dates:

Phase of Study Inspected	Date of Inspection	Date Reported to Management
Data Review	6, 7, 11 June 2002	6, 7, 11 June 2002
Report	20 June 2002	20 June 2002

Based on the inspections and the data reviewed, this report is a complete and accurate representation of the data.

George C. Amedro

George C. Amedro, B.S.
Quality Assurance Auditor

12 July 02
Date

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1. INTRODUCTION

The purpose of this report is to describe the method validation for the quantitative determination of ammonium perfluorooctanoate (APFO), measured as the perfluorooctanoate anion (PFOA), in human serum samples. The objectives of the method validation were to validate a sample preparation procedure, determine the lower limit of quantitation (LLQ) for routine analysis, demonstrate accuracy of dilution, determine recovery and matrix effect, and to provide selective, accurate, and reproducible quantitative results by turbo ion spray liquid chromatography/tandem mass spectrometry (LC/MS/MS). This work was conducted in accordance with Advion BioSciences, Inc. (Advion) Standard Operating Procedures (SOP).

2. EXPERIMENTAL

2.1. CHEMICALS AND MATERIALS

Pentadecafluorooctanoic acid ammonium salt (Lot# 421207/1) was obtained from Sigma-Aldrich, St. Louis, MO. The internal standard (IS), 9H-hexadecafluorononanoic acid (9H-HDFNA, No Lot# available), was obtained from Sigma-Aldrich, St. Louis, MO. A detailed list of chemicals and materials is found in Appendix A.

Stock and working solutions used to prepare the calibration curves and quality control (QC) samples for PFOA were prepared as described in Appendix A.

2.2. LC/MS/MS INSTRUMENTATION

The liquid chromatography/mass spectrometry system consisted of two LC-10AD vp pumps (Shimadzu, Columbia, MD), an SCL-10A vp pump controller (Shimadzu, Columbia, MD), a Perkin-Elmer Series 200 autosampler (Perkin-Elmer Corp., Norwalk, CT), a Betasil C_{18} column (2 x 50 mm, 5 µm particle size, ThermoHypersil-Keystone, Bellefonte, PA), a model 7970 column heater (Jones Chromatography USA Inc., Lakewood, CO), and a SCIEX API 3000 mass

spectrometer (Applied BioSystems, Concord, Ontario). A detailed list of the instrumentation and instrument conditions is found in Appendix A.

2.3. SAMPLE PREPARATION AND EXTRACTION PROCEDURE

For each analytical run, duplicate 25-µL aliquots of the calibration curve samples were prepared as described in Appendix A. The calibration curve concentrations were 0.05, 0.1, 0.25, 0.5, 1, 2, 5, 7.5, and 10 µg/mL for PFOA.

Human serum QC samples were prepared in advance of the validation study at concentrations of 0.15, 3, and 8 µg/mL PFOA for QC1, QC2, and QC3, respectively, as detailed in Appendix A. QC4 (50-µg/mL dilution QC) was prepared at a concentration exceeding the calibration curve range, and was assayed using a 10-fold dilution.

2.4. HUMAN SERUM VALIDATION DATA

The data were collected using selected reaction monitoring (SRM) turbo ion spray LC/MS/MS in the negative ion mode. Peak areas were integrated by the SCIEX program MacQuan, version 1.6, residing on a Macintosh computer. Background subtraction was performed using Excel 98 to correct for the presence of PFOA in the control serum lots as detailed in Appendix A (A.14.0). Following peak area integration and background subtraction, the results tables from MacQuan were saved as text files and uploaded to the Advion BioSciences, Inc. (Advion) file server where a weighted ($1/x^2$) quadratic regression was performed using the software package Watson v 6.1.0.03 (InnaPhase, Inc., Philadelphia, PA). All concentration data were downloaded from Watson to Excel 97 with three decimal places for this report, with the exception of QC LLQ and Std 1 replicates, which were downloaded with four decimal places. Means, CV values, and RE values were calculated in Excel prior to rounding. Concentration data, concentration means, CV values, and RE values were rounded to three significant figures in Excel prior to reporting. The data for the human serum validation are stored in Advion Notebook 02120.

All calculations were based on the peak area ratio of PFOA to the internal standard. Concentrations of PFOA in QC samples were determined by inverse prediction from the calibration curve.

2.5. ASSAY EVALUATION

2.5.1. Intra- and Inter-Assay Precision

The intra- and inter-assay precision of the method was assessed by determining the coefficient of variation (CV) observed in the analysis of QC samples. The CV was determined by dividing the standard deviation by the mean concentration for each QC level and expressing the result as a percentage. The intra-assay precision was expressed as the CV of the replicate analyses of a QC level during a single validation run. The inter-assay precision was expressed as the CV of the overall mean of the individual replicate concentrations of the QC samples for three validation runs. QC1, QC2, and QC3 were assayed in replicates of six. In addition, the inter-assay CV was also reported for calibration standards at all levels.

2.5.2. Intra- and Inter-Assay Accuracy

The intra- and inter-assay accuracy of the method was assessed by determining the relative error (RE) observed in the analysis of QC samples. The RE was determined by subtracting the nominal concentration from the mean concentration for each QC level, dividing the result by the nominal value, and then expressing the result as a percentage. The intra-assay accuracy was expressed as the RE of the replicate analyses of QC samples during a single validation run. Inter-assay accuracy was expressed as the RE of the overall mean of the individual replicate concentrations of the QC samples for three validation runs. QC1, QC2, and QC3 were assayed in replicates of six. In addition, the inter-assay RE was also reported for calibration standards at all levels.

2.5.3. Sensitivity: Lower Limit of Quantitation (LLQ)

A human serum QC was prepared at a concentration of 0.05 µg/mL PFOA and assayed in replicates of six. The LLQ was determined by obtaining the back-calculated concentrations from these QC samples. The mean concentration, CV, and RE were also calculated.

2.5.4. Selectivity

The selectivity of the assay was determined by LC/MS/MS. To monitor for interference from the biological matrix within runs, unfortified control blank human serum samples were assayed with all experiments except recovery and matrix effect.

In addition, six replicate zero samples (control blank human serum samples fortified with IS) were extracted in each of the two different lots of control serum used for the standard curves and QC samples. These zero samples were used for the background subtraction due to the presence of PFOA in the control serum lots (Section A.14.0.).

To monitor for lot-specific matrix interference, six separate lots of human serum were spiked with PFOA at the LLQ and upper limit of quantitation (ULQ) concentration levels and were analyzed along with a control blank and zero sample prepared from each lot.

2.5.5. Chromatographic Carryover

The carryover of analyte from the injection of one sample to another was assessed in each run by placing control blanks after each high standard (STD9) and monitoring for analyte and IS response.

2.5.6. Accuracy and Precision of Dilution

The accuracy and precision of dilution in the analysis of PFOA in human serum was assessed. QC4 samples (50 µg/mL) were analyzed at a 10-fold dilution in replicates of six. The mean concentration, CV, and RE were calculated.

2.6. STABILITY OF PFOA IN HUMAN SERUM

The stability of PFOA in human serum during sample storage, preparation and analysis will be assessed and reported in the 1 to 100 ng/mL-concentration range human serum method validation.[1]

2.7. REPRODUCIBILITY OF REINJECTING PREPARED SAMPLES

The reproducibility of reinjecting extracted and reconstituted serum samples was investigated by reinjecting a set of previously-assayed standards and QC samples that had been stored after injection at room temperature for 65 hours. The CV and RE of the QC samples were used to assess processed sample stability in reconstitution solution. All QC samples were assayed in replicates of six.

2.8. EXTRACTION RECOVERY

The determination of extraction recovery was initially performed in Runs 6 and 7, but the data obtained from those experiments are believed to be inaccurate, mainly due to the higher than expected absolute recoveries seen (100% maximum expected from procedure after correction for 1/10 aliquot removed from organic layer during extraction). It is suspected that because of the large differences (10-fold) in concentration between the samples spiked before extraction (pre-extract) and the samples spiked after extraction (post-extract) in those experiments, coupled with the non-linearity seen in detector responses, the predicted recoveries were biased. The experiment was repeated in Run 8 in which the post-extract samples were diluted 10-fold to compensate for the 1/10 aliquot. Accordingly, the concentrations of the

pre- and post-extract samples would now be much closer to each other and thus be less biased by the non-linearity.

The extraction recovery of PFOA from human serum was determined in MacQuan by performing separate weighted ($1/x^2$) regressions for the pre-extract and post-extract samples which were prepared at the nominal concentrations 0.15, 3, and 8 µg/mL in replicates of five. The extraction recovery was calculated as the slope ratio of the pre-extract curve over the post-extract curve. The IS was spiked post-extraction for PFOA recovery determination.

The extraction recovery of the IS from human serum was determined by comparing the peak area ratios (PAR) of pre-extract and post-extract samples (5 µg/mL 9H-HDFNA) assayed in replicates of five. In this experiment only, the PFOA was used as internal standard and was spiked post-extraction for the 9H-HDFNA recovery determination. The extraction recovery (% Recovery) was determined by dividing the pre-extract PAR by the post-extract PAR and expressing the result as a percentage.

2.9. Matrix Effect on Ionization of PFOA and 9H-HDFNA in Human Serum

The matrix effect on the ionization of PFOA in human serum extract was determined by comparing the peak area of samples (0.15, 3, and 8 µg/mL for PFOA) spiked in blank human serum extract (post-extract) with the peak area of an unextracted solution (neat spike). The matrix effect was determined by subtracting the neat spike peak area from the post-extract peak area, dividing the result by the neat peak spike peak area, and expressing the result as a percentage. Five replicates were used at each concentration.

The matrix effect on the ionization of 9H-HDFNA in human serum extract was similarly determined by comparing the peak area of blank human serum extract spiked with 5 µg/mL 9H-HDFNA after extraction with the peak area of an

unextracted solution (neat spike). The post-extract and neat solution samples were prepared in replicates of five.

3. RESULTS AND DISCUSSION

A quantitative analytical procedure using turbo ion spray LC/MS/MS in the negative ion mode was developed to meet the high sensitivity, selectivity, and reproducibility requirements for the determination of PFOA in human serum. A list of the validation runs is presented in Table 1.

The full-scan turbo ion spray mass spectrum of PFOA showed the base peak ion at m/z = 413 which is attributed to the deprotonated molecule (Figure 1). The full-scan product ion spectrum of PFOA showed the base peak product ion at 169 (Figure 2).

The full-scan turbo ion spray mass spectrum of 9H-HDFNA showed the base peak ion at m/z = 445 which is attributed to the deprotonated molecule (Figure 3). The full-scan product ion spectrum of 9H-HDFNA showed the base peak product ion at 381 (Figure 4).

The following respective $[M-H]^-$ ions were used in data acquisition for PFOA and the IS in human serum (nominal):

PFOA	$m/z = 413 \rightarrow 169$
9H-HDFNA	$m/z = 445 \rightarrow 381$

The SRM chromatograms from a representative control blank human serum extract are shown in Figure 5. SRM chromatograms from a representative control human serum extract containing only the internal standard (zero sample), are shown in Figure 6. Both Figures 5 and 6 show the presence of PFOA in the control human serum.

Figures 7 and 8 are SRM chromatograms from representative extracts from calibration standards 1 (LLQ) and 9 (ULQ), respectively.

3.1. ASSAY EVALUATION RESULTS

3.1.1. Intra- and Inter-Assay Precision

Table 2 presents the precision data for the PFOA QC samples from the three validation runs. The intra- and inter-assay precision (CV) was ≤7.70% for PFOA at QC1, QC2, and QC3 concentration levels. Table 3 presents the precision data for calibration standards. The CV for calibration standards was ≤10.0% for PFOA. These data indicate acceptable intra- and inter-assay precision for the determination of PFOA in human serum.

Only five replicates of QC1 were successfully prepared in Run 3 due to a broken test tube. Also, results for only five replicates of QC3 in Run 5 were calculated due to a probable preparation error. This is in compliance with Advion SOPs.

3.1.2. Intra- and Inter-Assay Accuracy

Table 2 presents the accuracy data for the PFOA QC samples from the three validation runs. The intra- and inter-assay accuracy (RE) ranged from –12.3 to 9.00% for PFOA. Table 3 presents the accuracy data for calibration standards. The RE for calibration standards ranged from –3.99 to 6.92% for PFOA in human serum. These data indicate acceptable intra- and inter-assay accuracy for the determination of PFOA in human serum.

3.1.3. Calibration Curve Fit

The calibration curves were fit by a weighted ($1/x^2$) quadratic regression. Coefficients of determination (r^2) were ≥0.9950 for PFOA in human serum. The calibration curve statistics are shown in Table 4.

3.1.4. Sensitivity: Lower Limit of Quantitation (LLQ)

Tables 5 shows the results from the QC at the LLQ for PFOA. The experiment demonstrated that 0.05 µg/mL is an acceptable LLQ level for PFOA. The CV was 2.95%, and the RE was 9.73% for the LLQ QC.

3.1.5. Selectivity

The assay was highly selective for PFOA. No chromatographic interferences were observed at the retention time of PFOA or the IS in the control serum samples analyzed (Figure 5). The control blanks did show the presence of PFOA in the control human serum.

The selectivity between matrix lots produced acceptable results after background subtraction (Table 6). The precision (CV) for the PFOA samples was 7.18 and 5.21% for the LLQ and ULQ samples, respectively. The corresponding accuracy was 0.133 and 11.8% for the LLQ and ULQ samples.

3.1.6. Chromatographic Carryover

A chromatographic peak was observed at the retention time for PFOA in the human serum control blanks following high standards. The responses were comparable to those of the control blanks injected before the standard curves. This indicates that carryover was negligible for PFOA. Carryover for the internal standard was insignificant.

3.1.7. Accuracy and Precision of Dilution

The results from QC4 samples diluted 10-fold are shown in Table 7. The CV was 4.25% and the RE value was –10.6% for PFOA. These data demonstrate acceptable results for the dilution of samples.

3.2. REPRODUCIBILITY OF REINJECTING EXTRACTED SAMPLES

The results of reinjecting extracted and reconstituted samples containing PFOA after storage for 65 hours at room temperature in reconstitution solution are shown in Table 8. The CV values for samples injected initially and those reinjected after 65 hours in reconstitution solution ranged from 2.68 to 8.12%, and the RE values range from –12.3 to –1.41% for PFOA. These data indicate that reinjecting samples after storage for 65 hours in reconstitution solution at room temperature is acceptable.

3.3. EXTRACTION RECOVERY

The extraction recoveries of PFOA and the IS, 9H-HDFNA, from human serum are shown in Tables 9 and 10, respectively. The mean recovery values were 81.8% for PFOA and 90.9% for 9H-HDFNA.

3.4. MATRIX EFFECT ON IONIZATION OF PFOA AND 9H-HDFNA IN HUMAN SERUM

The results of the matrix effect of human serum extract on the ionization of PFOA and the IS are shown in Tables 11 and 12, respectively. The overall mean matrix effect was 1.62% for PFOA and 8.07% for 9H-HDFNA, indicating slight enhancement of ionization.

4. SOP DEVIATION

According to Advion SOP DOCU0015.02, the volume of non-matrix solvent used for spiking QC samples must be ≤5% of the total volume. QC4 (dilution QC) was prepared by spiking a volume of stock solution that was 10% of the total volume so that new stock solution did not have to be prepared. This deviation did not affect the quality of the data.

There were no other known SOP deviations during the validation.

5. DATA RETRIEVAL

The data for the human serum validation are stored in Advion Notebook 02120 and in the Advion archives.

6. CONCLUSIONS

The turbo ion spray LC/MS/MS assay procedure for PFOA in human serum has proven to be sensitive, selective, accurate, and reproducible. Its high sensitivity allows reliable and reproducible quantitation of PFOA down to a level of 0.05 µg/mL in human serum based on 25-µL samples.

7. REFERENCE

1. Advion Report No. 02086VDJA_DU.DOC, "Method Validation for the Quantitation of Ammonium Perfluorooctanoate (APFO), Measured as the Perfluorooctanoate Anion (PFOA, 1 to 100 ng/mL Concentration Range) in Human Serum by Turbo Ion Spray LC/MS/MS," to be issued.

8. TABLES

Table 1: Validation Run Descriptions

Run No.	Assay Date	Run Description	Status
1	6-May-02	Accuracy and Precision; Dilution	Accepted
2	7-May-02	Accuracy and Precision; LLQ	Rejected
3	8-May-02	Accuracy and Precision; LLQ	Accepted
4	9-May-02	Reinjection of Run 1	Accepted
5	10-May-02	Accuracy and Precision; Selectivity	Accepted
6	22-May-02	Recovery and Matrix Effect	Rejected
7	23-May-02	Recovery and Matrix Effect	Accepted (recovery rejected)
8	5-June-02	Recovery	Accepted

Table 2: Accuracy and Precision of the PFOA Assay in Human Serum for Quality Control Samples from Three Validation Runs

	PFOA Concentration (µg/mL)		
	QC1	QC2	QC3
Run Number	0.15	3	8
1	0.147	2.73	8.47
	0.138	2.55	8.35
	0.139	2.56	7.54
	0.156	2.59	7.45
	0.144	2.67	7.37
	0.125	2.68	7.57
Mean	0.142	2.63	7.79
CV (%)	7.33	2.68	6.26
RE (%)	-5.67	-12.3	-2.61
3	0.164	2.82	7.62
	0.159	2.78	7.97
	0.158	2.74	7.48
	0.152	2.85	7.33
	0.153	2.77	7.77
	NS	2.69	7.83
Mean	0.157	2.77	7.67
CV (%)	3.10	2.07	3.06
RE (%)	4.80	-7.56	-4.16
5	0.169	2.96	7.83
	0.166	2.88	8.17
	0.157	2.78	8.06
	0.162	2.88	EQB
	0.165	2.81	7.75
	0.162	2.92	8.65
Mean	0.164	2.87	8.09
CV (%)	2.53	2.32	4.38
RE (%)	9.00	-4.24	1.12
Overall Mean	0.154	2.76	7.84
Overall CV (%)	7.70	4.33	5.02
Overall RE (%)	2.59	-8.04	-2.06

CV = (SD/Mean)*100

RE = [(Mean-Nominal)/Nominal]*100

NS = No sample. Only 5 replicates were prepared for QC1 in Run 3.

EQB = Exceeds quadratic bounds

Table 3: **Accuracy and Precision of the PFOA Assay in Human Serum for Calibration Standards from Three Validation Runs**

	PFOA Concentration (µg/mL)								
	STD1	STD2	STD3	STD4	STD5	STD6	STD7	STD8	STD9
Run Number	0.05	0.1	0.25	0.5	1	2	5	7.5	10
1	0.0534	0.103	0.255	0.574	1.01	2.06	4.80	7.75	9.84
	0.0463	0.0967	0.246	0.469	0.932	1.95	4.83	6.97	11.6
3	0.0513	0.112	0.243	0.539	1.02	2.02	4.90	7.34	10.5
	0.0457	0.102	0.231	0.492	1.01	1.90	4.66	7.20	11.0
5	0.0562	0.106	0.252	0.505	1.05	2.11	4.95	7.26	11.0
	0.0436	0.0950	0.244	0.488	0.996	1.95	4.66	7.26	10.1
Mean	0.0494	0.102	0.245	0.511	1.00	2.00	4.80	7.30	10.7
CV (%)	10.0	6.06	3.42	7.55	3.82	3.88	2.49	3.49	6.08
RE (%)	-1.17	2.45	-1.93	2.23	0.233	-0.125	-3.99	-2.71	6.92

CV = (SD/Mean)*100

RE = [(Mean-Nominal)/Nominal]*100

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Table 4: Calibration Curve Parameters for PFOA in Human Serum from Three Validation Runs

Run Date	Run Number	A	B	C	Coefficient of Determination (r^2)
6-May-02	1	-0.011789	0.360080	0.000634	0.9950
8-May-02	3	-0.009249	0.317953	-0.000595	0.9955
10-May-02	5	-0.008130	0.289836	-0.000240	0.9951
Mean		-0.009723	0.322623	-0.000067	0.9952

$y = Ax^2 + Bx + C$, weighted $1/x^2$

Table 5: Lower Limit of Quantitation of PFOA in Human Serum

	PFOA Conc. (µg/mL)
	QC LLQ
Run 3	0.05
	0.0562
	0.0537
	0.0574
	0.0540
	0.0547
	0.0532
Mean	0.0549
CV (%)	2.95
RE (%)	9.73

CV = (SD/Mean)*100

RE = [(Mean-Nominal)/Nominal]*100

Table 6: **Lower Limit of Quantitation of PFOA and Selectivity in Six Separate Lots of Human Serum**

Run 5	PFOA Concentration (µg/mL)	
	LLQ	ULQ
Serum lot	0.05	10
22-48635	0.0544	10.6
55-03231	0.0467	10.6
55-03232	0.0508	10.8
55-03681	0.0531	11.4
55-03624	0.0503	11.6
55-03707	0.0451	12.0
Mean	0.0501	11.2
CV (%)	7.18	5.21
RE (%)	0.133	11.8

CV = (SD/Mean)*100

RE = [(Mean-Nominal)/Nominal]*100

Table 7: Accuracy and Precision of the PFOA Assay in Human Serum Dilution QC Samples from One Validation Run

	PFOA Conc. (µg/mL)
	QC4 (1 in 10 dilution)
Run 1	50
	47.5
	42.7
	45.3
	43.9
	42.9
	46.0
Mean	44.7
CV (%)	4.25
RE (%)	-10.6

CV = (SD/Mean)*100

RE = [(Mean-Nominal)/Nominal]*100

Table 8: **Reinjection Reproducibility of QC Samples Containing PFOA After Storage in Reconstitution Solution for 65 Hours at Room Temperature**

	PFOA Concentration (µg/mL)			
	QC1	QC2	QC3	QC4 (1 in 10 dilution)
	0.15	3	8	50
Run 1	0.147	2.73	8.47	47.5
t=0	0.138	2.55	8.35	42.7
	0.139	2.56	7.54	45.3
	0.156	2.59	7.45	43.9
	0.144	2.67	7.37	42.9
	0.125	2.68	7.57	46.0
Mean	0.142	2.63	7.79	44.7
CV (%)	7.33	2.68	6.26	4.25
RE (%)	-5.67	-12.3	-2.61	-10.6
Run 4	0.150	2.78	8.10	47.6
t=65 hours	0.146	2.88	8.81	45.2
	0.140	2.62	7.76	47.4
	0.145	2.79	7.52	45.8
	0.141	2.65	7.63	46.0
	0.118	2.57	7.50	46.3
Mean	0.140	2.72	7.89	46.4
CV (%)	8.12	4.43	6.37	2.05
RE (%)	-6.67	-9.48	-1.41	-7.27

CV = (SD/Mean)*100

RE = [(Mean-Nominal)/Nominal]*100

Table 9: Extraction Recovery of PFOA from Human Serum

Run 8	PFOA Concentration (µg/mL)	
	Pre-Extract	Post-Extract
QC1	0.162	0.155
0.15 µg/mL	0.141	0.152
	0.155	0.147
	0.145	0.149
	0.146	0.144
Mean	0.150	0.149
RE (%)	-0.133	-0.400
QC2	3.21	3.40
3 µg/mL	3.07	3.27
	2.95	3.35
	3.05	3.36
	3.50	3.20
Mean	3.16	3.32
RE (%)	5.22	10.5
QC3	8.15	7.25
8 µg/mL	7.40	7.15
	7.51	7.12
	7.53	7.18
	7.39	7.22
Mean	7.60	7.18
RE (%)	-5.05	-10.2

Regression	Pre-Extract	Post-Extract	Recovery (%)
Coefficient of Determination (r^2)	0.9930	0.9878	
Intercept	0.01125	-0.01220	
Slope	0.23325	0.28522	81.8

Pre-Extract = Matrix spiked with PFOA prior to extraction
Post-Extract = Matrix spiked with PFOA after extraction
RE = [(Mean-Nominal)/Nominal]*100
%Recovery = ($Slope_{Pre\text{-}extract}$/$Slope_{Post\text{-}extract}$)*100

Table 10: Extraction Recovery of the Internal Standard, 9H-HDFNA, from Human Serum

Run 8	Peak Area Ratio (IS/PFOA)		Recovery (%)
	Pre-Extract	Post-Extract	
IS	0.43745	0.49204	
5 µg/mL	0.45424	0.49670	
	0.44736	0.49028	
	0.46195	0.50136	
	0.44684	0.49258	
Mean	0.44957	0.49459	90.9
CV (%)	2.03	0.901	

Pre-Extract = Matrix spiked with 9H-HDFNA prior to extraction

Post-Extract = Matrix spiked with 9H-HDFNA after extraction

CV = (SD/Mean)*100

%Recovery = $(Mean_{Pre\text{-}extract}/Mean_{Post\text{-}extract})*100$

Table 11: Matrix Effect on Ionization of PFOA in Human Serum

Run 7	PFOA Area		Matrix Effect
	Post-Extract	Neat Spike	(%)
QC1	19775	19573	
0.15 µg/mL	19835	18856	
	20826	20522	
	19880	18616	
	20597	18333	
Mean	20183	19180	5.23
CV (%)	2.43	4.59	
QC2	426092	399353	
3 µg/mL	418407	408972	
	408036	419660	
	425636	400556	
	430791	401508	
Mean	421792	406010	3.89
CV (%)	2.10	2.10	
QC3	772284	772628	
8 µg/mL	747001	794112	
	757322	805450	
	769807	817268	
	776010	803311	
Mean	764485	798554	-4.27
CV (%)	1.57	2.09	
Overall Mean			1.62

Post-Extract = Matrix spiked with PFOA after extraction
Neat Spike = Solution of PFOA without matrix
CV = (SD/Mean)*100
Matrix Effect = $[(Mean_{Post\ Extract} - Mean_{Neat\ Spike})/Mean_{Neat\ Spike}]*100$, where a negative number indicates ion suppression and a positive number indicates enhancement

Table 12: Matrix Effect on Ionization of 9H-HDFNA in Human Serum

Run 7	9H-HDFNA Area		Matrix Effect (%)
	Post-Extract	Neat Spike	
IS	349304	306352	
5 µg/mL	336593	330146	
	351612	310681	
	335236	322237	
	335737	311522	
Mean	341696	316188	8.07
CV (%)	2.36	3.08	

Post-Extract = Matrix spiked with 9H-HDFNA after extraction

Neat Spike = Solution of 9H-HDFNA without matrix

CV = (SD/Mean)*100

Matrix Effect = $[(Mean_{Post\ Extract} - Mean_{Neat\ Spike})/Mean_{Neat\ Spike}]*100$, where a negative number indicates ion suppression and a positive number indicates enhancement

9. FIGURES

Figure 1: Full-Scan Turbo Ion Spray Mass Spectrum of PFOA

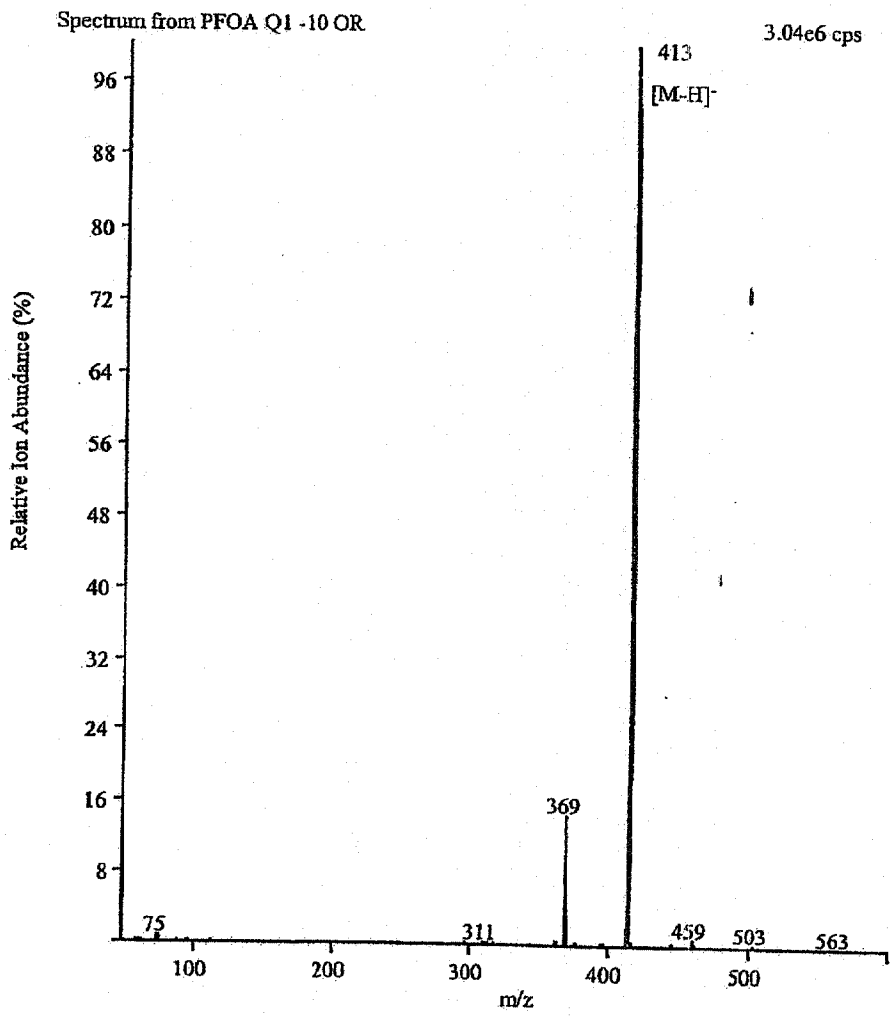


Figure 2: Full-Scan Product Ion Mass Spectrum of PFOA

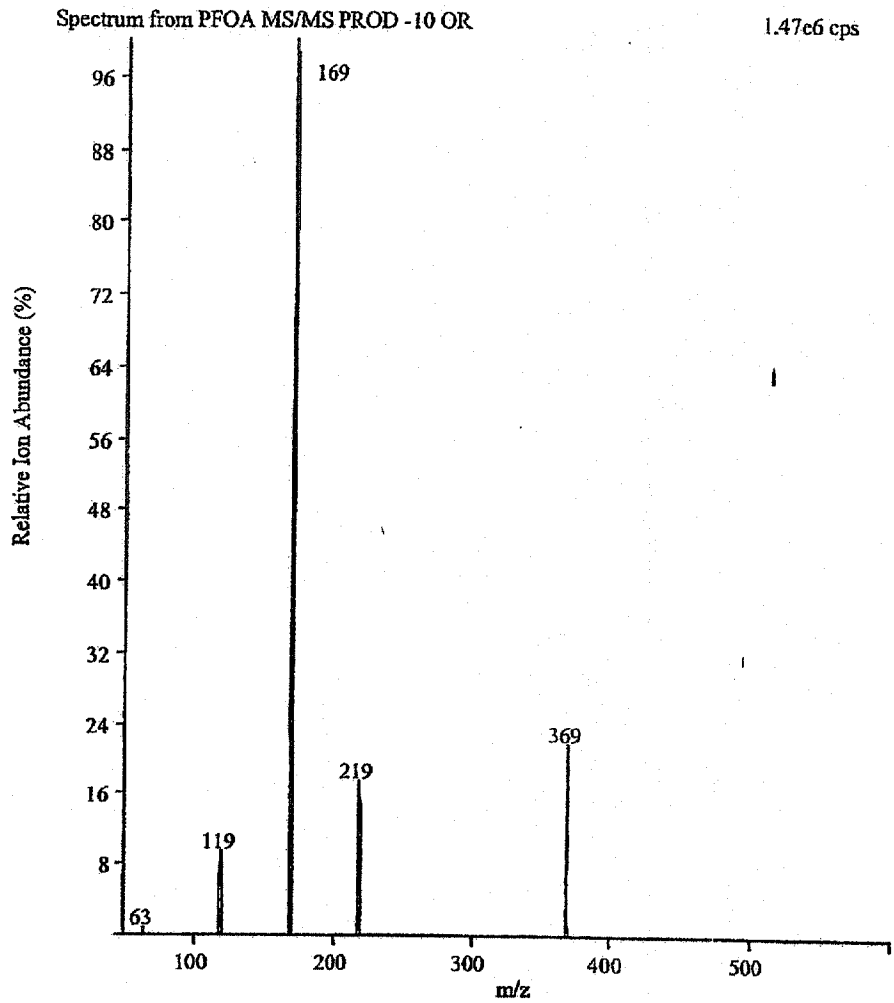


Figure 3: Full-Scan Turbo Ion Spray Mass Spectrum of 9H-HDFNA

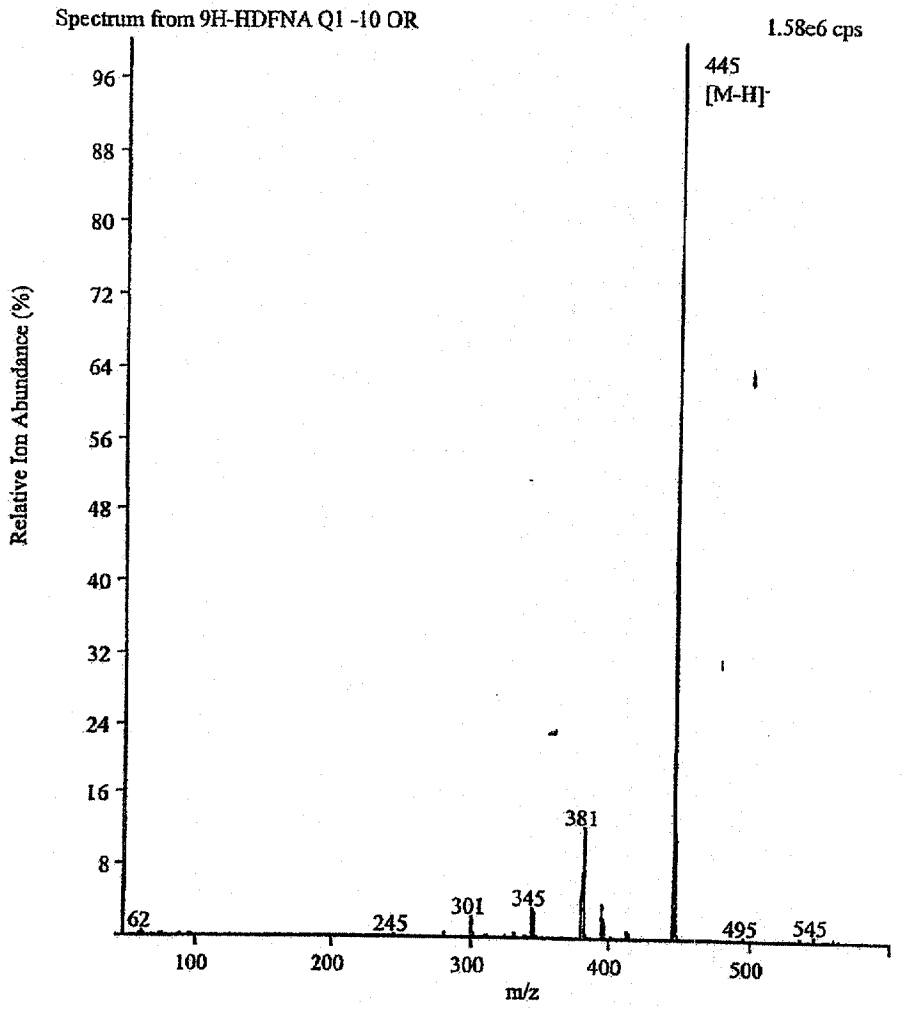


Figure 4: Full-Scan Product Ion Mass Spectrum of 9H-HDFNA

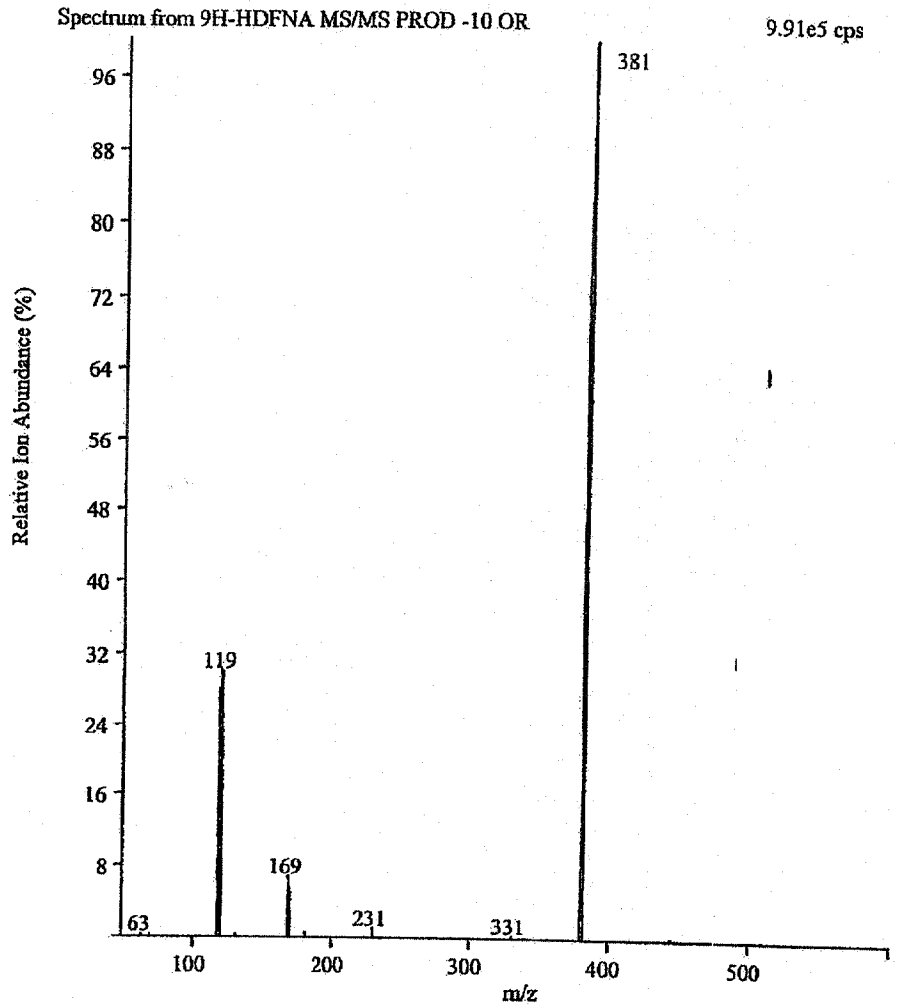
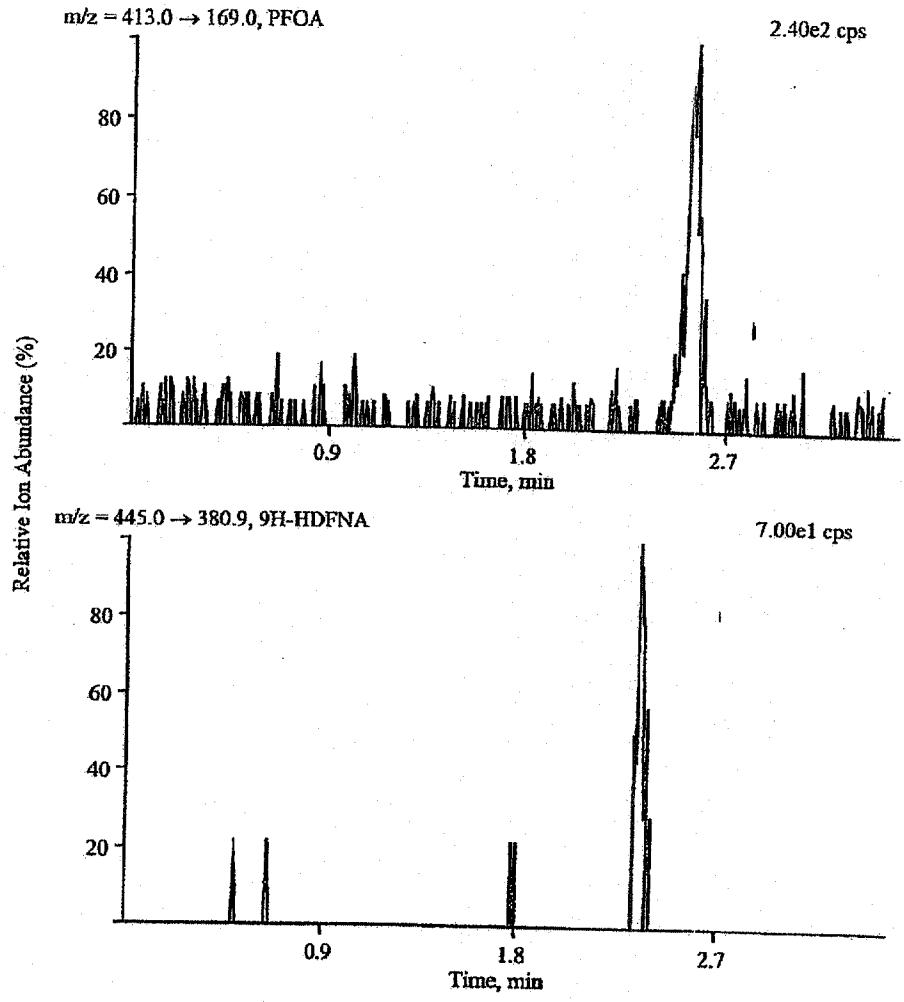
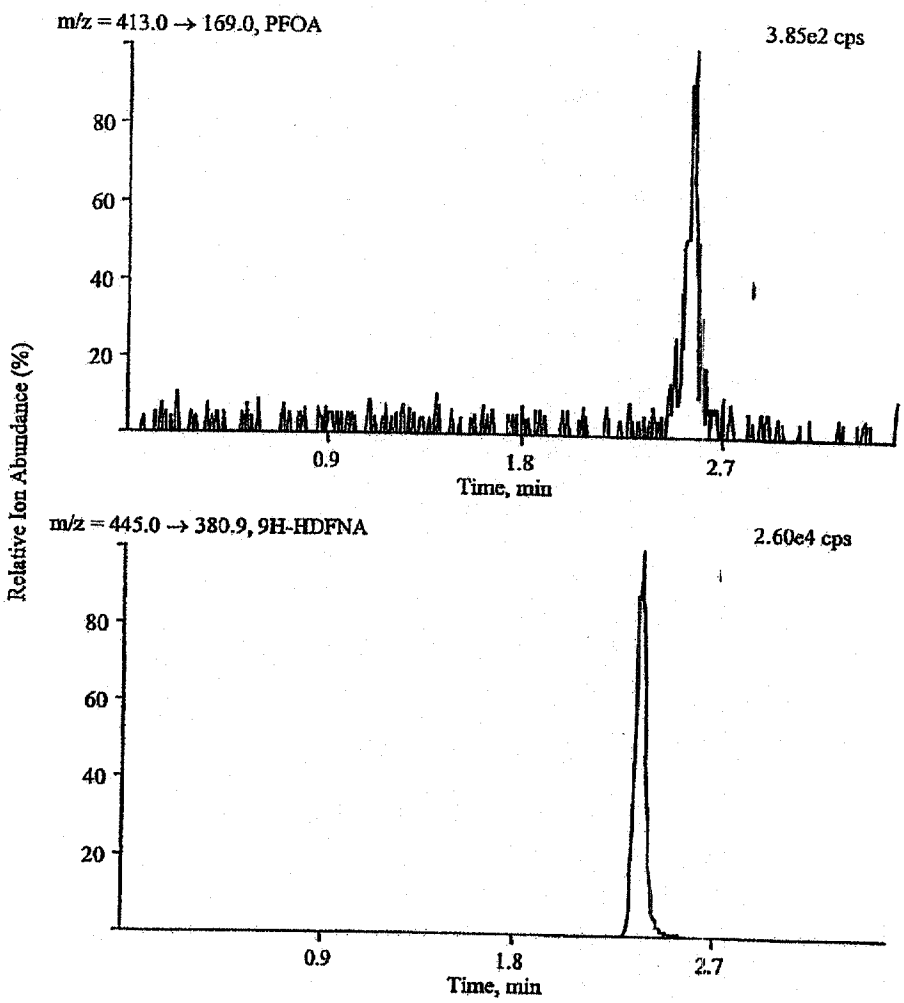


Figure 5: **Selected Reaction Monitoring Chromatograms of PFOA and the Internal Standard in Control Blank Human Serum Extract**



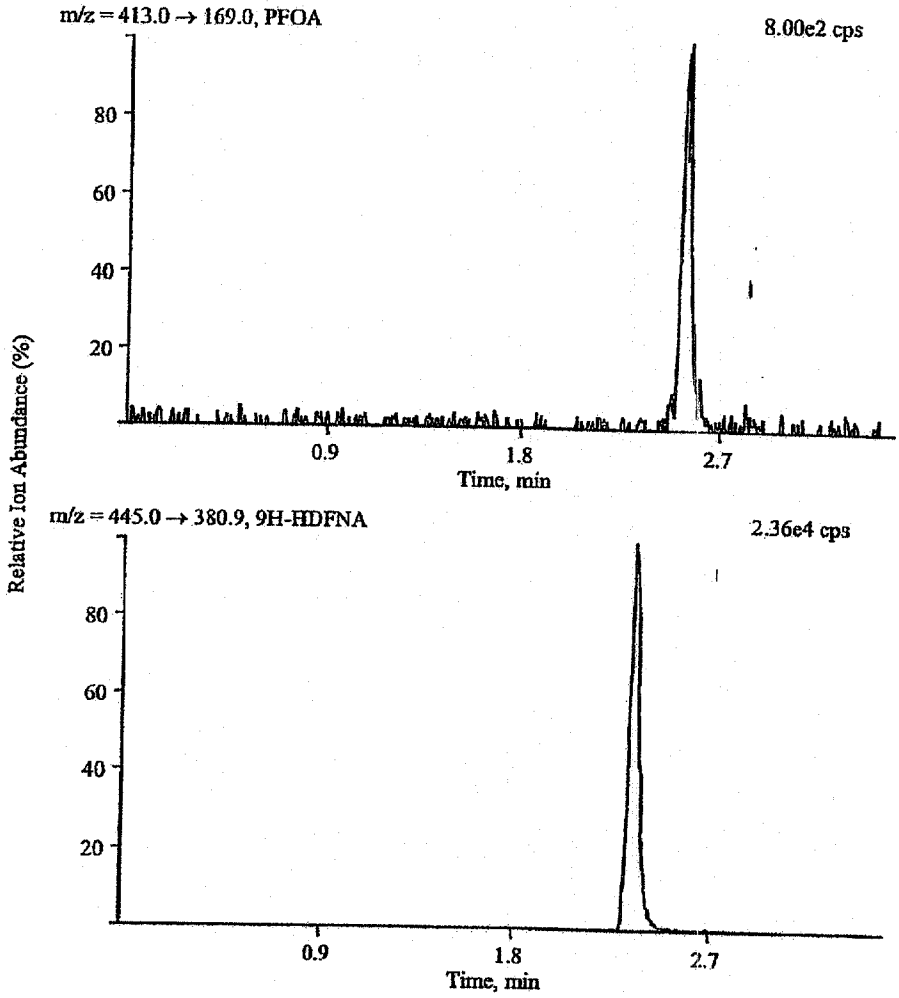
Control Blank, Run 1, Injection 7

Figure 6: **Selected Reaction Monitoring Chromatograms of PFOA and the Internal Standard in a Human Serum Extract Containing Internal Standard Only (Zero Sample)**



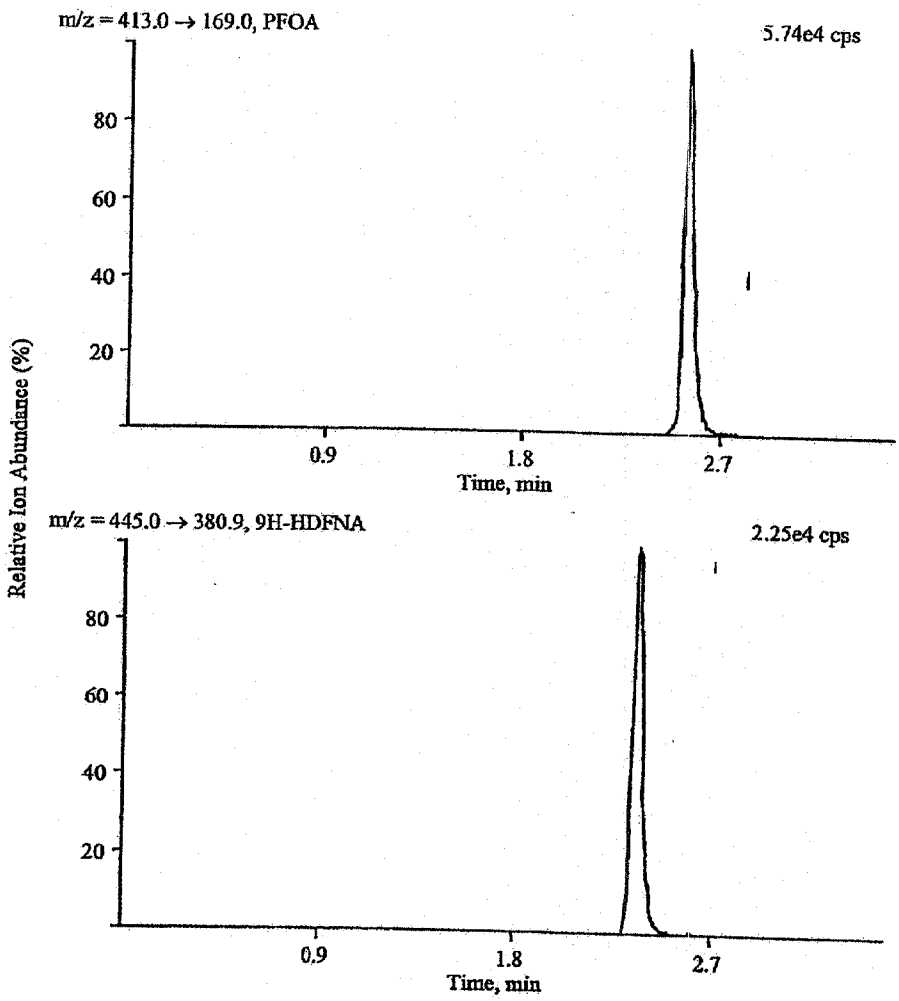
Zero Sample, Run 1, Injection 1

Figure 7: **Selected Reaction Monitoring Chromatograms of PFOA and the Internal Standard from a Standard 1 Human Serum Extract (0.05 µg/mL)**



Standard 1, Run 1, Injection 8

Figure 8: **Selected Reaction Monitoring Chromatograms of PFOA and the Internal Standard from a Standard 9 Human Serum Extract (10 µg/mL)**



Standard 9, Run 1, Injection 16

10. APPENDIX A: QUANTITATION OF AMMONIUM PERFLUOROOCTANOATE (APFO), MEASURED AS THE PERFLUOROOCTANOATE ANION (PFOA, 0.05 TO 10 μg/mL CONCENTRATION RANGE), IN HUMAN SERUM BY TURBO ION SPRAY LC/MS/MS

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Kathy Jo Palmer, B.S.
Jennie L. Romney, M.P.S.

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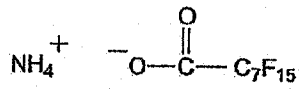
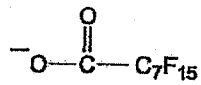
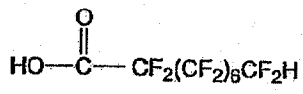
A.1.0 CHEMICAL STRUCTURE(S)



Ammonium Perfluorooctanoate (APFO) $C_8H_4F_{15}NO_2$ Monoisotopic Mass = 431.0



Perfluorooctanoate Anion (PFOA) $C_8F_{15}O_2$ Monoisotopic Mass = 413.0



9H-Hexadecafluorononanoic Acid (9H-HDFNA) $C_9H_2F_{16}O_2$ Monoisotopic Mass = 446.0

A.2.0 SPECIMEN(S)

This assay uses 25-µL aliquots of human serum. Human serum samples should be stored at –20 °C.

A.3.0 ASSAY PRINCIPLE

Perfluorooctanoate anion (PFOA) and its IS, 9H-hexadecafluorononanoic acid (9H-HDFNA), were extracted from human serum samples (25 µL) using a liquid-liquid extraction procedure. An aliquot of the organic layer of each sample was evaporated to dryness, reconstituted, and then analyzed by turbo ion spray liquid chromatography/tandem mass spectrometry (LC/MS/MS) in the negative ion mode.

A.4.0 COMPOUNDS

Pentadecafluorooctanoic acid ammonium salt (also known as ammonium perfluorooctanoate, APFO): Lot# 421207/1, 100% purity, 0.9582 salt factor, Sigma-Aldrich, St. Louis, MO.

Salt Factor: $$\frac{C_8F_{15}O_2}{C_8H_4F_{15}NO_2} = \frac{413.064}{431.10258} = 0.9582$$

9H-HDFNA: No Lot# available, 100% purity assumed, Sigma-Aldrich, St. Louis, MO.

A.5.0 CHEMICALS

All chemicals may be substituted with that of an equivalent manufacturer and grade of chemical.

Tetrabutylammonium Hydrogen Sulfate	HPLC Grade, Cat# J360-07, J.T. Baker, Phillipsburg, NJ
	HPLC Grade, Cat# 32503-27-8, Aldrich, Milwaukee, WI
Sodium Carbonate, Annhydrous	Cat# 3604-01, J.T. Baker, Phillipsburg, NJ

Sodium Bicarbonate	Cat# 3509-01, J.T. Baker, Phillipsburg, NJ
Ethyl Acetate	Cat# 100-4, Burdick & Jackson, Muskegon, MI
Ammonium Acetate	Cat# 24,019-2, Aldrich, Milwaukee, WI
Ammonium Hydroxide	Cat# AX1303-13, EM Science, Gibbstown, NJ
Water	Cat# 365-4, Burdick & Jackson, Muskegon, MI
Methanol	Cat# 230-4, Burdick & Jackson, Muskegon, MI
Acetonitrile	Cat# BJ015-4, Burdick & Jackson, Muskegon, MI
Human Serum	Biological Specialty Corporation, Colmar, PA

A.6.0 MATERIALS AND EQUIPMENT

Mass Spectrometer	SCIEX API 3000 atmospheric pressure ionization tandem triple quadrupole mass spectrometer equipped with TurboIonSpray™ interface, Applied BioSystems, Concord, Ontario
Data Acquisition System	API Standard Software, MacQuan v 1.6, LC2Tune v 1.4, MacDAD v 1.4.1, Bundler v 1.4, Multiview v 1.4, and Sample Control v 1.4, on a Power Macintosh G3/450, Applied BioSystems, Concord, Ontario
HPLC Pumps	Shimadzu LC-10AD vp pumps, Shimadzu Co., Columbia, MD
LC Pump Controller	Shimadzu SCL-10A vp, Shimadzu Co., Columbia, MD
Autosampler	Perkin-Elmer Series 200, Perkin-Elmer Corp., Norwalk, CT
HPLC Column	Betasil C_{18}, 5 µm particle size, 2 x 50 mm, Cat# 852055-701, ThermoHypersil-Keystone, Bellefonte, PA

Column Heater	Model 7970, Jones Chromatography USA Inc., Lakewood, CO
Harvard Syringe Pump 11	Harvard Apparatus Inc., South Natick, MA
Polypropylene 96-Well Blocks	Cat# 267006, Beckman Instruments, Inc., Fullerton, CA
Screw-capped Polypropylene Vials	16.5 x 101 mm, Cat# 60.541, Sarstedt, Inc., Newton, SC 28658
Screw-capped Polypropylene Vials	16.5 x 57 mm, Cat# 60.542, Sarstedt, Inc., Newton, SC
Siliconized Graduates Microtubes	1.5 mL, Cat# MH-815S, Phenix Research Products, Hayward, CA 94545
Polypropylene Centrifuge Tubes	50 mL with screw caps, Cat# 21008-178, VWR Scientific, Bridgeport, NJ
Polypropylene Bottles	175 mL Nalgene, Cat# 16120-953, VWR Scientific, Bridgeport, NJ
Polypropylene Bottles	1 L Nalgene, Cat# 16120-962, VWR Scientific, Bridgeport, NJ
TurboVap 96 Evaporator	Cat# 71000, Zymark Instruments, Hopkinton, MA 01748
Beckman GS6KR Refrigerated Centrifuge	Beckman, Palo Alto, CA 94304
Multi-tube Vortexer	Cat# 58816-115, VWR Scientific, West Chester, PA
Mechanical Shaker	Cat# 6000, Eberbach Corp., Ann Arbor, MI
Watson	Laboratory Information Management System v 6.1.0.03, InnaPhase Corp., Philadelphia, PA

Other general laboratory glassware and supplies were used.

A.7.0 PREPARATION OF CALIBRATION STANDARDS

Mix all solutions well. Unless otherwise noted, store solutions at 4 °C and bring to ambient temperature before use. Unless otherwise noted, prepare fresh solutions every three months or as needed.

A.7.1 Preparation of Analytical Standard Solutions

Standard Stock Solution, PFOA (500 µg/mL): Weigh approximately 2 mg pentadecafluoroactanoic acid ammonium salt and transfer to a 16.5 x 57 polypropylene vial. Dilute with appropriate volume of methanol to yield a 500-µg/mL solution after correction for salt factor. Vortex for one minute.

A.7.2 Preparation of Standard Curve

Prepare Standards 1 through 9 by dilution of Standard Standard Stock Solution or the appropriate standard into control serum according to the following table. Standard 9 is prepared in a 5-mL volumetric flask. Standard 1 through Standard 8 are prepared in 1.5-mL siliconized polypropylene microtubes.

Analytical Standard Dilution Table:

Standard No.	Final Conc. (µg/mL)	Solution to Use	µL of Solution	µL Control Serum	mL Total Volume
9	10	Std Stock	100	Add serum to 5-mL mark	5
8	7.5	STD9	375	125	0.5
7	5	STD9	250	250	0.5
6	2	STD9	100	400	0.5
5	1	STD9	50	450	0.5
4	0.5	STD7	50	450	0.5
3	0.25	STD7	25	475	0.5
2	0.1	STD5	50	450	0.5
1	0.05	STD5	25	475	0.5

A.8.0 PREPARATION OF INTERNAL STANDARD SOLUTIONS

Mix all solutions well. Unless otherwise noted, store solutions at 4 °C and bring to ambient temperature before use. Unless otherwise noted, prepare fresh solutions every three months or as needed.

Internal Standard Stock Solution, 9H-HDFNA (500 µg/mL): Weigh approximately 2 mg 9H-HDFNA and transfer to a 16.5 x 57 polypropylene vial. Dilute with appropriate volume of methanol to yield a 500-µg/mL solution. Vortex for one minute.

Internal Standard Working Solution, 9H-HDFNA (5 µg/mL): Transfer 250 µL of Internal Standard Stock Solution into a 25-mL class "A" volumetric flask containing approximately 20 mL of water. Dilute to volume with water. Vortex and transfer to a 50-mL polypropylene centrifuge tube.

A.9.0 PREPARATION OF QUALITY CONTROL SAMPLES

A.9.1 Preparation of Serum QC Samples

Prepare a 500-µg/mL QC Stock Solution in the same manner as the Standard Stock Solution in A.7.1. Prepare QC samples in a 5-mL volumetric flask by dilution of the QC Stock Solution, QC3, or QC2 into approximately 3 mL of control human serum (from a different lot than is used to prepare the standard curve) and diluting to volume according to the following table:

QC #	Analyte Conc. (µg/mL)	Solution to Use	µL of Solution	Dilute to Final Volume (mL)
QC4	50	QC Stock	500	5
QC3	8	QC Stock	80	5
QC2	3	QC3	1875	5
QC1	0.15	QC3	93.75	5
QC LLQ	0.05	QC2	83.1	5

Transfer 0.2-mL aliquots of each QC into microcentrifuge tubes and store frozen at -20 °C. Note that the QC LLQ was a one-time preparation and was not stored.

A.10.0 PREPARATION OF OTHER SOLUTIONS

HPLC-grade bottled water or equivalent should be used wherever water is called for. Mix all solutions well. Different volumes of the solutions in this section may be prepared if necessary. Unless otherwise noted, store at room temperature. Prepare fresh solutions every three months or as needed, unless otherwise noted.

0.5 M Tetrabutylammonium Hydrogen Sulfate, pH 10: Dissolve approximately 17 g of tetrabutylammonium hydrogen sulfate in 40 mL water in a 175-mL polypropylene bottle. Adjust the pH to 10 with 10 M and 1 M sodium hydroxide. Transfer to a 100-mL class "A" volumetric flask and dilute to the mark with water. Transfer to a 175-mL polypropylene bottle.

10 M Sodium Hydroxide: Dilute approximately 40 g sodium hydroxide to the mark with water in a 100-mL class "A" volumetric flask. Mix and transfer to a 175-mL polypropylene bottle.

1 M Sodium Hydroxide: Dilute 10 mL 10 M sodium hydroxide to the mark with water in a 100-mL class "A" volumetric flask. Mix and transfer to a 175-mL polypropylene bottle.

0.25 M Sodium Carbonate:0.25 M Sodium Bicarbonate: Dissolve 26.5 g sodium carbonate and 21 g sodium bicarbonate in approximately 500 mL water. Transfer to a 1-L polypropylene graduated cylinder and dilute to the mark with water. Mix and transfer to a 1-L polypropylene bottle.

1 M Ammonium Acetate: Dissolve 7.7 g ammonium acetate to the mark with water in a 100-mL class "A" volumetric flask. Mix and transfer to a 175-mL polypropylene bottle.

2 mM Ammonium Acetate: Add 2 mL of 1 M ammonium acetate to approximately 900 mL water in a 1000-mL polypropylene graduated cylinder and dilute to volume with water. Mix and transfer to a 1-L polypropylene bottle.

10:90 Methanol:2 mM Ammonium Acetate: Combine 100 mL methanol and 900 mL 2 mM ammonium acetate in a 1000-mL polypropylene graduated cylinder. Transfer to a 1-L polypropylene bottle.

90:10 Methanol:2 mM Ammonium Acetate: Combine 900 mL methanol and 100 mL 2 mM ammonium acetate in a 1000-mL polypropylene graduated cylinder. Transfer to a 1-L polypropylene bottle.

1% Ammonium Hydroxide: Dilute 3.6 mL ammonium hydroxide to the mark with water in a 100-mL class "A" volumetric flask. Mix and transfer to a 100-mL glass reagent bottle.

0.01% Ammonium Hydroxide: Dilute 2.5 mL 1% ammonium hydroxide to the mark with water in a 250-mL class "A" volumetric flask. Mix and transfer to a 250-mL glass reagent bottle.

80:20 Acetonitrile:0.01% Ammonium Hydroxide: Combine 800 mL acetonitrile and 200 mL 0.01% ammonium hydroxide in a 1-L glass reagent bottle.

A.11.0 LIQUID-LIQUID EXTRACTION PROCEDURE

1. Thaw samples and QCs.
2. Prepare the standards as outlined in Section A.7.2.
3. Label 16.5 x 101 mm screw-capped polypropylene tubes for each sample, standard, QC, control blank, and zero sample. Standards, carryover control blanks, and selectivity control blanks are analyzed in duplicate. QCs are analyzed in replicates of six. Six replicate zero samples are prepared in each of the two different lots of control serum used for the human serum standard curves and human serum QC samples.
4. Aliquot 25 µL of each standard, QC, zero sample, control blank, and sample into the appropriate tube.
5. Add 25 µL of Internal Standard Working Solution (5 µg/mL 9H-HDFNA) to all tubes except for the control blank samples. Add 25 µL of water to each control blank.
6. Add 1 mL of 0.5 M tetrabutylammonium hydrogen sulfate, pH 10 to each tube.
7. Add 2 mL of 0.25 M sodium carbonate:0.25 M sodium bicarbonate to each tube.
8. Add 3 mL ethyl acetate to each tube.
9. Shake on reciprocal shaker for 20 minutes at medium speed.
10. Centrifuge at 3200 rpm for 20 minutes
11. Transfer a 300-µL aliquot of the organic layer to a 96-well block.
12. Evaporate the eluate to dryness under nitrogen at 35 °C for approximately 30 minutes at a maximum pressure of 50 psi.
13. Reconstitue the dried extracts in two steps: Add 400 µL acetonitrile and vortex for 60 seconds. Add 400 µL purified water and vortex for 60 seconds.
14. Apply a cover film to the 96-well block.

A.12.0 TYPICAL INSTRUMENT CONDITIONS

HPLC Conditions:

Mobile Phase (gradient): A: 10:90 methanol:2 mM ammonium acetate

B: 90:10 methanol:2 mM ammonium acetate

Mobile Phase Gradient Conditions:

Time (min)	Function/Value
0.0	45% B
0.5	45% B
2.3	100% B
3.0	100% B
3.5	45% B
5.00	STOP

Flow Rate	300 µL/min
Autosampler	PE Series 200 (with 50-µL stainless steel loop)
Autosampler Temperature	Ambient
Autosampler Needle Wash	80:20 acetonitrile:0.01% ammonium hydroxide
Injection Volume	10 to 15 µL
HPLC Column	Betasil-C_{18}, 5 µm particle size, 2 mm x 50 mm
Typical Initial Column Pressure	73 bar (variable)
Autosampler Run Time	4.3 minutes

Analyte	Representative Retention Time (minutes)
PFOA*	2.5
9H-HDFNA	2.3

*Note: The PFOA chromatographic peak may show a small peak on its leading edge, which is most likely an isomeric component in the PFOA chemical standard.

Mass Spectrometer Conditions:

Curtain Gas	UHP Nitrogen
Nebulizer Gas	UHP Nitrogen
Collision Gas	UHP Nitrogen
TurboIonSpray™ Temperature	350 °C
Auxiliary Gas	UHP Nitrogen at 8 L/min

Selected Reaction Monitoring:

Analyte	Transition Monitored (±0.2)	Dwell Time
PFOA	m/z = 413 → 169	200 ms
9H-HDFNA	m/z = 445 → 381	200 ms

Ionization Mode	Negative Ion
Ion Spray Voltage:	3000 V
Declustering Potential	10 V
Collision Energy	25.5 eV
MS Acquisition Time	3.0 minutes
Pause Time	2 ms

Calibrate the mass axis of the instrument by infusion of Rhodapex mass calibration solution at a flow rate of 10 µL/min. Optimize the sensitivity of the instrument using an infusion of a 0.1 µg/mL mixed solution of PFOA and 9H-HDFNA at 10 µL/min into a flow of 190 µL/min of mobile phase using the initial gradient condition (45% eluent B). Mass spectrum peak widths should be approximately 0.6 amu at half-height in both single MS and MS/MS modes.

One set of calibration standards was injected at the beginning and one set of calibration standards was injected at the end of each analytical run. Additional control blank and zero samples may be used to monitor possible carryover or

contamination. Three replicates of each background subtraction zero sample are placed before each standard curve.

All polytetrafluoroethylene (PTFE)-containing materials are removed from the LC pumps and replaced with either stainless steel or PEEK. This is done to remove these items as potential sources of PFOA.

A.13.0 SYSTEM SUITABILITY

System suitability criteria were established during the validation based upon the response of the 0.05 μg/mL PFOA calibration standards in human serum. The system suitability samples for sample analysis are prepared for each analytical run, and injections are made into the system prior to sample analysis and subject to the following criteria. The peak shape and retention times for the analyte and internal standard should be comparable to that observed during the validation. The signal (peak height) for the 0.05-μg/mL system suitability samples should be a minimum of 400 cps in order to proceed with sample analysis.

A.14.0 CALCULATIONS

Calculated concentrations are based on peak area ratios of analyte to IS. The peak area for the analyte transition is divided by the peak area for the corresponding internal standard transition. The calibration curves are fit using a $1/x^2$ quadratic regression.

Background Subtraction procedure:

1. Background subtraction zero samples prepared with the control human serum lot used to prepare the standard curves are identified as ZERO_HSTD, and those prepared with the control human serum lot used to prepare the QC samples are identified as ZERO_HQC. Three replicates are placed before each standard curve.
2. After analysis, the data are processed in MacQuan, and the mean area ratio (area PFOA/area IS) from the six zero samples in each of the two control serum lots is

calculated in Excel from the data in the MacQuan results table (.DAT file). This yields two mean area ratios. If the coefficient of variation (CV) of a mean ratio is greater than 20%, then outlier values are removed and the mean is re-calculated. The Excel data are saved electronically (_ZERO file), and a hardcopy of the spreadsheet, showing the mean area ratios, is included in the analytical run documentation.

3. The applicable mean area ratios are subtracted from the raw area ratios for the standards and QC samples. Background subtraction calculations are performed in Excel using four significant figures for the mean area ratios, and again using the data in the MacQuan results table (.DAT file). The Excel data are saved electronically (_SUB file), and a hardcopy of the spreadsheet, showing the original and the background-subtracted data, is included in the analytical run documentation.
4. The background-subtracted data are copied to the original MacQuan results table (.DAT file) in Excel with the background-subtracted area ratios in the "Area" column of the .DAT file. The Excel feature of "paste values" is used. A value of 1 is placed in the "IS Area" column in the .DAT file. This will provide the correct background-subtracted area ratios for the Watson LIMS regression. The label "n/a" is entered in the analyte area column for control blanks. The Excel data are saved electronically (_SUB.DAT file) but not printed.
5. The background-subtracted data (_SUB.DAT file) are uploaded to Watson LIMS. These data will appear in the hardcopy printout from Watson LIMS (Import Information: Peak Areas).
6. The electronic files are placed into the appropriate folder for the analytical run on the file server in the LIMFILES directory.

Data are acquired and integrated using SCIEX software applications Sample Control (v. 1.4) and MacQuan (v. 1.6). The data are formatted in the Advion laboratory information management system (Watson, v. 6.1.0.03).

PFOA concentrations can be expressed as APFO by multiplying the PFOA values by 1/salt factor.

AR226_3405

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000130

Title: Bioanalytical Method Validation for the Quantitation of Perfluorooctanoic Acid in Human Serum

Authors: David J. Anderson[1]; Kimberly L. Norwood[1]; Stephen Lowes[1]; Mary A. Kaiser[2]; Barbara S. Larsen[2]

Institutes: [1]Advion BioSciences, Inc., Ithaca, New York; [2]Dupont Experimental Station, Wilmington, Delaware

Novel Aspect: A rigorous bioanalytical method validation of a representative, ubiquitous perfluorinated compound.

Introduction

Perfluorinated surfactants have received increased attention in the environmental and human health communities due to their ubiquitous presence, as well as their environmental persistence and possibly long half-lives in the human bloodstream. Advances in analytical methodology have facilitated the detection of these compounds at background levels in the low parts-per-billion range in human blood plasma and serum. The analytical uncertainty associated with these measurements is open to scientific criticism, and the errors are often unacceptable when compared to typical bioanalytical acceptance criteria. Application of the bioanalytical approach to method validation will be presented for the quantitation of perfluorooctanoic acid (PFOA) in human serum for two LC/MS/MS methods.

Methods

The bioanalytical methods both utilized ion-pairing, liquid-liquid extraction followed by gradient elution liquid chromatography and tandem mass spectrometry. Shimadzu LC 10AD pumps, a PE200 autosampler, and ionspray SRM MS/MS (positive ion) on a PE Sciex API 3000 were used in both methods. The target ranges of quantitation for the two methods were 1 ng/mL to 100 ng/mL and 0.05 µg/mL to 10 µg/mL. A structural analog, 9H-hexadecafluorononanoic acid, was used as the internal standard (IS). Due to the presence of PFOA in control human serum, the standard curves for the lower-level method were prepared in rabbit serum. Quality control (QC) samples were assayed in both human and rabbit serum to validate the use of rabbit serum standards for the quantitation of PFOA in human serum. Background subtraction was used to correct for the presence of PFOA in the control serum in both methods. In addition, extensive measures were taken to eliminate potential sources of PFOA from the extraction and the chromatographic system.

Preliminary Data

Higher-Level Method: The assay demonstrated a lower limit of quantitation of 50 ng/mL based upon a 25 µL aliquot of human serum. The calibration curves were fitted with a $1/x^x$ weighted quadratic regression, and the coefficients of determination (r^r) were ≥ 0.9950. The intra- and inter-assay accuracy (RE, -12.3 to 9.00%) and precision (CV, 2.07 to 7.70%), based upon the QC samples, were within the acceptance criteria (± 15%). The extraction recoveries of PFOA and the IS were 81.8 and 90.9%, respectively.

Lower-Level Method: The assay demonstrated a lower limit of quantitation of 1 ng/mL based upon a 50 µL aliquot of human serum. The calibration curves were fitted with a $1/x^x$ weighted quadratic regression, and the coefficients of determination (r^r) were ≥ 0.9929. The intra- and

inter-assay accuracy (RE, -0.567 to 5.57%) and precision (CV, 1.77 to 4.66%), based upon the human serum QC samples, were within the acceptance criteria (± 15%).

Keywords: Ionspray, MS/MS, Liquid Chromatography; Quantitative Analysis; Selected Reaction Monitoring

(Revision: 31 January 2003)

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AR226_3406

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RECYCLED

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AR226-3406

BIOANALYTICAL REPORT

Title:	Quantitative Determination of Ammonium Perfluorooctanoate (APFO), Measured as the Perfluorooctanoate Anion (PFOA), in Human Serum from Study DW04 Using Turbo Ion Spray LC/MS/MS
Date:	30 September 2003
Authors:	David J. Anderson, M.S. Susannah L. Murphy, B.S. Jennie L. Romney, M.P.S. Advion BioSciences, Inc. 15 Catherwood Road Ithaca, New York 14850
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Advion Report No.:	02331ADJA_DU.DOC
Advion Internal Study ID:	DW04
Number of Pages:	19

Summary and Conclusions

The concentration of ammonium perfluorooctanoate (APFO), measured as the perfluorooctanoate anion (PFOA), was determined in human serum samples collected during the Study DW04 using a selective, accurate, and reproducible analytical method developed by Advion BioSciences, Inc., Ithaca, NY.

Human serum samples (0.025 mL) were extracted by a liquid-liquid extraction procedure to isolate PFOA and the internal standard (9H-hexadecafluorononanoic acid, 9H-HDFNA). Following reconstitution, sample extracts were analyzed by turbo ion spray liquid chromatography/tandem mass spectrometry (LC/MS/MS) in the negative ion mode.

All samples were successfully analyzed within one run. The lower limit of quantitation was 0.05 μg/mL for PFOA. The precision of this assay (CV) as determined from the analysis of quality control (QC) samples for PFOA was ≤4.11%.

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ADVION BIOSCIENCES

SIGNATURE PAGE

Title: Quantitative Determination of Ammonium Perfluorooctanoate (APFO), Measured as the Perfluorooctanoate Anion (PFOA), in Human Serum from Study DW04 Using Turbo Ion Spray LC/MS/MS

Advion Report No.: 02331ADJA_DU.DOC

Reported by: _____ 30SEP2003
David J. Anderson, M.S. Date
Manager of Bioanalysis

Authorized for Release by: _____ 30.SEP.03
John R. Perkins, Ph.D. Date
Director of Bioanalysis

QAU STATEMENT

Periodic inspections of the bioanalytical portion of Study DW04 were conducted by the Quality Assurance Unit of Advion BioSciences (Advion).

The study was inspected on the following dates:

Phase of Study Inspected	Date of Inspection	Date Reported to Management
Sample Login Binder	8 January 2003	8 January 2003
Data Review	31 December 2002	31 December 2002
Report	17 September 2003	18 September 2003

Based on the inspections and the data reviewed, this report is a complete and accurate representation of the data.

George C. Amedro
George C. Amedro, B.S.
Quality Assurance Auditor

30 Sep 03
Date

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1. INTRODUCTION

1.1. Study Description and Objective

The objective of this study was to determine the concentrations of ammonium perfluorooctanoate (APFO), measured as the perfluorooctanoate anion (PFOA), in human serum samples collected during Study DW04. The study ID was generated by Advion BioSciences, Inc. (Advion) for internal tracking purposes. Human serum samples were analyzed using a selective liquid-liquid extraction, turbo ion spray liquid chromatography/ tandem mass spectrometry (LC/MS/MS) assay. The work described in this bioanalytical report was conducted in accordance with Advion standard operating procedures (SOP).

2. METHODS

2.1. Analytical Procedure(s)

PFOA concentrations were determined in human serum according to the validated LC/MS/MS method (1). Serum samples (0.025 mL) were extracted by a liquid-liquid extraction procedure to isolate the analyte and internal standard (IS) from human serum. Following reconstitution, sample extracts were separated by reversed-phase chromatography on a 2 x 50 mm (5 µm) Betasil C_{18} column (ThermoHypersil-Keystone, Bellefonte, PA) with an initial mobile phase of 45% Eluent B (90:10 methanol: 2 mM ammonium acetate) and 55% Eluent A (10:90 methanol:2 mM ammonium acetate). 9H-hexadecafluorononanoic acid (9H-HDFNA) was used as the IS for PFOA. PFOA concentrations were determined by turbo ion spray liquid chromatography/tandem mass spectrometry (LC/MS/MS) in the negative ion mode.

Following background subtraction (for calibration standards, QC samples, and zero samples), study sample concentrations were determined from a weighted ($1/x^2$), quadratic regression of peak area ratios (peak area of PFOA/peak area of 9H-HDFNA) versus nominal concentration of nine calibration standards. The nominal concentrations of the calibration standards were 0.05, 0.1, 0.25, 0.5, 1, 2, 5, 7.5 and 10 µg/mL PFOA.

The lower limit of quantitation (LLQ) for this assay was 0.05 µg/mL PFOA. Quality control (QC) serum samples at three different concentrations (0.15, 3, and 8 µg/mL PFOA) were analyzed in replicates of three.

The acceptance criteria for calibration standards stipulated that at least three-fourths of the calibration standards must remain on the calibration curve for each analytical run. Calibration standards may be rejected if they show deviations >15% from their nominal concentration (20% at the LLQ). The coefficient of determination (r^2) must be ≥0.98.

The acceptance criteria for the quality control samples stipulated that two-thirds of the individual QC samples must be within ±15% of the nominal concentration, and at least

one-half of the replicates at each QC concentration must be within ±15% of the nominal concentration.

A summary of the sample and assay information for Study DW04 is given in Table 1. Trip blanks were prepared at Advion in advance of the collection of serum samples in this study. The trip blanks were prepared by adding control human serum to collection tubes. The purpose of the trip blanks was as a precautionary means to monitor for potential contamination of study samples during shipment.

2.2. Assay Site

All samples were analyzed at Advion BioSciences, Inc., Ithaca, NY.

2.3. Data Processing

The data were collected using turbo ion spray LC/MS/MS in the negative ion mode. Peak areas were integrated by the Applied BioSystems program MacQuan, version 1.6, residing on a Macintosh computer. Following peak area integration, the results tables from MacQuan were saved as text files, which were used to perform background subtraction, using Excel 98, to correct for the presence of PFOA in the control serum lots. Background-subtracted data were saved as MacQuan text files and uploaded to the Advion file server where a weighted ($1/x^2$) quadratic regression was performed using the software package Watson (v 6.1.0.03, InnaPhase Corp., Philadelphia, PA). Concentration data were downloaded from Watson with three significant figures. Statistics were downloaded from Watson with three decimal places and rounded to three significant figures prior to reporting.

3. RESULTS

3.1. Assay Performance

The performance of the assay for PFOA as determined from the analysis of QC samples is documented in Table 2. The intra-assay precision (CV) of QC samples ranged from 3.14 to 4.11% for PFOA. There was no marked inaccuracy in the results from these QC samples; mean accuracy (RE) ranged from -10.7 to -6.33%.

The performance of daily calibration curves is documented in Table 3. There was no marked inaccuracy in the results from these standards; mean accuracy ranged from -2.60 to 5.00%.

The slope, y-intercept, and coefficient of determination (r^2) for the analytical run are presented in Table 4. The r^2 value was 0.9958 for PFOA in human serum.

All Advion personnel assigned to analyze samples for this project were required to successfully extract QC samples and calibration standards. Results of the extraction were reviewed by a trained analyst against the pre-defined acceptance criteria for this assay. Results are maintained in the study records of Advion.

Representative chromatograms from a PFOA control blank and zero sample are presented in Figures 1 and 2, respectively. Representative chromatograms from PFOA standards 1 and 9 are presented in Figures 3 and 4, respectively.

3.2. Analytical Results for Study DW04

PFOA concentrations in human serum from Study DW04 are presented in Table 5. All data were rounded to no less than three significant figures before reporting in Table 5. The two trip blanks are identified as subject numbers 98009 and 98010.

4. DATA RETRIEVAL

The calculated concentration data from the analysis of human serum samples for Study DW04 are maintained on file in the archives of Advion BioSciences, Inc., Ithaca, NY in Advion Notebook 02331.

5. REFERENCES

1. Advion BioSciences Validation Report 02120VDJA_DU.DOC. Method Validation for the Quantitation of Ammonium Perfluorooctanoate (APFO), Measured as the Perfluorooctanoate Anion (PFOA, 0.05 to 10 µg/mL Concentration Range), in Human Serum by Turbo Ion Spray LC/MS/MS. 12 July 2002.

6. TABLES

Table 1: Summary of Sample and Assay Information for Study DW04

Species/Matrix:	Human/Serum
Sample Collection and Storage Information:	
Anticoagulant/Stabilizer:	Not applicable
Date Received at Advion:	10 October 2002
Storage Temperature at Advion:	-20 °C
Number of Study Samples Received:	62
Number of Study Samples Analyzed:	62
Assay Information:	
Assay Period:	29 October 2002
Analyte:	**PFOA**
Analytical Standard:	PFOA (supplied as ammonium perfluorooctanoate, APFO)
Lot No:	421207/1
Source:	Sigma-Aldrich
Internal Standard:	9H-HDFNA
Lot No:	None available
Source:	Sigma-Aldrich
Calibration Range:	
Regression Method:	Quadratic
Weighting Factor:	$1/x^2$
Lower Limit of Quantitation:	0.05 µg/mL
Upper Limit of Quantitation:	10 µg/mL

Table 3: Precision and Accuracy for PFOA Calibration Standards in Human Serum for Study DW04

	PFOA Concentration (µg/mL)								
Run Number	STD1	STD2	STD3	STD4	STD5	STD6	STD7	STD8	STD9
	0.05	0.1	0.25	0.5	1	2	5	7.5	10
1	0.0444	0.0984	0.232	0.495	0.948	1.93	4.92	7.68	10.2
	0.0534	0.111	0.262	0.512	1.00	2.11	4.85	7.53	9.86
Mean	0.0489	0.105	0.247	0.504	0.974	2.02	4.89	7.61	10.0
CV (%)	NA	NA	NA	NA	NA	NA	NA	NA	NA
RE (%)	-2.20	5.00	-1.20	0.800	-2.60	1.00	-2.20	1.47	0.00

CV = (SD/Mean)*100
RE = [(Mean-Nominal)/Nominal]*100
NA = Not applicable

Table 4: **Calibration Curve Statistics for the Determination of PFOA in Human Serum for Study DW04**

Run Number	Quadratic Coefficient (A)	Linear Coefficient (B)	Intercept (C)	Coefficient of Determination (r^2)
1	-0.004962	0.357472	-0.001110	0.9958

$y = Ax^2 + Bx + C$, weighted $1/x^2$, after background subtraction

Table 5: **Concentrations of PFOA in Human Serum Samples from Study DW04**

Subject Number	PFOA Concentration (µg/mL)
57178	0.168
57179	0.175
57180	0.0788
57181	1.65
57182	<LLQ
57183	<LLQ
57184	<LLQ
57185	0.0561
57186	<LLQ
57187	1.13
57188	1.11
57189	<LLQ
57190	<LLQ
57191	<LLQ
57192	<LLQ
57193	<LLQ
57194	<LLQ
57195	<LLQ
57196	0.0543
57197	<LLQ
57198	0.0978
57199	0.347
57200	0.127
57201	0.0834
57202	0.277
57203	0.0506
57204	0.297
57205	0.233
57206	0.0527
57207	0.174
57208	0.125
57209	<LLQ
57210	0.0565
57211	0.210
57212	<LLQ
57213	<LLQ
57214	0.658

...continued

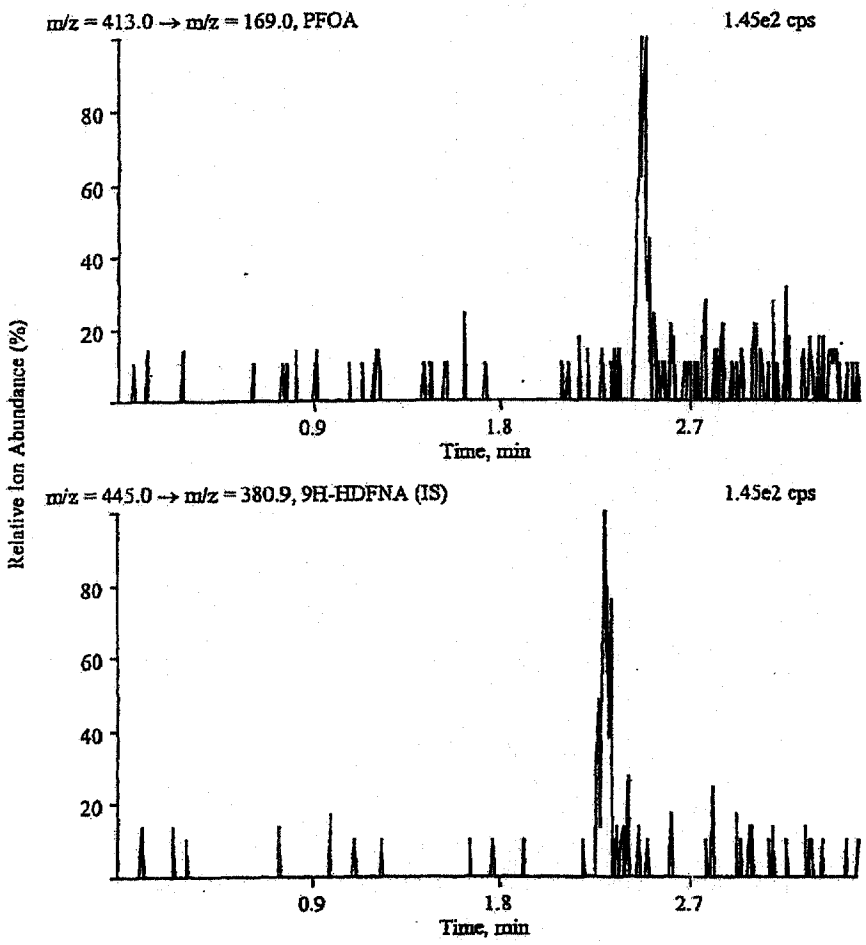
Table 5: **(Continued) Concentrations of PFOA in Human Serum Samples from Study DW04**

Subject Number	PFOA Concentration (µg/mL)
57215	0.0910
57216	0.0750
98009	<LLQ
98010	<LLQ
98039	<LLQ
98040	<LLQ
98041	0.244
98047	0.0598
98048	0.137
98049	<LLQ
98055	0.106
98056	0.199
98133	<LLQ
98134	0.0885
98135	0.242
98136	0.226
98137	0.359
98138	0.122
98139	0.0629
98140	<LLQ
98141	0.127
98142	0.264
98143	0.0807
98144	<LLQ
98145	<LLQ
98146	0.0576
98147	0.313

<LLQ: Less than the Lower Limit of Quantitation (0.05 µg/mL)

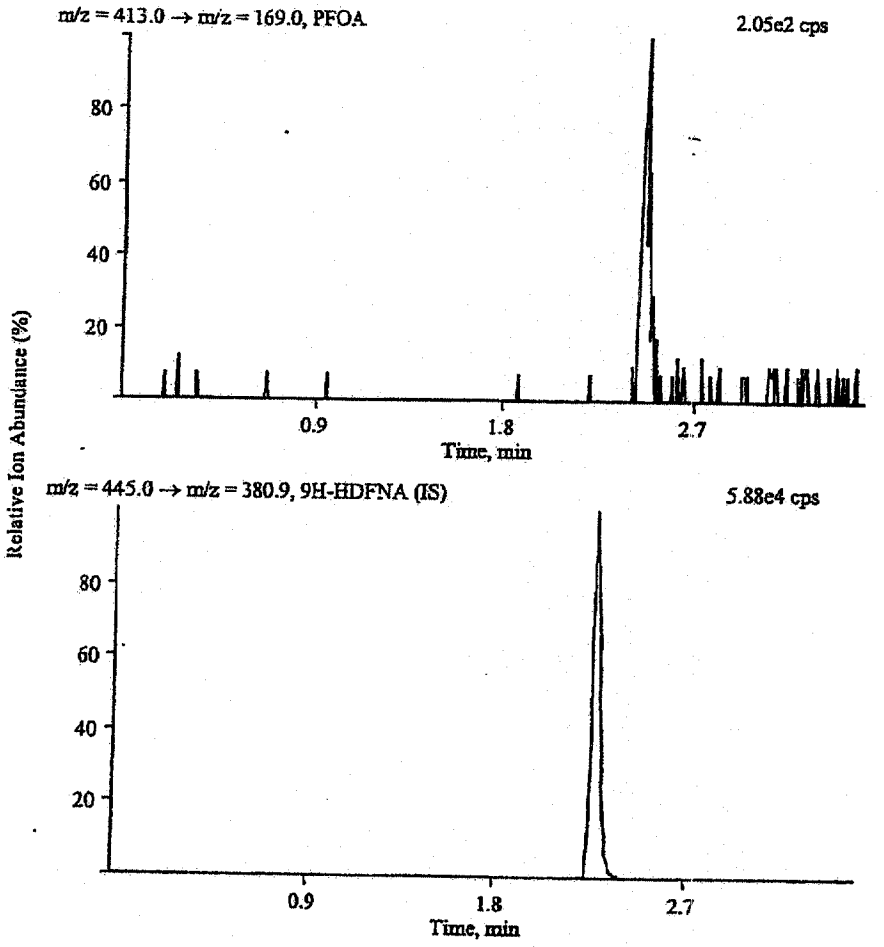
7. FIGURES

Figure 1: **Selected Reaction Monitoring Chromatograms of PFOA and the Internal Standard in Control Blank Human Serum Extract**



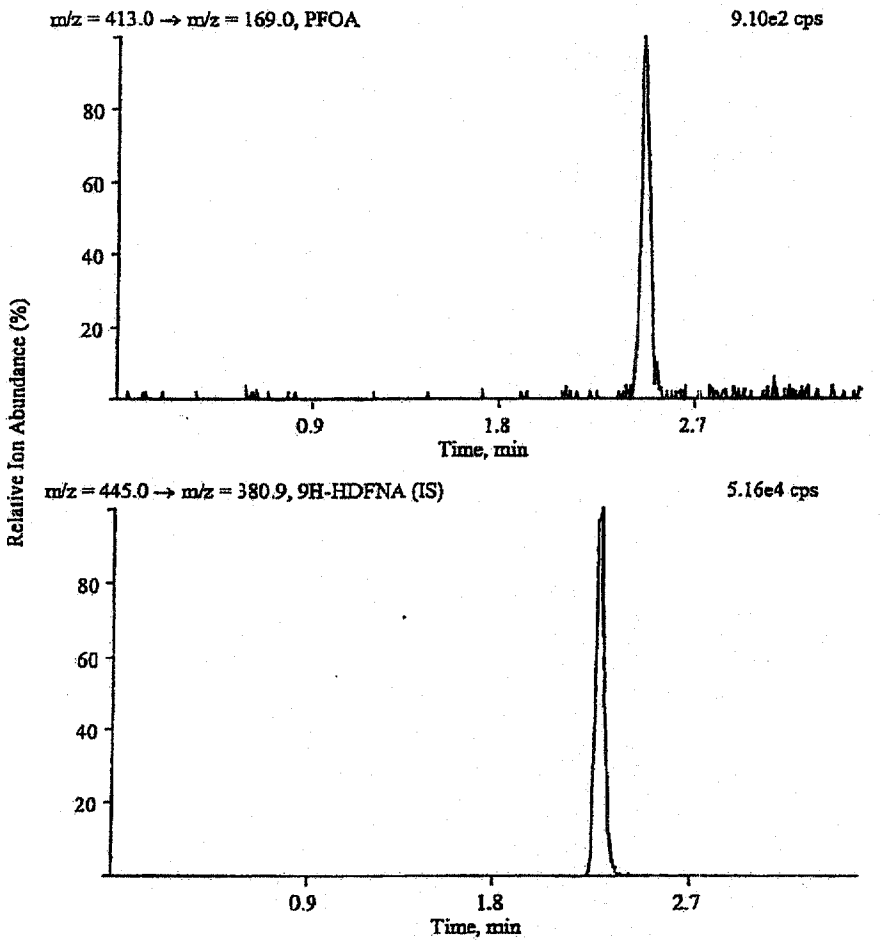
Control Blank, Run 1, Injection 7

Figure 2: **Selected Reaction Monitoring Chromatograms of PFOA and the Internal Standard from a Human Serum Extract Containing Internal Standard Only (Zero Sample)**



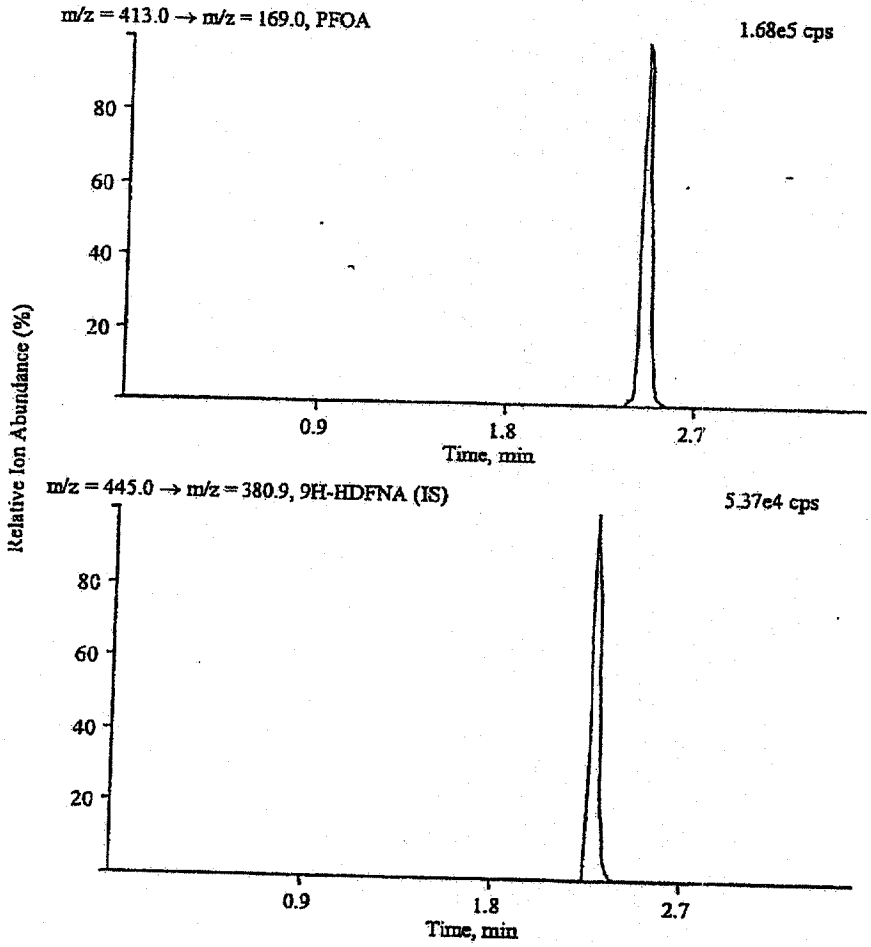
Zero Sample, Run 1, Injection 93

Figure 3: **Selected Reaction Monitoring Chromatograms of PFOA and the Internal Standard from a Standard 1 Human Serum Extract (0.05 μg/mL)**



Standard 1, Run 1, Injection 8

Figure 4: **Selected Reaction Monitoring Chromatograms of PFOA and the Internal Standard from a Standard 9 Human Serum Extract (10 µg/mL)**



Standard 9, Run 1, Injection 16

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TITLE

Method of Analysis for the Determination of Perfluorooctanoic Acid (PFOA) in Serum by LC/MS/MS - Revision 2

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1. SUMMARY

This report details a method of analysis for perfluorooctanoic acid (PFOA) in serum.

PFOA is extracted from serum by protein precipitation in acetonitrile. Quantification of PFOA is accomplished by liquid chromatography/tandem mass spectrometry (LC/MS/MS) analysis using selected reaction monitoring (SRM). The chemical formula of PFOA is given in section 2 of this method.

The lower limit of quantitation (LLOQ) for this method is 10 ppb for PFOA in serum.

Quantification is performed using extracted calibration standards containing an internal standard.

This method was developed using monkey serum. The overall percent recovery ± standard deviation for PFOA in monkey serum at 10, 100, and 1000 ppb was 94% ± 6.9% (Table I).

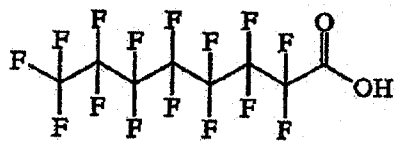
A representative calibration curve for PFOA in monkey serum is shown in Figure 1. Representative chromatograms for PFOA in monkey serum are shown in Figures 2 to 4.

2. EXPERIMENTAL COMPOUNDS

The structure of perfluorooctanoic acid (PFOA) and the internal standard are given below.

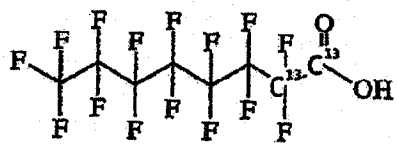
PFOA

Chemical Name	=	perfluorooctanoic acid
Molecular weight	=	414



^{13}C – PFOA

Chemical Name	=	perfluorooctanoic acid, [1,2-di-^{13}C]
Molecular weight	=	416



3. CHEMICALS AND SUPPLIES

3.1. CHEMICALS

Chemical	Grade	Source	Catalog No.
Methanol (MeOH)	HPLC	EM Science	JT9093-2
Acetonitrile (ACN)	HPLC	EM Science	AX0145-1
Ammonium Acetate	Reagent	Sigma-Aldrich	A-7330
OmniSolv Water	HPLC	EM Science	WX0004-1

3.2. STANDARDS

Standard	Lot Number	Purity (%)	Source
perfluorooctanoic acid (PFOA)	21002	97	Oakwood Products
perfluorooctanoic acid, [1,2-di-^{13}C]	NA	96.35	DuPont

3.3. EQUIPMENT AND SUPPLIES

Equipment	Supplier
Balance, analytical (display at least 0.0001 g)	Mettler
Centrifuge	Eppendorf
2 mL eppendorf centrifuge tubes	VWR
Disposable micropipets (50-100uL, 100-200uL)	Drummond (VWR)
Class A pipets and volumetric flasks	various suppliers
Hypercarb drop-in guard column (4 mm) (part # 844017-400)	Keystone
Stand-alone drop-in guard cartridge holder	Keystone
125-mL LDPE narrow-mouth bottles	Nalgene
2 mL clear HPLC vial kit (cat # 5181-3400)	HP
Standard lab equipment (graduated cylinders, disposable tubes etc.)	various suppliers
LC/MS/MS and HPLC systems	As described in section 4.5.

Note: Equivalent materials may be substituted for those specified in this method if they can be shown to produce satisfactory results.

Notes:

1. In order to avoid contamination, the use of disposable labware is highly recommended (tubes, pipets, etc.).
2. PTFE or PTFE lined containers or equipment, including PTFE-lined HPLC vials for the HPLC autosampler must <u>not</u> be used.
3. It is necessary to check the solvents (methanol) for the presence of contaminants by LC/MS/MS before use. Certain lot numbers have been found to be unsuitable for use.
4. Use disposable micropipets or pipets to aliquot standard solutions to make calibration standards and sample fortifications.
5. The hypercarb cartridges should be changed when the system contaminants (elevated baseline) move to within 1 minute from the elution of PFOA.

3.4. SOLUTIONS

(1) 2 mM ammonium acetate solution is prepared by weighing 0.15 g of ammonium acetate and dissolving in 1 L of OmniSolv Water.

Note: The aforementioned example is provided for guidance, alternative volumes may be prepared as long as the ratios of the solvent to solute are maintained.

3.5. Preparation of Standards and Fortification Solutions

Analytical standards are used for three purposes:

1. Calibration Standards – These standards are prepared in control monkey serum and are used to calibrate the response of the detector used in the analysis.
2. Laboratory Control Spikes – These fortifications are usually prepared at concentrations corresponding to the LLOQ and 10x LLOQ and are used to determine analytical recovery. Laboratory control spikes are prepared in control monkey serum.
3. Matrix Spikes – These fortifications are prepared by spiking into the field samples at known concentrations. Matrix spikes are used to evaluate the effect of the sample matrix on analytical recovery.

The absolute volumes of the standards may be varied by the analyst as long as the correct proportions of solute to solvent are maintained. Alternate concentrations may be prepared as long as the preparation and concentration are accurately recorded in the raw data. Note also that additional concentrations may be prepared if necessary.

3.5.1. Stock solution

Prepare individual stock solutions of ~ 100 µg/mL of PFOA and ^{13}C-PFOA by weighing out ~ 10 mg of analytical standard (corrected for purity) and dilute to 100 mL with methanol in a 100-mL volumetric flask. Each stock solution (in 125-mL LDPE bottles) is to be stored in a refrigerator at 2°C to 6°C and is stable for a maximum period of 1 year from the date of preparation.

3.5.2. Fortification Solutions

a. Prepare a fortification standard of 10.0 µg/mL for PFOA by diluting 10.0 mL of the PFOA solution described in 3.5.1 to 100 mL with acetonitrile in a volumetric flask.
b. Prepare a fortification standard of 1.0 µg/mL for ^{13}C-PFOA by diluting 1.0 mL of the ^{13}C-PFOA solution described in 3.5.1 to 100 mL with acetonitrile in a volumetric flask.
c. Prepare a fortification standard of 1.0 µg/mL for PFOA containing 0.005 µg/mL of ^{13}C-PFOA by diluting 10.0 mL of the PFOA solution described in 3.5.2.a and 0.5 mL of the ^{13}C-PFOA solution described in 3.5.2.b to 100 mL with acetonitrile in a volumetric flask.
d. Prepare a fortification standard of 0.1 µg/mL for PFOA containing 0.005 µg/mL of ^{13}C-PFOA by diluting 1.0 mL of the PFOA solution described in 3.5.2.a and 0.5 mL of the ^{13}C-PFOA solution described in 3.5.2.b to 100 mL with acetonitrile in a volumetric flask.
e. Prepare a fortification standard of 0.01 µg/mL for PFOA containing 0.005 µg/mL of ^{13}C-PFOA by diluting 0.1 mL of the PFOA solution

described in 3.5.2.a and 0.5 mL of the ^{13}C-PFOA solution described in 3.5.2.b to 100 mL with acetonitrile in a volumetric flask.

Store all fortification standard solutions in a refrigerator (in 125-mL LDPE bottles) at 2°C to 6°C for a maximum period of 1 year from the date of preparation, after which time it is necessary to make new standards using the stock solution.

3.5.3. Calibration Standards

The calibration standards are processed through the extraction procedure, identical to the samples. The fortification of the standards before extraction is done according to the following table:

Conc. Of Mixed Fortification Solution (µg/mL)	Fortification Volume (µL)	Volume of Control Sample (mL)	Conc. of Extracted Calibration Standard (ppb)
0.01	100	0.1	10
0.01	200	0.1	20
0.1	50	0.1	50
0.1	100	0.1	100
0.1	200	0.1	200

4. METHOD

4.1. Flow Diagram

The flow diagram of the method is given below, followed by a detailed description of each step.

<u>Method Flow Diagram</u>

Measure 0.1 mL of sample (using disposable micropipette)
(fortify samples when designated)

↓

Protein precipitation in acetonitrile

↓

LC/MS/MS analysis

4.2. Sample Processing

No sample processing is needed for serum samples. However, frozen samples must be allowed to completely thaw, un-aided, at room temperature. Samples

stored refrigerated should also be allowed to equilibrate to room temperature. All samples must be thoroughly mixed before being sampled for extraction.

4.3. Sample Preparation

a. Each batch of samples extracted (typically 30 or less) must include at least one reagent control (acetonitrile blank), one matrix control (method blank), and two matrix controls fortified at known concentrations to verify procedural recovery for the batch.
b. At least one sample per batch should be extracted in duplicate.
c. At least one sample extracted should be separately fortified at a known concentration and carried through the procedure to verify recovery. Additional matrix spikes may be performed at the sponsor's request.

4.4. Extraction

1. Measure 0.1 mL of sample into 2 mL eppendorf centrifuge tubes (fortify with analyte as needed, close lid, and vortex ~ 10 seconds).
2. Add enough acetonitrile containing internal standard at 0.005 µg/mL (accounting for fortification volume) to make extraction volume 500 µL and vortex for ~ 10 seconds.
3. Centrifuge for ~ 10 minutes at ~ 14,000 rpm.
4. Analyze samples using electrospray LC/MS/MS.

4.5. Quantitation

4.5.1. LC/MS/MS System and Operating Conditions

Instrument:	PE SCIEX API 4000 Biomolecular Mass Analyzer SCIEX Turbo Ion Spray Liquid Introduction Interface
Computer:	Dell OptiPlex GX 110
Software:	PE Sciex Analyst 1.2
HPLC Equipment:	Hewlett Packard (HP) Series 1100 Quatpump G1311A Vacuum Degasser G1322A Autoinjector G1313A Column Compartment G1316A

Note: Two 4 × 10 mm hypercarb drop-in guard cartridges (Keystone, part # 844017-400) are attached in-line after the purge valve and before the sample injector port to trap any residue contaminants that may be in the mobile phase and/or HPLC system.

HPLC Column: Genesis C_8 (Jones Chromatography), 2.1 mm x 50 mm, 4μ
Column Temperature: 30° C
Injection Volume: 5 μL
Mobile Phase (A): 2 mM Ammonium Acetate in OmniSolv Water
Mobile Phase (B): Methanol

Time	% A	% B	Flow (mL/min)
0.0	40	60	0.3
3	40	60	0.3
3.5	0	100	0.3
3.7	0	100	0.5
7	0	100	0.5
7.5	40	60	0.5
9	40	60	0.5
9.5	40	60	0.3
12	40	60	0.3

It may be necessary to adjust the HPLC gradient in order to optimize instrument performance.

Ions monitored:

Analyte	Mode	Transition Monitored	Approximate Retention Time
PFOA	Negative	413 → 369	~2.8 min.
^{13}C-PFOA	Negative	415 → 370	~2.8 min.

The retention times may vary, on a day-to-day basis, depending on the batch of mobile phase etc. Drift in retention times is acceptable within an analytical run, as long as the drift continues through the entire analysis and the standards are interspersed throughout the analytical run.

Note: An alternative LC/MS/MS system may be used once demonstrated to be equivalent.

4.5.2. Tune File Parameters

The mass spectrometer is tuned for the analyte by infusing a ~ 1 μg/mL standard solution of PFOA (at 10 μL/min, using an infusion pump) via a "T" into a stream of mobile phase containing 60% methanol and 40% 2mM ammonium acetate at 0.3 mL/min flow rate. The analyte is initially tuned for the parent ion and then tuned for the product ion. Once the instrument is tuned, the optimized parameters are saved as a tune file. This tune file is then used during routine analysis.

4.5.3. Calibration Procedures

a. Inject the same aliquot (5 μL) of each calibration standard into the LC/MS/MS.

b. Use linear standard curves for quantitation. Linear standard curves are generated for each analyte by linear regression using 1/x weighting of the ratio analyte peak area/internal standard peak area versus the ratio of the concentration of analyte/concentration of internal standard using Analyst 1.2 (or equivalent) software system. Any calibration standard found to be a statistical outlier by using the appropriate outlier test (e.g. Huge Outlier Test), may be excluded from the calibration curve. However, the total number of calibration standards that could be excluded must not exceed 20% of the total number of standards injected and at least one calibration standard at the LLOQ must be retained.

c. The correlation coefficient (r) for calibration curves generated must be ≥0.9925 (r^2 ≥0.985). If calibration results fall outside these limits, then appropriate steps must be taken to adjust instrument operation, and the standards or the relevant set of samples should be reanalyzed.

4.5.4. Sample Analysis

a. Inject the same aliquot (5 µL) of each standard, sample, recovery, control, etc. into the LC/MS/MS system.

b. Standards corresponding to at least five or more concentration levels must be included in an analytical set.

c. An entire set of calibration standards should be injected at the beginning of a set followed by calibration standards interspersed every 5-10 samples (to account for a second set of standards). As an alternative, an entire set of calibration standards may be included at the beginning and at the end of a sample set. In either case, calibration standards must be the first and last injection in a sample set.

d. The concentration of each sample/fortification/control is determined from the standard curve, based on the peak area of each analyte. The standard responses should bracket responses of the residue found in each sample set. If necessary, dilute the samples in 50:50 methanol:water to give a response within the standard curve range.

e. Fortification recoveries falling within 85 to 115% (80 to 120% for levels at the LLOQ) are considered acceptable.

f. Extracted samples must be stored refrigerated between 2°C to 6°C until analysis.

g. Samples in which no peaks are detected (i.e. signal : noise ratio < 3:1) at the corresponding analyte retention times will be reported as ND (not detected). Samples in which peaks are detected at the corresponding analyte retention

times but are less than the lowest concentration of the calibration standards (10 ppb where LLOQ = 10 ppb) will be reported as <10 ppb.

4.6. Acceptance Criteria

The following criteria must be met to ensure the presence of PFOA and ^{13}C-PFOA:

1. The chromatograms must show the following peaks:
   PFOA: a daughter ion at 369 amu from a parent of 413 amu
   ^{13}C-PFOA: a daughter ion at 370 amu from a parent of 415 amu

2. Any analyte present in method blanks must be at least 5-fold lower than the LLOQ. Any analyte present in the reagent blank must be at least 5-fold lower than the LLOQ.

3. Recoveries of lab control spikes and matrix spikes must be between 85-115% (80-120% for levels at the LLOQ) of their known values. Any method fortification (lab control spike) falling outside the acceptable limits warrants re-extraction of the entire analytical set. Any matrix spike outside the acceptable range should be evaluated by the analyst to determine if re-extraction is warranted.

4. Any calibration standard found to be a statistical outlier by using an appropriate outlier test, may be excluded from the curve. However, the total number of calibration standards that could be excluded must not exceed 20% of the total number of standards injected and at least one calibration standard at the LLOQ must be retained.

5. The correlation coefficient (r) for calibration curves generated must be ≥ 0.9925 ($r^2 \geq 0.985$). If calibration results fall outside these limits, then appropriate steps must be taken to adjust instrument operation, and the standards or the relevant set of samples should be reanalyzed.

4.7. Performance Criteria

The following two criteria must be performed as a system suitability test, before the commencement of analysis when using an instrumentation set-up that has not been used for this method.

First Criterion:
Run a standard solution on LC/MS/MS corresponding to the estimated LLOQ and obtain a signal-to-noise ratio of at least 9:1, compared to a reagent blank. If this criterion cannot be met, optimize and change instrument operating parameters.

Second Criterion:
Run a set of standards of five or more concentration levels, spanning a range starting at or below the LLOQ up to the highest concentration level to be included in the analysis. Generate a calibration curve for each analyte and obtain a linear regression with a coefficient of determination (r^2) of at least 0.985. Once this criterion is met, samples may be analyzed with standards interspersed.

4.8. TIME REQUIRED FOR ANALYSIS

A set of 35 samples (1 reagent control, 1 matrix control, 1 laboratory spike, 2 laboratory control spikes, and 30 samples) can be taken through the extraction procedure in approximately 8 hours by one person. The LC/MS/MS analysis (standards and 35 samples) will take approximately 9 hours.

5. CALCULATIONS

a. Use Equation 1 to calculate the amount of analyte found (in ng/mL, based on peak area) using the standard curve (linear regression parameters) generated by the Analyst software program.

Equation 1:

$$\text{Analyte found (ppb)} = \frac{(\text{Analyte Peak area/IS peak area}) - \text{intercept})}{\text{slope}} \times \text{IS conc. (ng/mL)}$$

b. For samples fortified with known amounts of analyte prior to extraction, use Equation 2 to calculate the percent recovery.

Equation 2:

$$\text{Recovery (\%)} = \frac{\text{Analyte found (ppb)} - \text{avg. Analyte found in control (ppb)}}{\text{Amount Analyte added (ppb)}} \times 100\%$$

6. SAFETY

The analyst should read the material safety data sheets for all standards and reagents before performing this method. Use universal precautions when handling standards and reagents, including working in fume hoods and wearing laboratory coats, safety glasses, and gloves. Use blood-borne pathogen handling precautions when handling serum.

Table I. Recovery of PFOA from Fortifications In Monkey Serum

Summary of PFOA Recoveries for 10 ppb Fortification in Monkey Serum

Exygen ID	Sponsor ID	Extraction Date	Analysis Date	Fort. Level (ppb)	% Recovery
0300808 Spk A	Lot 40K7400	05/30/03	05/30/03	10	95
0300808 Spk B	Lot 40K7400	05/30/03	05/30/03	10	94
0300808 Spk C	Lot 40K7400	05/30/03	05/30/03	10	98
				AVERAGE:	96
				STANDARD DEVIATION:	2.1
				RELATIVE STANDARD DEVIATION:	2.2

Summary of PFOA Recoveries for 100 ppb Fortification in Monkey Serum

Exygen ID	Sponsor ID	Extraction Date	Analysis Date	Fort. Level (ppb)	% Recovery
0300808 Spk D	Lot 40K7400	05/30/03	05/30/03	100	92
0300808 Spk E	Lot 40K7400	05/30/03	05/30/03	100	90
0300808 Spk F	Lot 40K7400	05/30/03	05/30/03	100	93
				AVERAGE:	92
				STANDARD DEVIATION:	1.5
				RELATIVE STANDARD DEVIATION:	1.7

Summary of PFOA Recoveries for 1000 ppb Fortification in Monkey Serum

Exygen ID	Sponsor ID	Extraction Date	Analysis Date	Fort. Level (ppb)	% Recovery
0300808 Spk G	Lot 40K7400	05/30/03	05/30/03	1000	107
0300808 Spk H	Lot 40K7400	05/30/03	05/30/03	1000	95
0300808 Spk I	Lot 40K7400	05/30/03	05/30/03	1000	81
				AVERAGE:	94
				STANDARD DEVIATION:	13.0
				RELATIVE STANDARD DEVIATION:	13.8
				OVERALL AVERAGE:	94
				OVERALL STANDARD DEVIATION:	6.9
				OVERALL RELATIVE STANDARD DEVIATION:	7.3

Figure 1. Calibration curve for PFOA in Control Monkey Serum

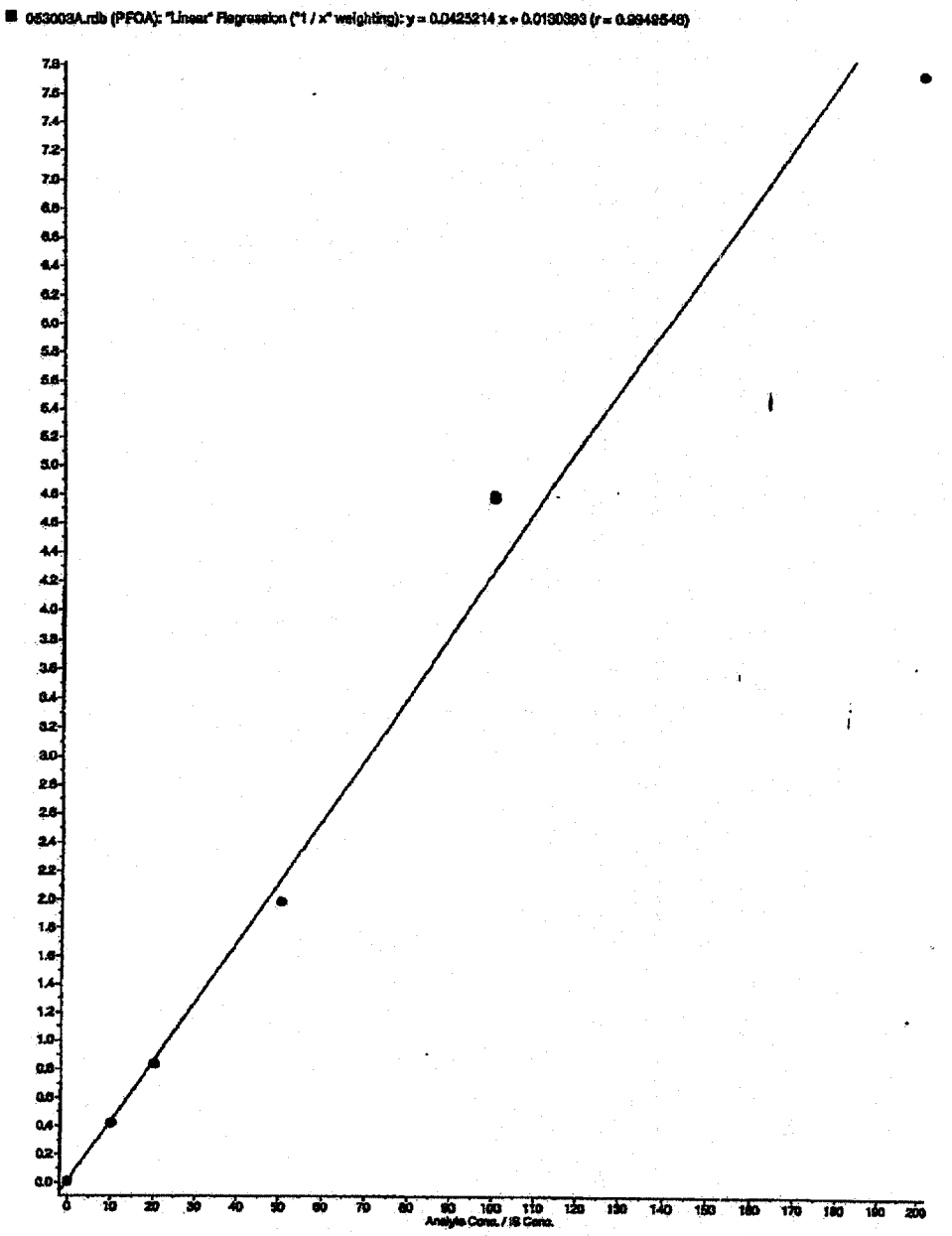


Figure 2. Representative Chromatogram of a Control Monkey Serum Sample for PFOA with ~ 5 ng/mL of ^{13}C-PFOA

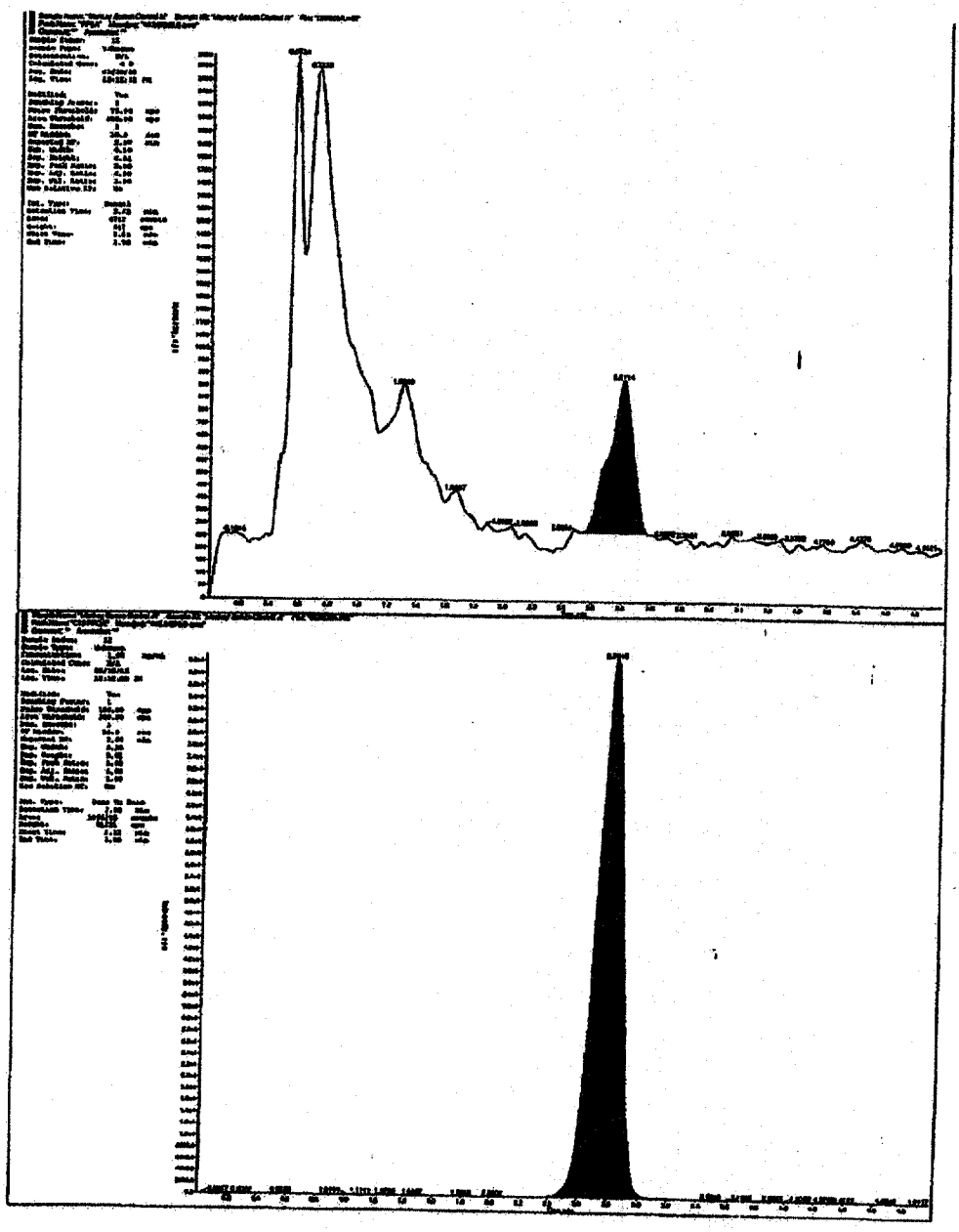


Figure 3. Representative Chromatogram of a 10 ppb Standard for PFOA in Control Monkey Serum with ~ 5 ng/mL of ^{13}C-PFOA

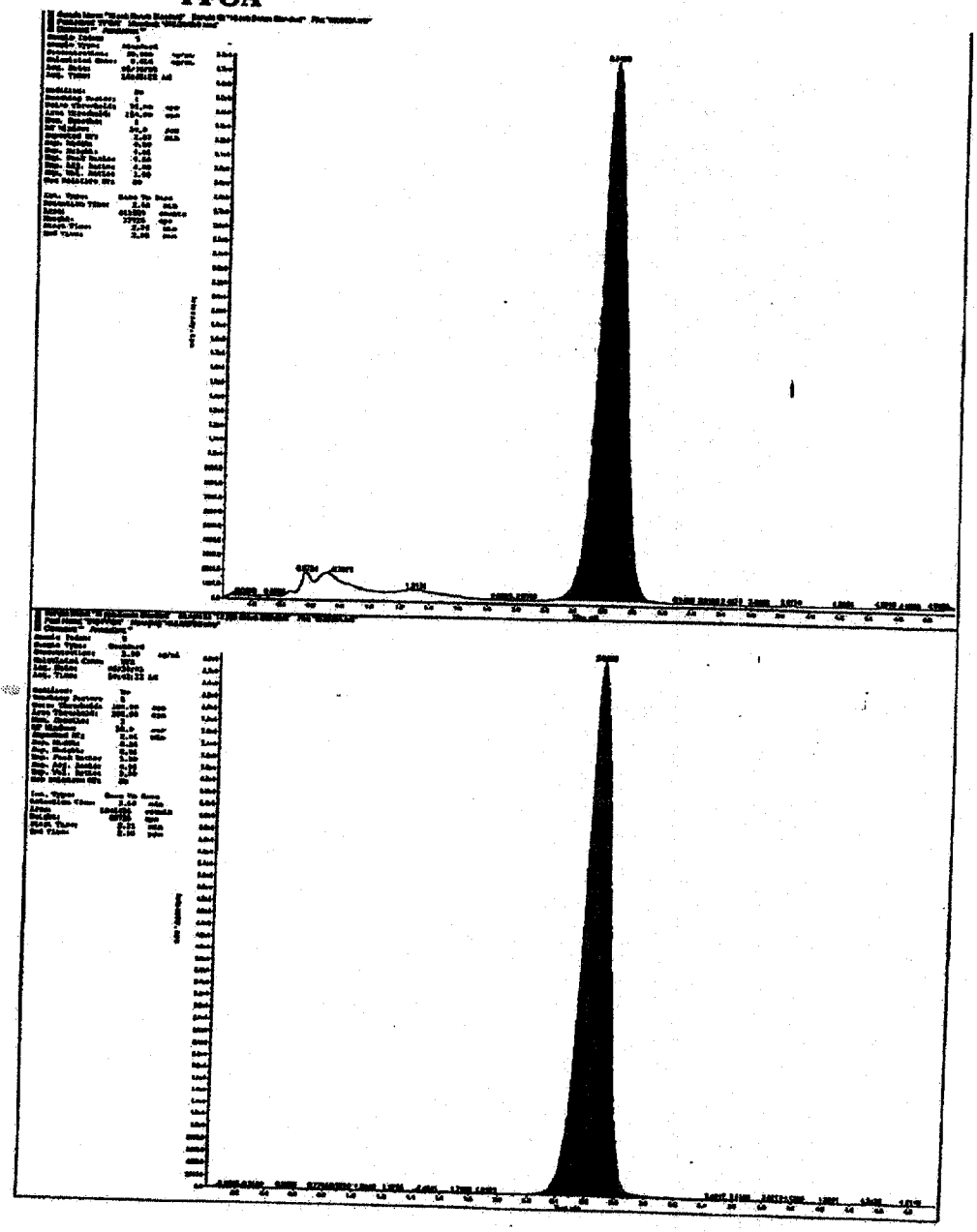
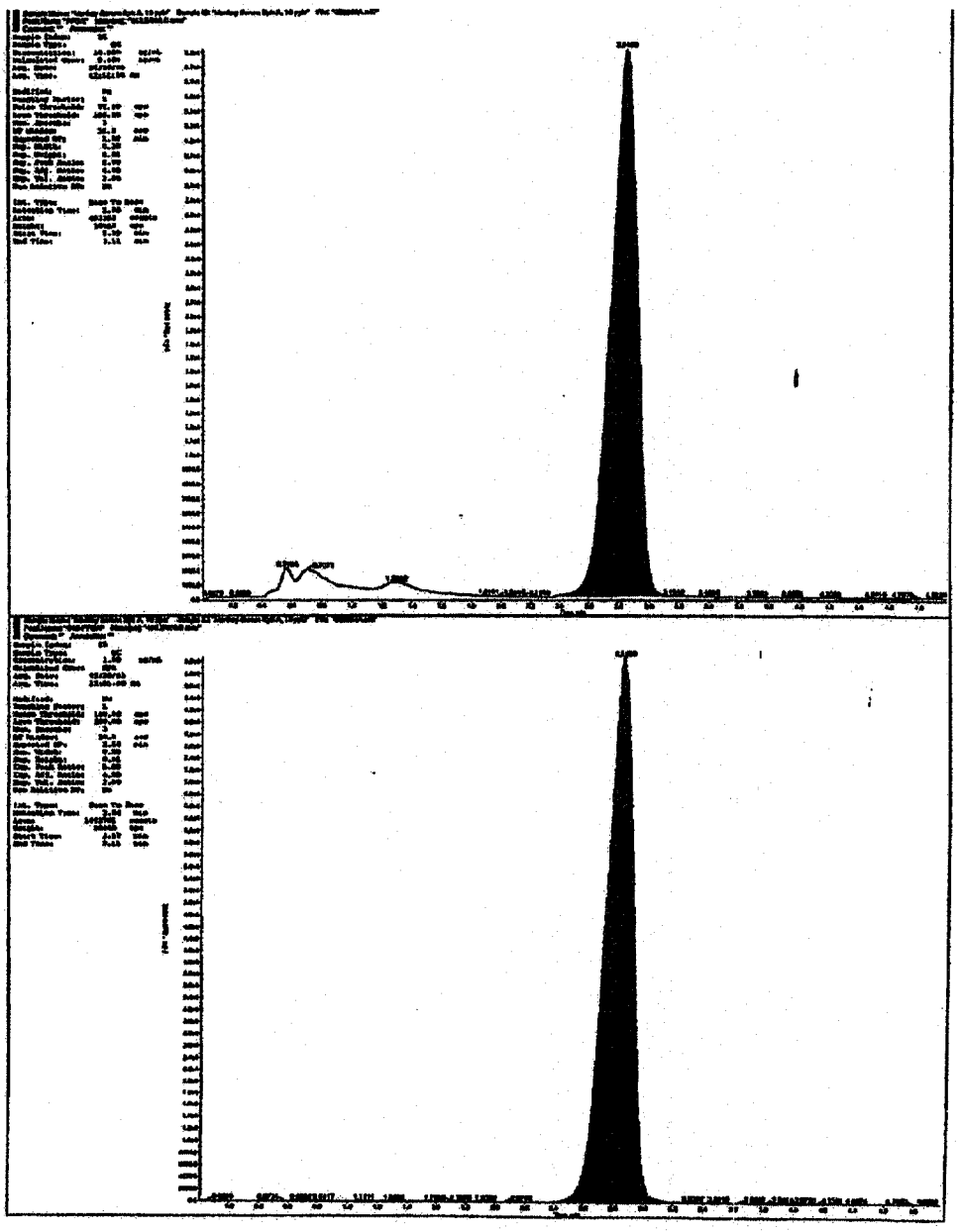


Figure 4. Representative Chromatogram of Control Monkey Serum Fortified at 10 ppb with PFOA and with ~ 5 ng/mL of ^{13}C-PFOA



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Validation of Determination of Total Fluorine in Blood by Wickbold Torch with Direct Potentiometric Detection.

Principle:
Wickbold Torch (WT) is an analytical sample digestion method where the fluorine-containing sample is combusted by hydrogen/oxygen flame and converted to inorganic fluoride. Fluoride is condensed and absorbed in a small amount of water. The resulting solution is then analyzed by direct potentiometry using a fluoride ion-selective electrode (F-ISE) to obtain its concentration in the measured solution. This concentration is directly proportional to the total amount of fluorine being combusted by WT.

Procedure:
Validation of determination of Fluorine by WT/F-ISE in blood was performed in two steps:

1. Validation of potentiometric determination of fluoride by F-ISE.
2. Validation of determination of fluorine in blood by WT/F-ISE.

A. Validation of potentiometric determination of fluoride by F-ISE.

The following method was used for direct potentiometric determination of fluoride:

1.1 Calibration curve dE vs. log c_F was measured daily where dE is the difference between the F-ISE potential of 20 ppb F^- reference solution and the F^- standard solution. 20 ppb reference solution was measured immediately before each measured calibration standard. c_F is the concentration of F^- in the calibration standard. Calibration standards containing 30, 50, and 100 ppb F^- were used.

1.2 Performance of the F-ISE was evaluated daily based on the deviation of the calibration curve slope from the theoretical slope value (S). Considering that the F-ISE was operated in the non-linear portion of its response, the tolerance of S ± 5 was allowed.

Where $S = \frac{RT}{F}\ln 10$

Where R is universal gas constant, T is temperature in Kelvin, and F is Faraday's constant.

1.3 Validation samples for F-ISE measurement were prepared by dissolving the appropriate amount of dried NaF in MiliQ H_2O. This primary stock solution was serially diluted with water to produce appropriate concentrations of F^- in water. All F^- solutions (including those from samples) were transferred and stored in plastic (HDPE) bottles.

1.4 To evaluate the contribution of F-ISE measurement and the sample manipulation to the uncertainty of the final WT analytical results, simulated samples were treated the same way as the actual WT blood samples would be. Except, the burning process was not performed. That is, 1.5g of sample (recorded with analytical precision) was transferred to a plastic bottle to which the appropriate amount of NaAc buffer and F^-

spike was added. The volume of the solution was then increased to 150g with MiliQ water (to simulate the final volume after the WT burn). The amount of F^- spike added to each sample solution was calculated in a way that, after dilution of the solution to 150g, the contribution of F^- spike to the final F^- concentration would be exactly 20 ppb (the same as the concentration of the reference solution measured before each sample/standard). The system blank was simulated in the same way (0.0000g of sample was added to the simulated system blank bottle).

1.5 pH and ionic strength of each measured solution were kept constant by means of sodium acetate (NaAc) buffer added to each measured solution to produce a constant NaAc concentration in each measured solution. pH was kept at 5.

1.6 F-ISE was allowed to equilibrate with each measured solution for 10 minutes at a constant stirring rate. After each 10-min measurement the electrode was dipped for 6 seconds into a rinsing solution (stirring on during rinsing). Timing and stirring rate were controlled electronically by Titrino 751 potentiometric titrator system.

Results and Discussion

Accuracy, reproducibility, and operator to operator variability were evaluated for automated determination of F^- by F-ISE.

Accuracy was evaluated by means of relative error of a single determination of samples at 1, 5, 20, and 100 ppm F^- in water.

Reproducibility was evaluated at 1, 5, and 100 ppm concentration levels by analysis of multiple identically prepared samples (n = 10).

Operator to operator variability was evaluated by having two operators perform the above accuracy and reproducibility analyses independently.

Table I.

Accuracy evaluation of determination of F^- by F-ISE by two operators.

	Operator I		Operator II	
Actual F^- concentration (ppm)	Determined F^- concentration (ppm)	relative error (%)	Determined F^- concentration (ppm)	relative error (%)
1	1.38	38[a]	0.88	-12
5	5.23	4.8	5.10	2.0
20	21.7	8.4	19.9	-0.4
100	109	9.2	90.2	-9.8

[a] measurement influenced by extensive exposure of F-ISE to water, disregard result (see text)

Table II.

Reproducibility evaluation of determination of F^- by F-ISE at 5 ppm by two operators.

	Operator I[a]		Operator II[b]	
Actual F^- concentration (ppm)	Determined F^- concentration (ppm)	relative error (%)	Determined F^- concentration (ppm)	relative error (%)
5	5.57	11	5.10	2.0
5	5.39	7.7	4.95	-1.0
5	5.31	6.2	4.92	-1.6
5	5.65	12.9	4.90	-2.0
5	5.27	5.4	4.85	-2.9
5	5.24	4.7	5.06	1.1
5	5.16	3.1	4.84	-3.1
5	5.22	4.4	4.89	-2.1
5	5.05	1.1	4.83	-3.4
5	5.17	3.9	4.85	-2.9
average	5.31	6.1	4.92	2.2
st. dev.	0.18	3.7	0.09	0.8
%CV	3.47		1.87	

[a] disposable graduated glassware used for volume transfers
[b] volumetric glassware used for volume transfers

Table III.

Reproducibility evaluation of determination of F^- by F-ISE at 100 ppm by two operators.

	Operator I		Operator II	
Actual F^- concentration (ppm)	**Determined F^- concentration (ppm)**	**relative error (%)**	**Determined F^- concentration (ppm)**	**relative error (%)**
100	106	6.2	105	5.3
100	97.1	-2.9	104	4.2
100	108	8.3	103	3.2
100	101	1.3	129[a]	29[a]
100	106	5.7	91	-8.7
100	109	8.8	105	5.2
100	103	3.3	108	7.8
100	103	2.5	103	2.8
100	110	9.6	105	5.1
100	105	5.1	107	7.3
average	105	5.4	104	5.5
st. dev.	3.84	2.9	4.90	2.0
%CV	3.66		4.73	

[a] measurement influenced by extensive exposure of F-ISE to water, result excluded from average, st. dev., and %CV calculations (see text)

It can be seen form tables I, II, and III that the accuracy (as indicated by % relative deviation from the nominal concentration value) and precision (as indicated by standard deviation and %CV's of replicate measurements) of the F-ISE determination of F^- in water do not seem to be operator-dependent.

As indicated by the results summarized in Table II, the accuracy and precision of the method can be improved approximately two-fold when more accurate volumetric glassware is employed for solution preparation and volume transfers during the analysis. The accuracy and precision of the technique did not improve when higher F^- concentrations were analyzed as indicated by the standard deviation and %CV values in Table III compared to Table II. This is due to the fact that the F^- concentrations in the final simulated WT solutions resulting form 100 ppm samples had to be 20x diluted to fit to the calibration curve range. This additional step and more sample manipulation had adverse effect on the standard deviations and %CV's one would expect from higher concentration samples.

The results shown in Table III include one significant outlier. The results shown in Table I, II, and III were obtained when water was used as washing solution for F-ISE (see Procedure 1.6). If the electrode is allowed to rest in water (e.g. during,

loading/unloading the sample changer, titrator data entry, when the sample sequence is finished) for extended period of time (more than 30 seconds), the electrode will be entering the next sample solution polarized to very high potentials. Consequently, the 10-min equilibration time will not be sufficient for that solution. Since all data solutions are measured in pairs (20 ppb reference and an actual sample/standard), it is usually the 20 ppb reference measurement which gets affected. Therefore, the problem is easy to diagnose by comparing all the 20 ppb measurements for the day and correlating the way the analysis was done with any observed 20 ppb outlier. This situation occurred for one sample in Table I and one sample in Table III. Both of these results should be disregarded. In order to minimize this effect, 10 ppb F^- solution was used as wash solution for subsequent experiments.

It is necessary to note that a similar effect was observed (to a much smaller extent) for the 20 ppb reference measurement measured right after 100 ppb standard. This is due to the fact that 100 ppb standard (highest concentration standard) produces relatively low electrode potentials compared to the rest of the standards and samples. Therefore the next solution might require slightly longer equilibration time. It is critical for WT analysis that the 20 ppb reference corresponding to the system blank for a sample set is not influenced by this effect because all the results for the sample set depend on the value and accuracy of the measurement of system blank (and its 20 ppb reference solution). To avoid this situation, the standards should be measured in a descending order, that is 20, 100, 20, 50, and 20, 30 ppb (where the 20 ppb is the reference solution measured before each standard, see part A 1.1). When the standards are measured in this order, it is the 20 ppb reference corresponding to 50 ppb standard which will get slightly affected and not the system blank reference. More accurate WT data can be produced this way. The effect on 50 ppb measurement is minimized by means of linear regression performed on all three standards. This is also supported by the fact that the correlation coefficients of our calibration curves from multiple days were higher than 0.999 (frequently values higher than 0.9999 were observed).

Since the effects and observations discussed above could not be made until the results in Table I, II, and III were obtained, additional testing was performed at 1 ppm F^- levels. The results from these tests are summarized in Table IV. In this table, 0.5g sample size was used (to simulate the extent of dilution for real WT blood samples), and the changes discussed above were implemented (standards measured in descending order, 10 ppb F^- solution used as wash solution).

Table IV.

Reproducibility evaluation of determination of F^- by F-ISE at 1 ppm
0.5g sample size

	Operator II	
Actual F^- concentration (ppm)	**Determined F^- concentration (ppm)**	**relative error (%)**
1.0	1.13	13
1.0	1.12	12
1.0	0.98	-1.6
1.0	1.01	0.7
1.0	1.01	0.9
1.0	1.00	0.2
1.0	0.93	-7.1
1.0	0.92	-8.0
1.0	0.84	-16
1.0	0.87	-13
average	0.98	7.2
st. dev.	0.09	6.0
%CV	9.64	

B. Validation of determination of fluorine in blood by WT.

The method for determination of fluorine in whole blood by WT/F-ISE was evaluated in terms of accuracy, reproducibility, and carryover.

Accuracy of the determination was evaluated based on the % relative deviation of the results produced by the method compared to the targeted fluorine contents in the blank blood samples spiked with known amounts of fluorine.

Reproducibility/precision was evaluated based on multiple analyses of samples prepared at the same fluorine concentration level. Multiple analyses of the same sample were performed as well as analyses of identically prepared samples on different days.

Carryover evaluation was done by comparing the absolute fluorine amounts determined during system blank determination (before the start of any sample analysis) with the absolute fluorine amounts determined immediately after the analysis of high fluorine containing samples (approx. 25 and 100 ppm). For these determinations, 0.0000g of sample was burned and treated the same way as if it was a real blood sample.

All the blood for the WT validation was from male rats not treated with any special fluorinated diet. Fluorine spiked into blood was in the form of aqueous solution of ammonium perfluorooctanoate (abbreviated as C8). Appropriate amounts of solid C8 were weighed and dissolved in water to produce the targeted concentrations of fluorine in water/blood. All the sample preparation and standard C8 preparation was done on a weight/weight basis in order to ensure the best possible accuracy. Every final blood sample contained 90% of blood matrix and 10% of spike. Sample size of all blood samples processed through WT was 0.5g (measured with analytical precision).

Table V.

Accuracy evaluation of WT/F-ISE determination of F in whole rat blood at low concentration levels.

Actual F concentration (ppm)	Determined F concentration (ppm)	relative error (%)
0	-0.13	-
0.17	-0.20	-
0.55	0.70	27
1.02	1.07	4.9
1.02	0.84	-17
4.81	4.44	-7.7

Analysis by: Operator I
Apparatus: WT1

Table VI.

Accuracy and carryover evaluation of WT/F-ISE determination of F in whole rat blood at high concentration levels.

Actual F concentration (ppm)	Determined F concentration (ppm)	relative error (%)	System Blank F content (µg)
sys. blank 1			*0.750*
0	-0.03	-	
10.18	10.48	2.9	
25.42	23.64	-7.0	
sys. blank 2			*0.769*
101.36	96.04	-5.2	
sys. blank 3			*0.879*

Analysis by: Operator: I
Apparatus: WT1

Table VII.

Reproducibility evaluation of WT/F-ISE determination of F in whole rat blood at high concentration levels.

Actual F concentration (ppm)	Determined F concentration (ppm)	relative error (%)
23.46	23.33	-0.5
23.46	22.40	-4.5
23.46	21.60	-7.9
average	22.45	4.3
st. deviation	0.87	3.7
%CV	3.86	
Analysis by: Operator I **Apparatus:** WT1		
25.60	27.22	6.3
25.60	25.07	-2.1
25.60	26.10	2.0
average	26.13	3.4
st. deviation	1.07	2.5
%CV	4.11	
Analysis by: Operator II **Apparatus:** WT2		

Table VIII.

Reproducibility evaluation of WT/F-ISE determination of F in whole rat blood at low concentration levels.

Actual F concentration (ppm)	Determined F concentration (ppm)	relative error (%)
4.96	4.97	0.1
4.96	4.85	-2.3
4.96	4.91	-1.1
4.96	4.79	-3.3
4.96	4.78	-3.6
average	4.86	2.1
st. deviation	0.08	1.6
%CV	1.59	
1.01	1.09	7.6
1.01	0.93	-7.8
1.01	0.99	-2.4
average	1.00	5.9
st. deviation	0.08	3.1
%CV	7.86	
1.01	1.15	13
1.01	0.95	-5.5
1.01	0.92	-8.8
1.01	0.95	-6.1
1.01	0.96	-5.4
average	0.98	7.8
st. deviation	0.09	3.4
%CV	9.23	
0.52	0.46	-12
0.52	0.49	-5.8
0.52	0.52	-0.8
0.52	0.46	-12
0.52	0.37	-29
average	0.46	12
st. deviation	0.06	11
%CV	12.04	

Analysis by: Operator II
Apparatus: WT1

The results in Table VI indicate that the WT method for determination of F in blood does not suffer from significant carryover as can be judged from system blank values measured after 25.42 and 101.36 ppm samples. A slight increase in values is observed; however, we do not believe that the differences are significant enough to impact our results since the method is intended to be used primarily for samples containing less than 25 ppm of fluorine.

The accuracy of the method was evaluated across the concentration range from 0.17 to 101.36 ppm as indicated by results in Table V and VI. These data should be correlated with the reproducibility data shown in Table VII and VIII. As expected, the relative error values increase with decreasing F concentration, reaching 27% at 0.55 ppm level.

The reproducibility of the method at approximately 25 ppm was evaluated by two different operators using two different WT's. The results from these experiments are summarized in Table VII. It can be seen that at these concentration levels both operators achieved approximately the same reproducibility (%CV's of 3.86 and 4.11 %) as well as accuracy (relative errors of 4.3 ± 3.7 % and 3.4 ± 2.5 %). The reproducibility evaluation at concentrations of 5 ppm and lower are shown in Table VIII. Each data set in this table was analyzed by the same operator (Operator I) on different days. As expected, these results indicate that both precision (%CV's) and accuracy (relative errors) improve with increasing concentration. Although this operator did not conduct the reproducibility experiments at high concentrations (25 ppm) using the same apparatus as for the low concentrations, the results in Table VIII and VII indicate that he should still be able to achieve acceptable results using the current apparatus at higher than 5 ppm concentrations.

It is interesting to note that this operator achieved worse reproducibility and accuracy at 25.60 ppm using WT2 (Table VII) than he achieved at 4.96 ppm using WT1 (Table VIII). This may be due to the fact that the 4.96 ppm samples were analyzed at a later time and the operator had the opportunity to gain more experience with WT combustion method in general. This would suggest that the operator technique while operating WT apparatus is one of the important factors influencing the accuracy and reproducibility of the method. This is also supported by the fact that the other operator was not able to achieve accurate and reproducible results at concentrations of 5 ppm and lower using both WT's by the time the data above were generated. Therefore, a conclusion can be made that at low concentration levels these validation data should be linked to a specific operator using a specific WT apparatus.

Operator I was however, able to generate quantitatively valid data using WT2 at a later time. These data are summarized in Tables IX - XIII.

Data in Table VIII and IX indicate that Operator I/WT2 and Operator II/WT1 achieved equivalent precision and accuracy at the concentration level of approximately 5 ppm F in blood. This is indicated by similar values of standard deviations, %CV's (precision), and % relative errors (accuracy) of their respective replicate measurements at this concentration level.

Table IX.

Reproducibility evaluation of WT/F-ISE determination of F in whole rat blood at 5 ppm[a]

Actual F concentration (ppm)	Determined F concentration (ppm)	relative error (%)
5.30	4.99[b]	-5.8
5.02	4.85	-3.4
5.02	4.84	-3.5
5.02	5.07	1.0
5.02	4.94	-1.5
5.02	4.91	-2.1
average	4.92	2.9
st. deviation	0.09	1.7
%CV	1.88	

Analysis by: Operator I
Apparatus: WT2

[a] samples separated by lines were replicate analyses of the same sample within a particular day

[b] value not used for average, standard deviation, and %CV calculation because of different target F concentration.

Table X.

Evaluation of background fluorine levels in blank rat blood by WT/F-ISE[a]

Actual F concentration (ppm)	Determined F concentration (ppm)
blank blood	0.08
blank blood	0.10
blank blood	0.37
blank blood	0.10
blank blood	0.21
blank blood	0.31
blank blood	0.34
blank blood	0.35
blank blood	0.29
blank blood	0.24
blank blood	0.26
blank blood	0.26
blank blood	0.15
average	0.24
st. deviation	0.099
%CV	42.19

Analysis by: Operator I
Apparatus: WT2

[a] samples separated by lines were replicate analyses of the same sample within a particular day

Table XI.

Reproducibility evaluation of WT/F-ISE determination of F in whole rat blood at 1 ppm[a]

Actual F concentration (ppm)	Determined F concentration (ppm)
1.04	1.03
1.04	1.06
1.02	1.20
1.02	1.20
1.00	1.16
1.00	1.19
1.00	1.19
1.00	1.06
1.00	1.09
1.00	1.09
1.04	1.19
1.04	1.24
1.02	1.16
1.02	1.29
1.01	1.19
1.01	1.20
1.01	1.26
1.01	1.22
1.01	1.28
1.01	1.22
1.01	1.16
1.01	1.22
1.12	1.16
1.12	1.23
1.12	1.26
1.12	1.13
1.12	1.10
average	1.18
st. deviation	0.069
%CV	5.9

Analysis by: Operator I
Apparatus: WT2

[a] samples separated by lines were replicate analyses of the same sample within a particular day

Table XII.

Reproducibility evaluation of WT/F-ISE determination of F in whole rat blood at 0.5 ppm[a]

Actual F concentration (ppm)	Determined F concentration (ppm)
0.50	0.62
0.50	0.70
0.55	0.79
0.55	0.65
0.52	0.70
0.52	0.64
0.51	0.70
0.51	0.79
0.51	0.67
average	0.70
st. deviation	0.061
%CV	8.7

Analysis by: Operator I
Apparatus: WT2

[a] samples separated by lines were replicate analyses of the same sample within a particular day

Careful examination of the data presented in Table XI and XII shows that the results in both cases are about 0.2 ppm higher than the targeted concentration of F spiked into the samples. The constant nature of this systematic error suggests that the blank blood of these samples already contained some background level of F. If this is true and the operator performed the analysis in the consistent manner, standard deviations of these measurements should be ideally the same. Indeed, the values of standard deviations of the replicate measurements for these levels are equivalent. In order to evaluate the background F level for these samples, blank blood samples were analyzed using the same blood that was used to prepare the samples in Table XII and most of XI. The results are shown in Table X. As seen from the results shown in this table, the blank blood contained on average about 0.245 ppm F. The reproducibility of this measurement is not as great as for the other results shown, because these results are very close to the method limit of detection (LOD, see later for LOD, LOQ determination). **If** the average F blank concentration is above LOD of the method, the value can be deemed to be due to background F and it can subtracted from the results shown in Table XI and XII.

The results of F blood analyses at 1 and 0.5 ppm (Table XI and XII) corrected for background F are shown in Table XIII.

Table XIII.

Total F blood analyses at 1 and 0.5 ppm levels (from Table XI, XII) corrected for background F.

Average actual concentration (ppm)	Average measured concentration (ppm)	Standard deviation (ppm)	F content corrected for background (ppm)	% relative error
blank (n = 13)	0.24	0.099		
1.03 (n = 27)	1.18	0.069	0.94	-8.9
0.52 (n = 9)	0.70	0.061	0.46	-11.3

Analysis by: Operator I
Apparatus: WT2

Table XIII shows that after the correction of the applicable results for the background F in blank blood, the results show acceptable accuracy. This correction was possible only because the average background F concentration in blank rat blood was at the LOD of the method with the Operator I/WT2 (see Table XIV for LOD data). The determined blank blood concentration can therefore be deemed to be due to F and can be subtracted. It should be mentioned however, that the stated value (see Table X) is only an estimate because the value was under the LOQ (Table XIV). Hence, the great variability in this determination. It is realistic to expect some background level of F in blank rat blood because of the F composition of their diet. The F-ISE method described in this report was used to evaluate the concentration of ionizable inorganic F^- in the animal facility water that is generally fed to the rats in the Haskell Laboratory. The water contained 0.9 ppm F^-. In addition, the standard rodent diet also contains F in the range of 8-15 ppm (data supplied by Purina Mills, diet supplier). Because of the great variation of the F content in this diet (almost 100% variability) not all the blood will contain the same background F concentration. We had no indication that the blood used for data generated by Operator II, and Operator I at 5 ppm level contained any detectable background F levels. The blood used by Operator I/WT2 for blank, 0.5 and 1 ppm levels came from the same batch of animals.

Determination of limit of detection (LOD) and limit of quantitation (LOQ) of determination of total F in blood by WT/F-ISE.

Assuming that the results produced by WT/F-ISE behave according to normal distribution, the LOD and LOQ can be estimated from the standard deviation of replicate measurements of concentration levels close to the LOQ (not to exceed 10x LOQ). LOD was estimated as 3x the average standard deviation at low F concentration levels.

Limit of quantitation (LOQ) of WT/F-ISE method for analysis of total fluorine in blood was established taking into account the accuracy needed for the majority of

upcoming toxicological studies for which this method is intended. LOQ was estimated as 6x the average standard deviation at low F concentration levels. LOD and LOQ data for total F determination in blood by WT/F-ISE by both operators are shown in Table XIV.

Table XIV.

LOD and LOQ of determination of total F in blood by WT/F-ISE.

	Average actual concentration (ppm)	Average standard deviation of F determination (ppm)
Operator I/WT2	blank (n = 13)	0.099
	0.52 (n = 9)	0.061
	1.03 (n = 27)	0.069
	5.02 (n = 5)	0.093
	average	**0.081**
	LOD (3x avg. st. dev.)	**0.24**
	LOQ (6x avg. st. dev.)	**0.49**
Operator II/WT1	0.52 (n = 5)	0.055
	1.01 (n = 8)	0.085
	4.96 (n = 5)	0.077
	average	**0.072**
	LOD (3x avg. st. dev.)	**0.22**
	LOQ (6x avg. st. dev.)	**0.43**

Data shown in Table XIV indicate that both operators achieved equivalent LOD and LOQ with their respective WT's. Therefore, LOD of the WT/F-ISE determination of total F in whole blood is 0.24 ppm with both operator/WT combinations. Any results lower than this value will be reported in the future studies as "ND", standing for "not detected". LOQ of the method is 0.5 ppm and any data lower than 0.5 ppm but higher than or equal to 0.24 ppm will be reported as "< 0.5" indicating that F presence was detected but its concentration was too low to quantitate it with the required degree of accuracy.

The ability of automated F-ISE measurement of F^- in WT samples to produce accurate data is critical for the success of WT/F-ISE method. As mentioned earlier (part A, sect. 1.2) performance of F-ISE should be evaluated daily based by the deviation of calibration curve slope from the theoretical slope value. Since the F-ISE is operated at the limit of its performance as specified by manufacturer and within the non-linear portion of its response, the slope value agreement does not guarantee the accuracy of the results. As a result, measurement of a Quality Control (QC) sample was introduced whenever the F-ISE measurement was used. The QC sample was prepared independently by a third party. It was based on aqueous NaF. The targeted F^- concentration in the QC sample was 1 ppm. This sample was treated the same way as samples from WT (sample size 0.5g used,

NaAc and F^- spike added and filled to 150g). Since the QC sample was not processed through WT, its calculation cannot be based on WT system blank due to its different matrix. A 'QC system blank' was prepared instead (sample size 0.0000g used, NaAc and F^- spike added and filled to 150g) and used exclusively for QC calculation. A result from QC analysis based on 'QC system blank' should match the QC targeted concentration within 15 % as indicated by the results shown in Table IV. If this criterion is not fulfilled, a corrective action should be taken to ensure the accuracy of F-ISE data. Introduction of QC to the procedure impacts the sample throughput only slightly because all the F-ISE measurement is automated. However, higher confidence in the data can be obtained and it can also be used as a great troubleshooting aid when the results are not as expected.

Conclusions

Validation of determination of total fluorine in blood by Wickbold Torch in combination with direct potentiometric fluoride detection with Fluoride Ion Selective Electrode has been performed. It has been found that F-ISE determination of fluoride in samples processed through WT is operator-independent. Best possible accuracy and precision can be achieved if the F-ISE is not exposed to water and buffered 10 ppb F^- solution is used for the electrode rinse. In addition, calibration standards should be measured from highest to lowest concentration, and volumetric glassware should be used whenever possible for volume transfers. The electrode should not be exposed to high F^- concentrations as well and the electrode performance check and storage conditions outlined in its manufacturer manual should **not** be followed because they are intended for its operation in the linear portion of the electrode response. To ensure the accuracy of F-ISE measurement a QC sample was measured and the validity of its result compared to the targeted concentration value was assessed daily. The electrode performance was evaluated each time it was used based on the deviation of the calibration curve slope from the theoretical slope value. Short-term electrode storage should be done in a 20 ppb reference solution.

WT combustion method was evaluated for blood samples and it was found that the method does not suffer from significant carryover. Reproducibility and accuracy at high concentration levels was evaluated with different operators with different WT's. The results were generally equivalent. However, at low concentration levels, it was observed that the results greatly depend on operator/WT apparatus combination, which suggests the influence of the operator technique on the accuracy and precision of the method. For this reason, a careful consideration should be given if the data presented in this report were applied to any measurements requiring adjustments in the operator technique. This include (but is not limited to) analysis of different matrices and the operators using different apparatus than they used to generate the validation data in this report. That is, this validation report is valid only for total fluorine determination in blood and similar matrix (such as plasma, red blood cells) and for the particular operators using their respective WT's by which they generated these validation data. In addition, for validity of any data of future studies, it is assumed that the operators perform the analyses in exactly the same manner as they did when they generated data presented in this report. When more data becomes available for different matrices and different operator/WT combinations, attachments to this report will be written.

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July 23, 1979

CONFIDENTIAL

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JUL 26 1979
BRUCE W. KARRH, M.D.

MEMO TO: F. E. FRENCH, JR.
[redacted]

FROM : B. C. MC KUSICK BCM Kusick

DISCUSSION OF FLUOROCHEMICALS WITH 3M

On July 20, S. N. Boyd, G. L. Kennedy, F. J. Marascia, B. C. McKusick, R. E. Read, and R. D. Richardson of Du Pont met in Chicago with F. D. Griffith, L. C. Krogh, R. A. Prokop, and F. A. Ubel of 3M.

Richardson described measurements of organic fluorochemicals in blood of fluorosurfactant production employees at Chambers Works*. In contrast to experience at 3M, concentrations are normal. A retroactive study of medical records found no adverse health effects. The blood analysis program has been discontinued.

Kennedy described Haskell's subacute toxicity studies of CD&P fluorochemicals*. They are consistent with 3M animal data.

Prokop of 3M described a gas chromatographic method to determine perfluorooctanoic acid [redacted] in blood, urine, liver, and other biological materials. It can measure as little as 1.5 ppb. A paper has been prepared (copy attached) that should appear in about six months.

Ubel, the 3M medical director, said that no adverse liver effects or other health effects have been found among employees in [redacted] operations. Blood levels of organofluorine in employees have changed little despite steps to lessen exposure. Blood levels of employees moved to locations outside the fluorochemical area have dropped only slightly, although measurable amounts of organic fluorine is excreted. This was illustrated by data on an employee who had been in the fluorochemical area for 15 years and had the highest blood level of any (Table I).

(*Transparencies attached to copies of French, Simmons, & Reinhardt.)

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TABLE I

ORGANOFLUORINE IN ONE EMPLOYEE

Date	Blood Concentration, ppm RF	Blood Concentration, ppm F-	Blood Concentration, ppm [redacted]	Urine Conc., µg/24 hr. RF
July 76	39	0.05		
Oct 77	40	.03		
Apr 78	71		53	
May 78	67			
(At this point, he was transferred to another area)				
June 6, 78	66			484
June 13, 78	71			272
July 78	66			160
Aug 78	55			175
Oct 78	59			160
Jan 79	45			220
Apr 79	47			

3M got blood samples from 8 peasants in a Chinese village 30 miles from Canton. The ogranic fluorine was siginficantly lower (0.004-0.017 ppm), than values found in developed countries (e.g., 3M found 0.002-0.13 in 106 members of the general U.S. population).

Ubel said that a University of Minnesota professor is doing an epidemiology study of 4000-5000 employees who have worked at the oldest and biggest 3M plant manufacturing fluorochemicals. Nothing noteworthy has shown up, but the study has a long way to go.

A year ago all employees in fluorochemical manufacture were told the results of the blood study. 3M recently told them about it again. About 60 employees in the fluorochemical area have had blood organic fluorine measured. All who have been found to have elevated organic fluorine blood levels have been informed of the fact and told that 3M does not know what it means, but that no adverse health effects have been related to it. The employees have taken the information calmly.

Griffith, 3M manager of toxicology, reported data on 90-day studies of [redacted] in rats and monkeys (see attachment). The effects were similar to what Du Pont saw with similar materials. Thus, the liver was the main target organ.

There was no significant difference in effects between male and female rats, but males retained about 100 times more [redacted] Griffith said he would send me details on this.

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3M will start a metabolism study of radiolabeled $C_7F_{15}C^*O_2H$ in rats soon. This may show where [redacted] is being stored in the body.

Studies of [redacted] dust on animal skin indicates it does not penetrate the skin easily.

3M indicated interest in another review in about a year, or whenever one company has interesting results.

BCM/bjd

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AR226-3410

[redacted]

E. I. DU PONT DE NEMOURS & COMPANY
INCORPORATED
WILMINGTON, DELAWARE 19898

PLASTIC PRODUCTS AND RESINS DEPARTMENT

PERSONAL & CONFIDENTIAL

July 25, 1979

RECEIVED
JUL 26 1979
BRUCE W. KOCH, M.D.

TO: R. L. RICHARDS

FROM: J. W. RAINES

ORGANIC FLUOROCOMPOUNDS IN BLOOD

Published Article

Organic Fluorocompounds in Human Plasma: Prevalence and Characterization, by W. S. Guy, D. R. Traves, and W. S. Brey, Jr., was published by the American Chemical Society in 1976. They reported organic fluorine in blood plasma obtained from blood banks in 5 U.S. cities, determined by subtracting inorganic fluorine from total fluorine.

3M Company

May 30, 1978, informed Du Pont of elevated organic fluorine (1-71 ppm) in blood of employees exposed to long chain perfluoro surfactants such as the ammonium salt of perfluorooctanoic acid [redacted] which they supply to Du Pont. Control group was less than 1 ppm.

July 20, 1979, advised Du Pont:

- No adverse health effects.
- Decay rate after removal from exposure relatively slow (71 ppm - 47 ppm in one year).
- Fluorine in urine also decayed slowly (484 micrograms per 24 hours to 220 micrograms per 24 hours in 10 months).
- [redacted] not adsorbed through skin of rabbits.
- University of Minnesota professor is doing an epidemiology study on 4,000 - 5,000 employees who worked at 3M's oldest and biggest fluorochemical plant.

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- Eight Chinese peasants had significantly lower (0.004 - 0.017 ppm) blood levels than general U.S. population (0.002 - 0.13 ppm).

CL&P

Analyzed blood of 55 employees at Chambers Works. Average .15 ppm, range 0 - .37 ppm. Discontinued blood sampling. Exposure is not to same family of chemicals as that at Washington Works (WW) and 3M.

PP&R

- Analyzed blood of 8 employees potentially exposed to C-8 [redacted] at WW.

2 Laboratorians	.4 - .5 ppm
2 FEP Polymerization Operators	2.2 - 3.5 ppm
4 TFE Dispersion Polymerization Operators	9.5 - 21.1 ppm

- No adverse health effects attributable to C-8.
- Decided not to report to EPA under 8(e) of TOSCA because fluorine in blood per se was disclosed in 1976 article and because no adverse health effect is known, therefore, no substantial risk.

Program

- Obtain raw medical data from WW employees and study by Corporate Medical to confirm that liver function and other medical analyses are normal.
- Identify personnel in all jobs with potential exposure to C-8 for the past 10 years at WW.
- Analyze blood samples (Jackson Lab will do) of selected additional employees at WW to:
  - Check all employees currently exposed to C-8.
  - Verify that fluorine levels in blood are due to C-8 exposure rather than other fluoro-compounds.
  - Define the decay rate (confirm that found by 3M).

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- (Cont'd)
  - Communicate results of latest tests to WW employees before additional blood samples are taken.
- Defer blood sampling at Dordrecht until additional results are in from WW.
- Textile Fibers will decide by August 3 about sampling blood of employees at Spruance where they produce fibers from poly TFE dispersion containing .3% C-8.

JWR:ldb

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AR 226-3411

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AR226-3411

C-8 [ ] - AMMONIUM PERFLUOROOCTANOATE

CHRONOLOGICAL SUMMARY OF REPORTS

Month/Year	Sources	No. of People	No. of Samples	Organic Fluorides in Blood Aver. (ppm)	Organic Fluorides in Blood Range (ppm)
June 1978	3M Co. discussion	130	?		up to 70
May 1979	CD&P/Haskell review				
	3M Data				
	General Population	106	?	0.02	0.002-0.13
	Plant Office Worker				0.01-0.06
	Plant Worker General				0.13-1.18
	Plant Worker - F/C Area - newer plant -				0.9-9.1
	- older plant -				5.9-71
	Du Pont Data				
	Wilmington Control Group	25	23	0.094	0-0.38
	Chambers Works Group	55 (of 199)	54	0.15	0-0.37
July 1979	Du Pont Data				
	Initial Wash. Wks.	8	8	8.2	0.6-22
August 1979	3M Data				
	C-8 Packaging - 1 year service -				5-10
	15-20 yrs. service - typical				10-20
	Top levels				30-70
	Fl-Sulfonic Acid Area				1-4
Oct. 1979	Du Pont Data				
	Washington Works	78	86		0.1-22

RMS:ldb
10/18/79

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AR 226 - 3412

F&F DEPARTMENT
FC-143 DATA
FEBRUARY, 1980

SITE NAME	Weeks Exposure (approx.)	Blood Analysis Total F (ppm)	Blood Analysis Organic F (ppm)	Workplace* Conc. FC-143 mg/m³
Toledo				
• Load, mix, dispensing	190	2.	1.92	.0022
• Sample	292	1.08	0.98	<.0011
• Load finished product into drums	15	0.82	0.74	.0033
• Ambient temp.				oven → .001 room
Philadelphia, PE				
• Handle pxl/gum	200	0.46	0.36	0.00038
	50	1.15	1.07	<.00016
Philadelphia, Plant				
Quality Control Tester	100	0.6	0.5	0.0027
Process Operator	250	1.02	0.92	.002
Relief Operator	16**	0.46	0.37	
Marshall Lab Rm 432				<0.0001
	250***	1.12	1.02	
	Mean	0.97	0.88	
Fairfield				
Process Operator Coated glass fabric	56	>28.	>28. (bomb)	.005
			900. (torch)	.007

* Area samples, not personal samples

** Relief worker

*** Sprays every 2 weeks

AR 226 - 3413

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C-O-N-F-I-D-E-N-T-I-A-L

SUMMARY

ORGANIC FLUORIDES IN BLOOD SAMPLES

Location	Job Group	Number Sampled	Range ppm	Average ppm
Washington Works	Process Operators - TFE	26	0.2-21.7	5.79
	Process Operators - FEP	13	0.9-5.0	2.83
	Service Operators	18	0.5-5.0	2.14
	Mechanics	5	0.55-0.83	0.66
	Semi Works Laboratorians	8	0.2-1.5	0.56
	Monomer Operators* (*no service in polymer)	7	0.1-0.5	0.35
Wilmington	Background Group	25	0.0-0.78	0.13
Chambers Works	CD&P Operators (Fluoro Products)	55	0.0-0.37	0.15
Chambers Works - PPD	[redacted] Operators	14	0.02-0.21	0.12
Experimental Sta.-PPD	[redacted]	4	0.15-0.86	0.57
Spruance - TF	[redacted] Fiber Process Operators	6	0.0-0.29	0.13
Finishes Plants (F&F)		9	0.36-1.92	0.89

Fabrics Plant (F&F) (one sample - recheck and more samples recommended.)

RMS/is
3/3/80

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AR226-3414

[redacted]

5/14/81

- C-8 Level Locations Other than Washington Works

Location	No. of Samples	PPM C-8 Range	PPM C-8 Average
Wilmington	32	ND	ND
Haskell	9	ND - 0.030	0.007
Chestnut Run	15	ND - 0.043	0.006
Spruance	27	ND - 0.070	0.027
Fairfield	5	ND - 0.048	0.014
Toledo	7	ND - 0.014	0.003
Circleville	10	ND - 0.030	0.014

[redacted]

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AR 226- 3415

AR226-3415

ES-3575 REV. 8-61

E. I. DU PONT DE NEMOURS & COMPANY
INCORPORATED
HASKELL LABORATORY FOR TOXICOLOGY
AND INDUSTRIAL MEDICINE
ELKTON ROAD, NEWARK, DELAWARE 19711

CENTRAL RESEARCH AND DEVELOPMENT DEPARTMENT

[redacted]

August 25, 1982

PERSONAL AND CONFIDENTIAL

J. G. LOSCHIAVO
POLYMER PRODUCTS DEPARTMENT
PARKERSBURG

AMMONIUM PERFLUOROOCTANOATE (C-8)
IN HUMAN BLOOD

In reference to your July 29, 1982, letter to R. J. Zipfel (Retention of Ammonium Perfluorooctanoate [C-8] in Blood of Teflon® Workers) I would like to make several important suggestions. Acquisition and interpretation of C-8 blood concentrations in workers is very important in understanding how the human body handles C-8 and how accurately our animal models at Haskell correlate to the human situation. To better interpret these data, consider the following modifications:

- The 0.006 ppm blood level is termed a "rate" of accumulation when it would be more appropriate to call it an "average concentration" over the average of 91 days of employment. The average blood level of 0.006 ppm/day x 91 days gives the plateau, or steady-state, concentration (0.546 ppm) that more closely represents the dynamic aspects of exposure and elimination.

- The calculations assume a volume of distribution (Vd) equal to the blood compartment only (5.5 liters). Since C-8 is water soluble and binds protein, the Vd would actually be closer to the volume of total body water (approximately 42 liters/70 kg man).

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- To more accurately assess the retention of C-8 in the body as well as predict blood levels anticipated with continued low-level exposure, formulas commonly used to estimate drug-therapy regimen can be employed.

  Assumptions:

  - The blood level, Cp, is at a plateau (steady-state) concentration (i.e., absorption and elimination approximately equal).
  - The volume of distribution, Vd, is in total body water, or 42 liters.
  - The daily dose (D/T) is 0.081 mg/day.
  - The elimination half-life, t 1/2, is estimated from a literature report on one individual. The value is 655 days, but could vary considerably.

  Then from Goodman and Gilman (1970):

$$Cp = \frac{f \bullet 1.44 \bullet t\ 1/2}{Vd} \left(\frac{D}{T}\right)$$

  - where f = fraction absorbed
  - solving for f,

$$f = \frac{Cp \bullet Vd \bullet T}{1.44 \bullet t\ 1/2 \bullet D} = \frac{0.546\ mg/l \bullet 42\ell \bullet 1\ day}{1.44 \bullet t\ 1/2 \bullet 0.081\ mg/\ell}$$

  - then:

t 1/2 (days)	f	% Absorbed
30	6.55	655
197	1.00	100
360	0.55	55
655	0.30	30

- Thus, depending on the actual t 1/2, we can estimate only that greater than 30% of atmospheric C-8 is absorbed. This is in general agreement with your estimate, but until we know the actual t 1/2 we will not be able to accurately calculate fractional absorption.

- Regarding these calculations and in response to your suggestions in the July 29 memorandum,

  - More human data is necessary from two sources:

    1. current employees for determination of plateau (steady-state) concentrations

    2. employees no longer exposed to C-8 for determination of the blood t 1/2 and the urinary excretion rate.

  - We have performed radiochemical and biochemical analysis of the distribution and effects of C-8.

Timothy P. Pastoor

TIMOTHY P. PASTOOR
RESEARCH TOXICOLOGIST

TPP:sgl

BEST COPY AVAILABLE

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AR226-3416

ADDITIONAL INFORMATION FOR SUPERVISION

A 1976 report[1] indicates that the blood serum of the general population in the U.S. contains trace quantities of fluorine in both o and inorganic form. The concentration of inorganic fluorine has been to be related to fluoride ion in water supplies (natural and added). There is no ready explanation for the presence of organic fluorine.

A recent study by the 3M Company of their workers who manufacture and handle fluorosurfactants and their intermediates has revealed orga fluorine levels in their blood plasma in excess of those not engaged i these operations. 3M reported that a preliminary review of the medica histories and current health status of affected employees has not reve any unusual health conditions. A more detailed epidemiological study 3M workers has been initiated.

3M has identified two probable key sources of employee exposure i their operations. These are associated with (1) electrolytic cells ir which key intermediates are manufactured, and (2) packaging operations involving powdered products.

The specific products implicated in the 3M study are not manufactured nor used on the Chambers Works. Different fluorosurfactants manufactured on Chambers Works in the Chemicals and Development Manufa ing areas and are sold under the [redacted] trademark. The Chambers Work processes do not involve electrolytic fluorination and the products a handled throughout in liquid forms and are also sold in liquid forms. Despite the disimilarity between the Du Pont and 3M technology, all ha ing procedures for fluorosurfactants and intermediates should be revi for adequacy. Assistance may be obtained from [redacted]

A special medical program will be initiated for all employees currently engaged in fluorosurfactants operations. This program will not be extended to personnel who have previously worked with fluorosurfactants, but who are no longer involved, unless the results of th initial program indicate that necessity. Similarly, Engineering Depa ment, Environmental & Service Department and General Analytical Labor employees will not be included in the initial program though they sho be advised of the program.

The initial special medical program will include (1) a review of the medical records of the employee, and (2) special blood analyses a time of the employee's regular physical examination.

This program is concerned only with fluorosurfactants and their intermediates. Other fluorinated substances such as [redacted] fluorocai and fluoropolymers (e.g., [redacted], [redacted], etc.) are not implicated

(1) W. S. Guy, et.al:, Proceedings Amer. Chem. Soc., Fluorine and Biological Chemis Symposium, Chicago, 26 August 1975, Paper 7, page 117.

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EMPLOYEE BLOOD DATA

GROUP (sample size)	1979 DATA Organic fluorine ppm* Organic Fluorine, (Median value)	1981 DATA ppm C-8 as F, (mean)	1999 DATA ppm C-8 as F, (mean)	1999 DATA ppm Fluorine (mean)
3M DATA				
General population	0.002 - 0.3			
(median)	(0.02)			
# samples	106			
plant office workers	0.01 - 0.06			
plant worker - general	0.13 - 1.18			
plant worker - long service in F/C area				
Newer plant	0.09 -9.1			
Older plant	5.9 - 71			
DUPONT DATA				
Wilmington Control group	0 - 0.38***			
(mean)	(0.094)***			
***except two Wilm. Controls 10.6 & 0.78 ppm				
# samples	25			
Chambers Works group	0 - 0.37**	0 - 0.25	0 -0.061	0 - 0.37
(median or mean)	(0.15**)	(0.049)	(0.018)	(0.21)
** except one value 0.89 ppm				
# samples	55	33	42	42
Detection level		0.01	0.01	0.2
Method	OT	GC/EC	GC/EC	OT

AR 226 _ 3418

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AR226-3418

ANALYTICAL RESULTS: [redacted]* IN BLOOD
POLYMER PRODUCTS - CHAMBERS WORKS

July-August 1981

Production Building Operators	Building Mechanic	First Line Supervision	Technicians: Solution Prep**	Technicians: Emulsion Prep	Method Development Technician	
[redacted] as ppm Fluorine in Blood						
0.014	0.059	0.013	(0.013	0.020	N.D.	
0.062		0.016	0.015)	N.D.		
0.077		N.D.		<0.007		
0.140		0.032		<0.007		
0.150		0.015	(0.007	0.010		
0.025		0.033	0.007)			
0.084			(0.011			
0.110			0.016)			
0.039						
0.027						
0.250			(0.096			
0.150			0.120)			
0.014	-	0	0.007	0	-	Low
0.250	0.059	0.033	0.120	0.020	0	High
0.094	0.059	0.018	0.036	0.009	0	Mean

Overall Range: 0-0.250, Overall Mean: 0.049

*Ammonium Perfluorooctanoate
**Duplicate numbers reported for four individuals.
First number is pre-campaign, second number post-campaign.

JCL/dmb
8/27/81

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AR226_3419

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DUPONT
Haskell Laboratory for
Toxicology and Industrial Medicine
1090 Elkton Road
Newark, DE 19714

From: Robin C. Leonard
Epidemiology Program
[redacted]

Date: September 23, 1999

To: Barbara Dawson

Cc: [redacted]

Subject: C-8 Surveillance

I have looked at the results of the first sample of measurements from the C-8 surveillance project at Chambers Works. As would be expected for base-line samples, there is very little analysis that can be done at this point. It is possible, however, to note a few things about the distributions of the measurements.

Most of the samples had no detectable levels of fluoride ion. I think this indicates that we can assume a baseline of zero for fluoride ion in this group.

The sample measurements for C-8 ranged from below the limit of detection to 61 ppb. There is essentially no difference in the average measurement of C-8 for the operators, mechanics, and lab techs. The standard deviation for these groups, as well as the group as a whole, is very close to the average value. This indicates that there may be fairly large variation both between members of the group, and between samples from each individual. This underlines the importance of obtaining several samples from each of the study participants so that we have a better chance of understanding the sources of the variation in these measurements. This will be very important as we try to follow the disposition of these compounds throughout the cycle of campaign—non-campaign periods.

It is very important that we not overinterpret what is essentially baseline data. The design of the study requires that we wait for the the longitudinal (over time) measurements, both from the workers and from the environmental assays before we try to reach any conclusions about exposure compliance issues.

I hope this is helpful. Please call if you have any questions.

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AR226-3420

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From: Barbara J Dawson on 10/19/2000 12:01 PM

To: Beth F Basham/AE/DuPont@DuPont, Aaron Chen/AE/DuPont@DuPont, Michael J Daly/AE/DuPont@DuPont, Nicholas J DeStefano/AE/DuPont@DuPont, Mary Ann Hayes/DuPont@DuPont, James R Koterski/AE/DuPont@DuPont, Irene A Legiec/AE/DuPont@DuPont, Richard J Libutti/DuPont@DuPont, Douglas A Paine/AE/DuPont@DuPont, Michael L Szep/AE/DuPont@DuPont

[redacted]

Subject: C8 Follow-up Medical Surveillance

Just wanted to let everyone know that we plan to do the follow-up medical surveillance for the people who participated in the baseline study last year. Beginning next week, we will be asking each unit to schedule their people for an appointment in Medical on Wednesday, Thursday or Friday by calling Les Bacon. Note that Medical is not yet fully functional as a result of their relocation and that this note is relative only to C8 follow-up surveillance. Forty three people participated in the baseline surveillance which included:

- medical history questionnaire
- automated chemistry profile (analysis by LabCorps) - SMA-12 (includes HDL, cholesterol, glucose, uric acid, BUN, calcium, phosphorus, total protein, albumin, bilirubin, alkaline phosphatase, LDH, AST (SGOT), total cholesterol, creatinine and ALT (SGPT))
- complete blood count (analysis by LabCorps)
- perfluorooctanoic acid (PFOA) in blood (analysis by National Medical Services, Willow Grove, PA)
- total fluorine in blood (analysis by Chris Bowers' lab in Jackson Lab)

The follow-up surveillance will be identical to the baseline surveillance and each person's results will be compared his/her baseline. I am also working with the unit S&OH coordinators to identify others who need the baseline surveillance - these people are not included in the following list. We plan to do the follow-up on all of the original participants, whether or not they worked in the process. A decision still needs to be made relative to the people who are no longer on the site. An email message will be sent to each participant on Monday with copies to their unit manager and S&OH coordinator informing them of the program. I will forward a copy of the draft letter in another message. I recommend that you talk to the employees before they receive the email so that they know it is coming.

Workers in the surveillance will include:

Name	Shift	Area	Status
[redacted]	A	JL Tech	
	A	JL Tech	
	A	Operator/1205	
	medical	Mech/PPW	never worked in process
	A	Mech/PPW	
	A	Operator/1205	
	B	Operator/1205	
	B	Operator/1205	
	B	Mech/PPW	never worked in process
	B	JL Technician	
	B	JL Technician	
	B	Operator/1205	
	C	JL Technician	
	C	Mech/PPW	
	C	Mech/PPW	
	C	Operator/1205	
	C	JL Technician	
	C	Operator/1205	

"REDACTED"

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[redacted]	D	JL Technician	
	D	Operator/1205	
	D	JL Technician	
	D	Operator/1205	
	Day	Engineer/1205	never worked in process
	Day (12)	JL Technician	now in [redacted] J24
	Day	Elec/PPW	
	Day	Mech/PPW	
	Day	JL Technician	
	Day	JL Technician	now in K37
	Day	Mech/PPW	
	Day	FLS/PPW	
	Day	Mech/PPW	never worked in process
	Day	JL Technician	
	Day	Mech/PPW	
	Day	JL Chemist	
	Day	Engineer/PPW	
	Day	JL Chemist	
	Day	JL Technician	

People no longer on the site:

[redacted]	Operator/1205	retired
	Mech/PPW	retired
	JL Chemist	transferred
	JL Technician	pensioned

Prior to their visit, everyone should receive a copy of the medical history interval form and bring the completed form with them when they come to Medical. I will give copies to John Plum for the PPW workers and to Aaron Chen for the JL workers.

REDACTED

Company Sanitized. Does not contain TSCA CBI

AR226_ 3421

RECYCLED

000223

From: Barbara J Dawson on 10/19/2000 12:06 PM

To: Beth F Basham/AE/DuPont@DuPont, Aaron Chen/AE/DuPont@DuPont, Michael J Daly/AE/DuPont@DuPont, Nicholas J DeStefano/AE/DuPont@DuPont, Mary Ann Hayes/DuPont@DuPont, James R Koterski/AE/DuPont@DuPont, Irene A Legiec/AE/DuPont@DuPont, Richard J Libutti/DuPont@DuPont, Douglas A Paine/AE/DuPont@DuPont, Michael L Szep/AE/DuPont@DuPont

cc: [redacted]

Subject: C8 Medical Surveillance - Draft Letter to Participants

Here is a copy of the letter we plan to send to participants as approved by [redacted]

---------- Forwarded by Barbara J Dawson/AE/DuPont on 10/19/2000 12:04 PM ----------

From: Barbara J Dawson on 10/10/2000 10:58 AM

To:
cc:
bcc:
Subject: C8 Medical Surveillance - Draft Letter to Participants

Last year, you participated in a baseline C8 medical surveillance program which included analysis of your blood for perfluorooctanoate (PFOA) and total fluorine. You were asked to participate in this program because your job assignment at that time included the potential for exposure to C8. **We are now ready to conduct the post campaign surveillance.** Medical will draw additional blood samples which will be analyzed for PFOA and total fluorine. These results will be compared to your baseline results to determine if you received any exposure to this chemical during the past year. We will share the results and interpretation of the data with you.

Please contact your unit S&OH coordinator to make arrangements for an appointment at Medical. Blood will be drawn over the next few weeks on Wednesday, Thursday and Friday. Unit S&OH coordinators are:

[redacted]

If you have any questions, please contact me or your unit S&OH coordinator.

Company Sanitized. Does not contain TSCA CBI

AR226-3423

5pp

AR226-3424

PROPOSAL FOR FEASIBILITY ASSESSMENT

Estimating Exposure, Biopersistence, and Potential Liver Effects from Workplace Exposures to Organofluorines: A determination of the feasibility of appropriate analyses of historical surveillance data

Introduction

Concern regarding organofluorine exposure (C-8, [redacted] etc.) is based on the results of rodent testing. In animals, these organofluorine compounds induce a biological response known as peroxisome proliferation. Research with chemicals known to produce this response suggests that long-term administration to rodents results in the development of benign tumors of the liver, pancreas, and testis. However, other data indicate that man may be at little risk for occurrence of tumors since man is a low responder to this class of chemicals, i.e., peroxisome proliferators. However, other liver toxicity may occur in man that is independent of peroxisome induction. Based on experimental data, changes in liver function may be a means of detecting human biological response to these chemicals.

Additional concern with these compounds has been that these materials have been detected in the blood of exposed employees. Exposure potential is by inhalation or skin contact. It is known that these compounds are eliminated from the body very slowly. It is estimated that the half-life of C-8 may be as long as 3-5 years. At present, there are no available human data that demonstrate increased levels of blood organofluorines with discernible adverse health effects. However, there remains concern about the possibility of such effects, particularly with regard to liver function.

Background

In 1978, the 3M Company notified DuPont that they had observed elevated organic fluorine levels in the blood of their workers exposed to ammonium perfluoro-octanoate. Although the specific 3M product was not used at Chambers Works, Chambers Works conducted a special blood monitoring program in 1978-79 for our fluorosurfactant employees. Organic fluorine levels in the blood were found to be no different than the Wilmington control group levels. As a result, the blood monitoring program was terminated in 1979.

In 1999, Chambers Works conducted another special blood monitoring program for a subset of our fluorochemicals employees. Organic fluorine levels in the blood were found to be no different than the 1978-1979 Chambers Works levels and the 1978-1979 Wilmington control group levels.

Purpose

The objective of medical and exposure surveillance in a workplace population is to detect people with exposure-associated dysfunction who are at risk for developing clinical disease. When the exposure markers and effect markers are well-quantitated, such surveillance programs can provide valuable information as to safe occupational exposure levels. In addition, risk evaluations can be based on human data.

This proposal describes a biomonitoring project with the following objectives:

1. Establish pre-placement baseline levels of fluoride ion in blood and blood perfluorooctonoate level,
2. Monitor workplace exposure to C-8 by repeating the blood sampling every month,
3. Correlate biomonitoring results with Industrial Hygiene workplace air and personal monitoring results,
4. Establish rate of bioaccumulation of C-8 in workers,
5. Establish level of biopersistence in workers by continued surveillance following cessation of exposure.
6. Correlate data on biomarkers of effect (serum liver enzyme levels) with the biomarkers of exposure (fluoride ion in blood and blood perfluorooctonoate level).
7. Examine other health effect measures (medical history questionnaire, including smoking history; complete blood count, SMA-12) for potential confounders or modifiers.

Approach

A C-8 surveillance program at Chambers Works will take advantage of the proposed C-8 recycling program soon to be initiated. If the project is approved before work begins, the ability to collect pre-exposure baselines on both the biomarkers of exposure and of effect will not be compromised. The data matrix should contain the following variables:

1. Name
2. SSN
3. Date of Hire
4. Date of C-8 task initiation
5. Date of Birth
6. Current Task Assignment (job title, task name)

7. Time spent in task
8. Standard IH measures of exposure (preferably personal monitoring, but area data could be used), with an assessment of the potential for dermal exposure
9. Use of personal protective equipment
10. Laboratory results of C-8, fluoride ion, and liver enzyme measurements retained as serial data variables.

The protocol will prescribe data collection at monthly intervals for liver enzyme measurements, and area or personal monitoring at either weekly, or bi-weekly intervals, for a period of one year. The range and variance of these measurements, along with the total number of individuals in the potentially exposed population, will provide a good indication of whether there is clinical and/or epidemiological value in continuing the data collection.

It should be recognized that while liver enzymes are generally highly sensitive, they are nonspecific and of poor positive predictive value in identifying true occupational liver disease. (In low-risk workplaces, where measured exposure is low, the prevalence of occupation-associated liver disease may be so low that the positive predictive value of the screening test may also be very low. In these circumstances, other causes of liver dysfunction are the more likely reason for abnormal screening results.) However, the widely available batteries of enyzme tests are inexpensive and have the advantage of large bodies of general population data and associated "normal" values that are useful for comparison. In addtion, the availability of pre-exposure levels will enable each C-8 exposed worker to serve as his own control as the primary purpose of the study is to measure change in these biomarkers over time.

Responsibilities

The Occupational Health personnel at Chambers Works will be responsible for the collection and submission for analysis of the blood samples and the industrial hygiene monitoring data. The Corporate Epidemiology Program will assume responsibility for constructing the analytic data file and doing the assessment of the descriptive statistics on the population results at the end of the first year of data collection.

Employees will be asked to participate in a descriptive epidemiology project that will be directed to understanding whether or not C-8 exposures result in measurable blood changes. This communication will be done in person by site personnel with the corporate epidemiologist present to answer questions. Upon completion of the project, the employees will be notified, in person and in writing, of the results. Questions concerning medical surveillance will be handled by site Occupational Health staff.

Several of our fluoroprotectant and fluorosurfactant [redacted] products and intermediates were tested in an oral dose animal screening study at Haskell Lab to compare the biopersistence of total fluorine in the blood with the specific

Company Sanitized. Does not contain TSCA CBI

fluorochemical that 3M had identified. The preliminary screening information from the blood analysis after repeated oral doses so far indicates that our products do not absorb into the blood to the same high level nor persist in the blood compared with the 3M specific fluorochemical.

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AR226_3424

Chambers Works PFOA Recycle

Prior to start-up of the PFOA Recycle process, baseline blood samples were collected on workers who would be assigned to the recycle process and its support operations so that future sampling could be compared to the baseline levels. Blood monitoring is conducted as an industrial hygiene tool to evaluate the effectiveness of the controls. Baseline samples of 42 workers were collected in 1999. Samples were analyzed as whole blood for PFOA by a contract laboratory using gas chromatography with electron capture detector. This laboratory had been analyzing blood samples for Washington Works for several years. Workers who volunteered for testing included operators, mechanics and laboratory personnel involved with the PFOA recycling process. A second round of sampling was conducted in 2000 which included 30 people from the original 1999 group and 34 newly assigned workers. DuPont analytical chemists found that in both the 1999 and 2000 blood monitoring campaigns, the lowest calibration standard used by the lab was 100 ppb. PFOA was detected in many of the Chambers Works samples, but it could not be reliably quantified at concentrations less than 100 ppb. All of the samples in both the 1999 and 2000 blood monitoring campaigns showed results <100 ppb.

This experience led DuPont to work with a different contract analytical laboratory on another method that would be more sensitive and provide more scientifically accurate and reliable data at the low levels in which we were interested.

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Chambers Works, Deepwater, NJ

Date of Monitoring: September – October 2002

Matrix: Blood Serum

Operation: PFOA Recycle

Job Title	Number Sampled	# of Samples <LOQ (50 ppb)	Minimum Concentration (ppb)	Mean (ppb)	Median (ppb)	Maximum Concentration (ppb)	Standard Deviation
Entire Cohort	62	21	50	172	78.8	1650	286
Males	61	21	50	173	78.8	1650	288
Females	1	0	57.6	57.6	57.6	57.6	0
Operators	17	0	52.7	373	175	1650	461
Males	17	0	52.7	373	175	1650	461
Females	0	-	-	-	-	-	-
Mechanics	18	3	59.8	168	122	658	156
Males	18	3	59.8	168	122	658	156
Females	0	-	-	-	-	-	-
Laboratorians	21	15	50	35	<50	88.5	17
Males	21	15	50	35	<50	88.5	17
Females	0	-	-	-	-	-	-
Supervision	6	3	57.6	92	~54	313	113
Males	5	3	106	98.8	<50	313	
Females	1	0	57.6	57.6	57.6	57.6	0

Comments:

- Samples analyzed by Advion Laboratories using LC/MS/MS
- Means and standard deviations were calculated using 25 ppb (1/2 of the LOQ) for those samples reported as less than the LOQ.

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: November 17, 2004

DuPont Company
PFOA in Blood
Chambers Works
September - October 2002

Analyte	Biological Matrix	Subject	Concentration (µg/ml)	Concentration Units	Job Assignment
PFOA	Serum	57178	0.168	µg/ml	Operator
PFOA	Serum	57179	0.175	µg/ml	Operator
PFOA	Serum	57180	0.0788	µg/ml	Operator
PFOA	Serum	57181	1.65	µg/ml	Operator
PFOA	Serum	57187	1.13	µg/ml	Operator
PFOA	Serum	57188	1.11	µg/ml	Operator
PFOA	Serum	57198	0.0978	µg/ml	Operator
PFOA	Serum	57199	0.347	µg/ml	Operator
PFOA	Serum	57201	0.0834	µg/ml	Operator
PFOA	Serum	57202	0.277	µg/ml	Operator
PFOA	Serum	57204	0.297	µg/ml	Operator
PFOA	Serum	57205	0.233	µg/ml	Operator
PFOA	Serum	57206	0.0527	µg/ml	Operator
PFOA	Serum	57207	0.174	µg/ml	Operator
PFOA	Serum	57208	0.125	µg/ml	Operator
PFOA	Serum	57211	0.210	µg/ml	Operator
PFOA	Serum	57200	0.127	µg/ml	Operator
AVG			0.388		
STDEV			0.472		
MIN			0.053		
MAX			1.650		
MEDIAN			0.193		
PFOA	Serum	57182	0.025	µg/ml	JL Technician
PFOA	Serum	57183	0.025	µg/ml	JL Technician
PFOA	Serum	57184	0.025	µg/ml	JL Technician
PFOA	Serum	57185	0.0561	µg/ml	JL Technician
PFOA	Serum	57186	0.025	µg/ml	JL Technician
PFOA	Serum	57189	0.025	µg/ml	JL Technician
PFOA	Serum	57190	0.025	µg/ml	JL Technician
PFOA	Serum	57191	0.025	µg/ml	JL Technician
PFOA	Serum	57192	0.025	µg/ml	JL Technician
PFOA	Serum	57193	0.025	µg/ml	JL Technician
PFOA	Serum	57194	0.025	µg/ml	JL Technician
PFOA	Serum	57195	0.05	µg/ml	JL Technician
PFOA	Serum	57196	0.0543	µg/ml	JL Technician
PFOA	Serum	57197	0.025	µg/ml	JL Technician
PFOA	Serum	57203	0.0506	µg/ml	JL Technician
PFOA	Serum	57209	0.025	µg/ml	JL Technician
PFOA	Serum	57210	0.0565	µg/ml	JL Technician
PFOA	Serum	57212	0.025	µg/ml	JL Technician
PFOA	Serum	57213	0.025	µg/ml	JL Technician
PFOA	Serum	98049	0.025	µg/ml	JL Technician
PFOA	Serum	98134	0.0885	µg/ml	JL Technician

for results less than limit of quantitation (0.050 ug/ml),
one half of the LOQ is used for statistical analysis (0.025 ug/ml)

Prepared by Barbara J. Dawson, CIH, CSP
November 17, 2004

DuPont Company
PFOA in Blood
Chambers Works
September - October 2002

Analyte	Biological Matrix	Subject	Concentration (µg/ml)	Concentration Units	Job Assignment
AVG			0.035		
STDEV			0.017		
MIN			0.025		
MAX			0.089		
MEDIAN			0.025		
PFOA	Serum	57214	0.658	µg/ml	Mechanic
PFOA	Serum	57215	0.0910	µg/ml	Electrician
PFOA	Serum	57216	0.0750	µg/ml	Mechanic
PFOA	Serum	98039	0.025	µg/ml	Mechanic
PFOA	Serum	98041	0.244	µg/ml	Mechanic
PFOA	Serum	98047	0.0598	µg/ml	Mechanic
PFOA	Serum	98048	0.137	µg/ml	Mechanic
PFOA	Serum	98056	0.199	µg/ml	Lagger
PFOA	Serum	98135	0.242	µg/ml	Inst. Mechanic
PFOA	Serum	98136	0.226	µg/ml	Mechanic
PFOA	Serum	98137	0.359	µg/ml	Mechanic
PFOA	Serum	98138	0.122	µg/ml	Mechanic
PFOA	Serum	98139	0.0629	µg/ml	Electrician
PFOA	Serum	98140	0.025	µg/ml	Inst. Mechanic
PFOA	Serum	98141	0.127	µg/ml	Mechanic
PFOA	Serum	98142	0.264	µg/ml	Mechanic
PFOA	Serum	98143	0.0807	µg/ml	Mechanic
PFOA	Serum	98040	0.025	µg/ml	Mechanic
AVG			0.168		
STDEV			0.156		
MIN			0.025		
MAX			0.658		
MEDIAN			0.125		
PFOA	Serum	98009	<LLQ	µg/ml	BLANK
PFOA	Serum	98010	<LLQ	µg/ml	BLANK
PFOA	Serum	98055	0.106	µg/ml	1st line super
PFOA	Serum	98133	0.025	µg/ml	Engineer
PFOA	Serum	98144	0.025	µg/ml	Chemist
PFOA	Serum	98145	0.025	µg/ml	Area Mgr
PFOA	Serum	98146	0.0576	µg/ml	ATO
PFOA	Serum	98147	0.313	µg/ml	Unit Tech Ldr
AVG			0.092		
STDEV			0.113		
MIN			0.025		
MAX			0.313		
MEDIAN			0.0413		

for results less than limit of quantitation (0.050 ug/ml),
one half of the LOQ is used for statistical analysis (0.025 ug/ml)

Prepared by Barbara J. Dawson, CIH, CSP
November 17, 2004

DATA SUMMARY

Chemical: PFOA

Site: Chambers Works

Date of Monitoring: 2004

Matrix: Human Blood Serum

Operation: Secure Environmental Treatment

Job Title	Number Sampled	Minimum Concentration	Mean	Median	Maximum Concentration	Standard Deviation
Entire Cohort	29	13.3	46.48	37.9	174	36.05
Males	29	13.3	46.48	37.9	174	36.05
Females	0	-	-	-	-	-
Operators	10	15.7	70.31	71.8	174	51.53
Males	10	15.7	70.31	71.8	174	51.53
Females	0	-	-	-	-	-
Mechanics	19	13.3	33.94	36.1	65.55	14.59
Males	19	13.3	33.94	36.1	65.55	14.59
Females	0	-	-	-	-	-
Laboratorians	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Supervision	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-

Comments:

- Analysis by Exygen
- Where duplicate samples were run, averages of two were used for statistical analysis
- Descriptive statistics calculated using Microsoft Excel

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: December 9, 2004

DuPont Company
PFOA in Blood
Chambers Works
2004 Secure Environmental Treatment

	Operator	Mechanic
	65.8	26.55
	132	36.1
	174	55.8
	20.6	16.9
	15.7	22.75
	80.8	65.55
	80	23.4
	22.7	22.85
	77.8	33.6
	33.7	47.4
		46.1
		37.9
		43.3
		13.3
		40.3
		42.35
		16.3
		38.9
		15.5
Count	10	19
Min	15.70	13.30
Avg	70.31	33.94
Median	71.80	36.10
Max	174.00	65.55
Std Dev	51.53	14.59

	All
	65.8
	132
	174
	20.6
	15.7
	80.8
	80
	22.7
	77.8
	33.7
	26.55
	36.1
	55.8
	16.9
	22.75
	65.55
	23.4
	22.85
	33.6
	47.4
	46.1
	37.9
	43.3
	13.3
	40.3
	42.35
	16.3
	38.9
	15.5
Count	29
Min	13.30
Avg	46.48
Median	37.90
Max	174.00
Std Dev	36.05

December 9, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: PFOA

Site: Chambers Works

Date of Monitoring: 2004

Matrix: Human Blood Serum

Operation: Non-PFOA/Non-Telomers

Job Title	Number Sampled	Minimum Concentration	Mean	Median	Maximum Concentration	Standard Deviation
Entire Cohort	8	5.55	14.97	11.3	43.2	11.92
Males	8	5.55	14.97	11.3	43.2	11.92
Females	0	-	-	-	-	-
Operators	6	5.55	14.91	10.15	43.20	14.05
Males	6	5.55	14.91	10.15	43.20	14.05
Females	0	-	-	-	-	-
Mechanics	2	13.2	15.15	15.15	17.1	2.76
Males	2	13.2	15.15	15.15	17.1	2.76
Females	0	-	-	-	-	-
Laboratorians	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Supervision	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-

Comments:

- Analysis by Exygen
- Where duplicate samples were run, averages of two were used for statistical analysis
- Descriptive statistics calculated using Microsoft Excel

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: December 9, 2004

DuPont Company
PFOA in Blood
Chambers Works
2004 Non-PFOA/Non-Telomers

	Operator	Mechanic
	12.3	13.2
	43.2	17.1
	5.55	
	8.11	
	10.3	
	10	
Count	6	2
Min	5.55	13.20
Avg	14.91	15.15
Median	10.15	15.15
Max	43.20	17.10
Std Dev	14.05	2.76

All	
12.3	
43.2	
5.55	
8.11	
10.3	
10	
13.2	
17.1	
8	**Count**
5.55	**Min**
14.97	**Avg**
11.30	**Median**
43.20	**Max**
11.92	**Std Dev**

Prepared December 9, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: PFOA

Site: Chambers Works

Date of Monitoring: 2004

Matrix: Human Blood Serum

Operation: Former PFOA Recycle Operations

Job Title	Number Sampled	Minimum Concentration	Mean	Median	Maximum Concentration	Standard Deviation
Entire Cohort	23	17.2	241.3	95.7	1605	387.3
Males	23	17.2	241.3	95.7	1605	387.3
Females	0	-	-	-	-	-
Operators	15	37.9	330.05	170	1605	458.39
Males	15	37.9	330.05	170	1605	458.39
Females	0	-	-	-	-	-
Mechanics	8	17.2	74.89	59.3	163	51.63
Males	8	17.2	74.89	59.3	163	51.63
Females	0	-	-	-	-	-
Laboratorians	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Supervision	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-

Comments:

- Analysis by Exygen
- Where duplicate samples were run, averages of two were used for statistical analysis
- Descriptive statistics calculated using Microsoft Excel

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: December 9, 2004

DuPont Company
PFOA in Blood
Chambers Works
2004 Former PFOA Recycle Operation

	Operators	Mechanics
	Male	Male
	412	72.2
	84.3	46.4
	174	163
	95.7	44.4
	77.4	73.8
	1605	142.5
	53.4	39.6
	241	17.2
	188	
	56.6	
	37.9	
	1200	
	170	
	441	
	114.5	
Count	15	8
Min	37.90	17.20
Avg	330.05	74.89
Median	170.00	59.30
Max	1605.00	163.00
Std Dev	458.39	51.63

All	
412	
84.3	
174	
95.7	
77.4	
1605	
53.4	
241	
188	
56.6	
37.9	
1200	
170	
441	
114.5	
72.2	
46.4	
163	
44.4	
73.8	
142.5	
39.6	
17.2	
23	Count
17.20	Min
241.30	Avg
95.70	Median
1605.00	Max
387.30	Std Dev

Prepared December 9, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: PFOA

Site: Chambers Works

Date of Monitoring: 2004

Matrix: Human Blood Serum

Operation: Controls

Job Title	Number Sampled	Minimum Concentration	Mean	Median	Maximum Concentration	Standard Deviation
Entire Cohort	13	3.66	7.73	7.55	13.95	3.42
Males	10	3.66	8.32	7.98	13.95	3.63
Females	3	3.92	5.77	5.76	7.62	1.85
Operators	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Mechanics	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Laboratorians	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Supervision	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-

Comments:

- Analysis by Exygen
- Where duplicate samples were run, averages of two were used for statistical analysis
- Descriptive statistics calculated using Microsoft Excel

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: December 9, 2004

DuPont Company
PFOA in Blood
Chambers Works
2004 Controls

	Male	Female
	7.55	7.62
	9.59	5.76
	4.82	3.92
	13.95	
	8.41	
	5.72	
	3.66	
	4.88	
	12.6	
	12	
Count	10	3
Min	3.66	3.92
Avg	8.32	5.77
Median	7.98	5.76
Max	13.95	7.62
Std Dev	3.63	1.85

All Controls	
7.55	
9.59	
4.82	
13.95	
8.41	
5.72	
3.66	
4.88	
12.6	
12	
7.62	
5.76	
3.92	
13	**Count**
3.66	**Min**
7.73	**Avg**
7.55	**Median**
13.95	**Max**
3.42	**Std Dev**

Prepared December 9, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: PFOA

Site: Chambers Works

Date of Monitoring: 2004

Matrix: Human Blood Serum

Operation: Jackson Laboratory

Job Title	Number Sampled	Minimum Concentration	Mean	Median	Maximum Concentration	Standard Deviation
Entire Cohort	12	5.5	18.27	12.95	67.8	16.75
Males	10	7.16	20.23	15.8	67.8	17.76
Females	2	5.5	8.5	8.5	11.5	4.24
Operators	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Mechanics	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Laboratorians	6	7.16	24.35	18.05	67.8	22.59
Males	6	7.16	24.35	18.05	67.8	22.59
Females	0	-	-	-	-	-
Supervision	6	5.5	12.2	11.85	18.8	4.28
Males	4	11.5	14.05	12.95	18.8	3.5
Females	2	5.5	8.5	8.5	11.5	4.24

Comments:

- Analysis by Exygen
- Where duplicate samples were run, averages of two were used for statistical analysis
- Descriptive statistics calculated using Microsoft Excel

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: December 9, 2004

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DuPont Company
PFOA in Blood
Chambers Works
2004 Jackson Laboratory

	Technician	Supervision	
	Male	Male	Female
	7.63	18.8	5.5
	17.9	12.2	11.5
	18.2	13.7	
	27.4	11.5	
	7.16		
	67.8		
Count	6	4	2
Min	7.16	11.50	5.50
Avg	24.35	14.05	8.50
Median	18.05	12.95	8.50
Max	67.80	18.80	11.50
Std Dev	22.59	3.30	4.24

	All	All Male	All Sup
	7.63	7.63	18.8
	17.9	17.9	12.2
	18.2	18.2	13.7
	27.4	27.4	11.5
	7.16	7.16	5.5
	67.8	67.8	11.5
	18.8	18.8	
	12.2	12.2	
	13.7	13.7	
	11.5	11.5	
	5.5		
	11.5		
Count	12	10	6
Min	5.50	7.16	5.50
Avg	18.27	20.23	12.20
Median	12.95	15.80	11.85
Max	67.80	67.80	18.80
Std Dev	16.75	17.76	4.28

Prepared December 9, 2004
Barbara J. Dawson, CIH, CSP

AR226-3425

DU PONT DE NEMOURS (NEDERLAND) B.V.
DORDRECHT WORKS.

AR 226-3425

20 OCTOBER 1981

AL NO.:	OPERATORS	C-8 EXPOSURE		C-8 PPM IN BLOOD:
		WORKS IN POLYMER SINCE	AS POLYKETTLE OPERATOR SINCE	
-2239		1979	1980	1.4
-2240		1978	1979	1.4
-2241		1972	1975	8.1
-2242		1977	1979	3.4
-2243		1970	1974	4.5
-2293		1972	1974	7.8
-2294		1977	1978	5.9
-2295		1969	1969	6.6
-2396		1971	1973	6.6
-2397		1979	1981	2.6
-2530		1976	1978	20.0
-3906		"	"	18.0 (repaeted)
-2531		1973	1976	6.5
-2532		1975	1979	3.9
-2533		1972	1975	9.2
-2534		1968	1968	4.9 av = 5.4
-2613		1968	1970	4.8
-2614		1979	NEVER	0.59 (if high removed -
-2615		1970	NEVER	3.6
-2616		1968	1978	4.1
-2617		1975	1977	7.7 av = 4.8
-2618		1968	NEVER	2.1
	OTHERS:			
-3910		[redacted] OPERATOR '74-'78		3.7
-3915		" " '68-'78		1.2
-3919		" " '77-'78		0.53
-3912		[redacted] LABORATORY '74-'81		0.32
-3913		" " '79-'81		0.051
-3907		SHIFT MECHANIC '66-'81		0.40
-3911		ADMINISTRATOR NON EXPOSED		0.065
-3909		NON EXPOSED		0.012
-3914		" "		0.0098
-3917		" "		0.014

dh

Company Sanitized. Does not contain TSCA CBI

Time	Item	Leader
8:00-8:05	Review previous meeting minutes	Migliore
8:05-8:10	Results of Glas Review - Discuss "containment only" option	Chapman
8:10-8:25	Results of PAC Review	Chapman
8:25-8:30	Site Exposure Reduction Issues	Migliore
8:30-9:05	Understanding CEP Emission Values - CEP Definition of emissions - WW Emission Assumptions - DW Emission Assumptions - SW Emission Assumptions - C8 Emissions vs. Use Chart	 Migliore Zipfel Brandenburg Zipfel Zipfel
9:05-9:50	Reconciliation of Site emissions	Brandenburg Zipfel
9:50-10:00	Path forward items	Migliore

Topics for next month include:

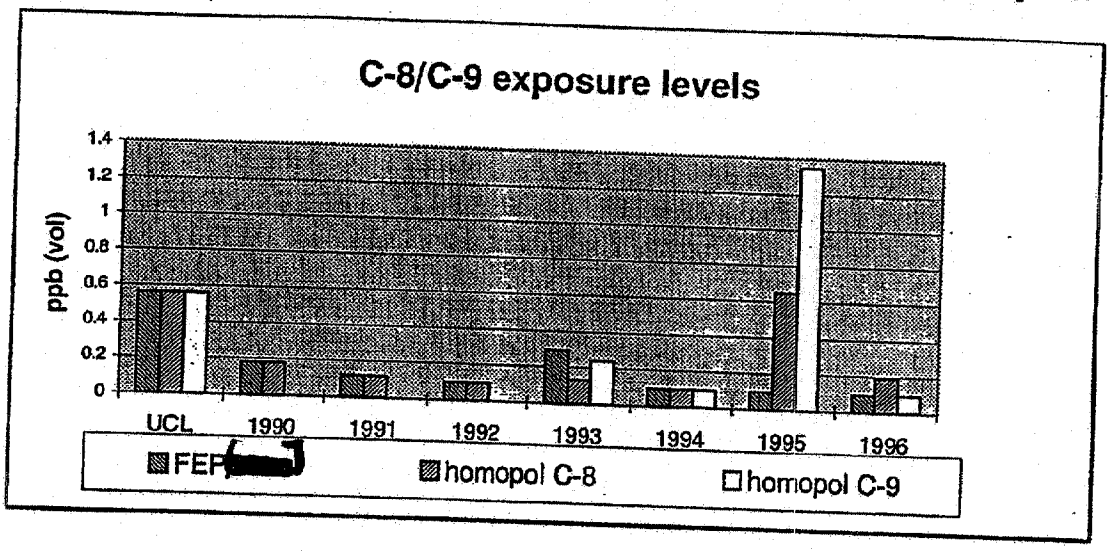
- Washington Works occupation health issues - Mattson/Playtis

Dordrecht Works Occupational Health

Arie Vermeulen covered exposure limits to C-8 and C-9 at DW. He reviewed occupational health programs designed to reduce exposure at DW. Details are in the chart and those attached on page A-6. There were high personal exposure levels, particularly to C-9, in 1995. The worst exposure points were the wax separators and the C-9 injection tank. These were corrected by several factors with the most important being local exhaust, PPE, and liquid C-9.

year	UCL	1990	1991	1992	1993	1994	1995	1996
FEP[redacted]	0.56	0.18	0.12	0.1	0.29	0.1	0.1	0.1
homopol C-8	0.56	0.18	0.12	0.1	0.13	0.1	0.65	0.19
homopol C-9	0.56				0.24	0.1	1.35	0.1

Company Sanitized. Does not contain TSCA CBI



Washington Works Occupational Health

Current efforts focus on implementing recommendations from the survey that John Migliore and Fran Mulherin conducted in 1996.

Corporate Environmental Plan (CEP) C-8 Emission Numbers

Roger Zipfel presented charts on C-8 emissions from Washington Works assuming (1) replacement of surfactant in FEP, PFA, and dispersion and (2) no replacement. He also reported the assumptions behind each case. He pointed out that we need to understand fugitive emissions of C-8 and their impact on total emissions.

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14ff

AR 226-3427

C-8 IN BLOED MONITORING RESULTS IN FLPR DORDRECHT

In past month of May blood samples were taken of 38 employees in the [redacted] Homo Polymers, FEP/[redacted] Monomers A-shift areas and some employees in the service areas. This as a part of a c-8 in blood monitoring program in co-operation with DuPont FLPR Parkersburg and Dyneon in Gendorf Germany. Dyneon is our partner in purifying the recovered c-8 and owner of the technology.
Previous c-8 in blood monitoring programs were conducted in 1997, 1981, 1982 en 1984.

Introduction

- C-8 is dispergator, required for the manufacturing of [redacted]
- C-8 is a toxic substantive that can be inhaled and absorbed via skin contact. The c-8 will be stored in the liver.
- C-8 is a toxic that should be discussed and registered in a yearly program with all employees.
- In the list of the Haskell lab, rev. July 1999, c-8 probably is no human carcinogen and developmental toxic
- The exposure limit is 0,56 ppb.
- C-8 in the human body can be measured only by analyzing the blood.
- Up till now it was not possible to define a maximum exposure limit for c-8 in blood.

The c-8 in blood samples were analyzed in two laboratories. All 38 samples were analyzed in the NMS lab in de U.S. while 19 each of them were also analyzed in the Schiwara lab in Germany as cross checks.
The analyze results of the two labs were corresponding pretty much. This makes that we have confidence in the results.

Characteristics of the analyze results

- [redacted] Monomers employees have lower c-8 levels.
- [redacted] Homopolymers employees have higher c-8 levels.
- [redacted] FEP and [redacted] employees have c-8 levels intermediate of both previous areas.
- Compared with the 1997 c-8 in blood analyzing program, there was a relatively slight difference in the c-8 levels of employees that co-operated in both the 1997 and the 2000 program.
- In week 29 the Managers Operations had a personnel contact with the six employees with the highest c-8 in blood levels to discuss possible sources of exposure and use of PPE. These contacts helped to determine some unknown exposure sources.

On July 13 a team of experts, Site physician, Site hygienist, FLPR c-8 coordinator, FLPR S&OH coordinator and Managers Operations, evaluated the results of the analyzes. Appointments were made to present the results to the employees involved and to inform all other FLPR and DuPont Dow Elastomers J.V. employees by means of an E-mail message.

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Conclusions

- There are considerable differences in c-8 levels between employees performing the same jobs. An explanation for this phenomenon might be that the one person will pick up more c-8 and demolishes it slower than another person.
- Give more attention to prevent skin exposure to c-8 and the use op proper PPE.
- Comparison of the DDT c-8 analyzes with that of PKB will be done later as the PKB results are not completed yet.

Path forward

- New samples to be taken from employees with high analyze results after ± two years from now.
- Further reduction of risk sources.
- Make up an inventory of the c-8 handling practices en use of PPE.
- Promotion of awareness to prevent exposure for all employees.
- Give special attention for prevention of exposure via the skin.

Sources for exposure

- High Pressure cleaning of Dispersion Poly kettles.
- All c-8 solved in water.
- All c-8 spills.
- PTFE Dispersions and non-dried Fine Powders.
- Coagulum and waste from the Wax trap.
- Supernate in [redacted]Homo Polymers and Thermal Converter areas.
- Fine Powder Dryers, especially during clean-outs.
- Granular production line.
- [redacted]FEP Wet Finishing system.
- Exhaust gasses and container changes in both c-8 recovery areas.
- Maintenance in c-8 containing equipment.

Actions taken to prevent exposure

- C-8 solved in water instead of c-8 powder in all areas.
- C-8 is injected automatically instead of weighing and handling of c-8 powder.
- Air exhausts on wax separators.
- Improve practices for cleaning of Fine Powder Dryers.
- Make up an inventory of emission sources and adequate actions.
- Proper procedures for use of PPE.
- Improvement of c-8 recovery systems.
- Communication with all employees.

Everybody's responsibility

The exposure prevention by the properly use of proper PPE, reporting of risks for exposure and cooperation to accomplish improvements. This also being an Arbolaw responsibility for all employees.

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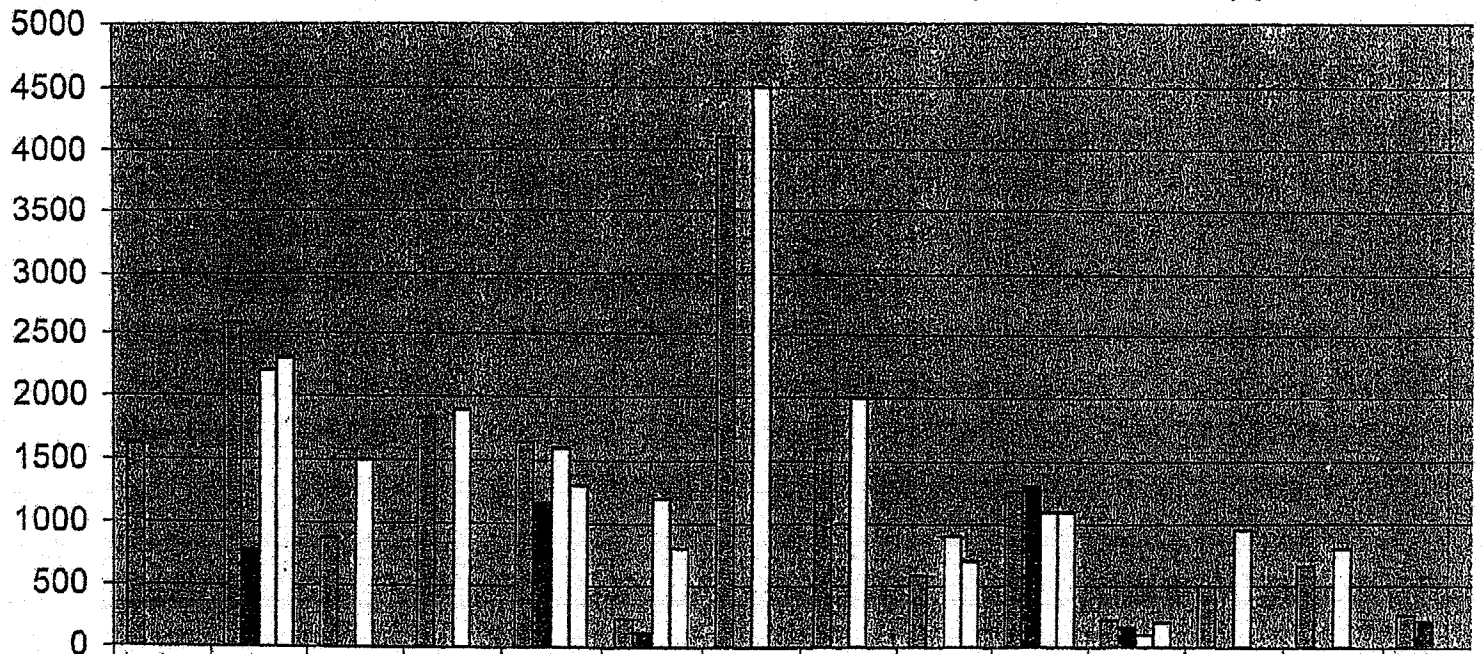
FLPR DDT c-8 in blood 1997 vs 2000 sample results in ppb



	1	2	3	5	6	8	9	13	15	10	4	7	11	12
Shell 97	1616	2581	880	1836	1642	229	4101	1594	582	1263	218	499	659	261
NMS 97		777			1162	120				1300	170			210
NMS 2000		2200	1500	1900	1600	1200	4500	2000	900	1100	100	950	800	
Schi 2000		2300			1300	800			700	1100	200			

Nrs 1 t/m 15 zijn van 1997 prog.

Control #	Sample ID	Rec'd Date	Test Name	Result (ppb)	Specimen	Acct. #
551474	1011.1	6/9/00	PERFLUOROOCTANOIC ACID	Failed re-analysis	Blood	95240
551475	1011.2	6/9/00	PERFLUOROOCTANOIC ACID	Failed re-analysis	Blood	95240
551476	1011.3	6/9/00	PERFLUOROOCTANOIC ACID	Failed re-analysis	Blood	95240
551477	1013.1	6/9/00	PERFLUOROOCTANOIC ACID	Failed re-analysis	Blood	95240
551478	1013.2	6/9/00	PERFLUOROOCTANOIC ACID	Failed re-analysis	Blood	95240
551479	1013.3	6/9/00	PERFLUOROOCTANOIC ACID	Failed re-analysis	Blood	95240
551480	1014.1	6/9/00	PERFLUOROOCTANOIC ACID	Failed re-analysis	Blood	95240
551481	1014.2	6/9/00	PERFLUOROOCTANOIC ACID	7,200	Blood	95240
551482	1014.3	6/9/00	PERFLUOROOCTANOIC ACID	10,000	Blood	95240
551483	1016.1	6/9/00	PERFLUOROOCTANOIC ACID	150	Blood	95240
551484	1016.2	6/9/00	PERFLUOROOCTANOIC ACID	7,600	Blood	95240
551485	1016.3	6/9/00	PERFLUOROOCTANOIC ACID	13,000	Blood	95240
551486	1012	6/9/00	PERFLUOROOCTANOIC ACID	42	Blood	95240
551487	1017	6/9/00	PERFLUOROOCTANOIC ACID	115	Blood	95240
561677	39-1980	6/9/00	PERFLUOROOCTANOIC ACID	98	Blood	95240
561678	30-5155	6/9/00	PERFLUOROOCTANOIC ACID	230	Blood	95240
561679	10-2935	6/9/00	PERFLUOROOCTANOIC ACID	1,100	Blood	95240
561680	7-12493	6/9/00	PERFLUOROOCTANOIC ACID	950	Blood	95240
561681	9-3789	6/9/00	PERFLUOROOCTANOIC ACID	4,500	Blood	95240
561682	11-3240	6/9/00	PERFLUOROOCTANOIC ACID	2,000	Blood	95240
561683	28-5566	6/9/00	PERFLUOROOCTANOIC ACID	270	Blood	95240
561684	36-5165	6/9/00	PERFLUOROOCTANOIC ACID	330	Blood	95240
561685	17-6063	6/9/00	PERFLUOROOCTANOIC ACID	1,400	Blood	95240
561686	20-5669	6/9/00	PERFLUOROOCTANOIC ACID	1,000	Blood	95240
561687	12-2180	6/9/00	PERFLUOROOCTANOIC ACID	900	Blood	95240
561688	27-5868	6/9/00	PERFLUOROOCTANOIC ACID	100	Blood	95240
561689	40-11825	6/9/00	PERFLUOROOCTANOIC ACID	38	Blood	95240
561690	41-3952	6/9/00	PERFLUOROOCTANOIC ACID	1,900	Blood	95240
561691	22-8215	6/9/00	PERFLUOROOCTANOIC ACID	4,900	Blood	95240
561692	3-5251	6/9/00	PERFLUOROOCTANOIC ACID	1,500	Blood	95240
561693	37-3145	6/9/00	PERFLUOROOCTANOIC ACID	68	Blood	95240
561694	42-5883	6/9/00	PERFLUOROOCTANOIC ACID	1,000	Blood	95240
561695	34-5523	6/9/00	PERFLUOROOCTANOIC ACID	820	Blood	95240
561696	6-5978	6/9/00	PERFLUOROOCTANOIC ACID	1,600	Blood	95240
561697	21-5421	6/9/00	PERFLUOROOCTANOIC ACID	1,500	Blood	95240
561698	4-12933	6/9/00	PERFLUOROOCTANOIC ACID	140	Blood	95240
561699	5-4588	6/9/00	PERFLUOROOCTANOIC ACID	1,900	Blood	95240
561700	2-1530	6/9/00	PERFLUOROOCTANOIC ACID	2,200	Blood	95240
561701	31-5652	6/9/00	PERFLUOROOCTANOIC ACID	45	Blood	95240
561702	38-2978	6/9/00	PERFLUOROOCTANOIC ACID	3,900	Blood	95240
561703	35-3405	6/9/00	PERFLUOROOCTANOIC ACID	800	Blood	95240
561704	13-4791	6/9/00	PERFLUOROOCTANOIC ACID	800	Blood	95240
561705	33-5474	6/9/00	PERFLUOROOCTANOIC ACID	1,800	Blood	95240
561706	8-5742	6/9/00	PERFLUOROOCTANOIC ACID	1,200	Blood	95240
561707	32-4507	6/9/00	PERFLUOROOCTANOIC ACID	1,500	Blood	95240
561708	29-5504	6/9/00	PERFLUOROOCTANOIC ACID	180	Blood	95240
561709	25-5996	6/9/00	PERFLUOROOCTANOIC ACID	1,300	Blood	95240
561710	15-4708	6/9/00	PERFLUOROOCTANOIC ACID	4,500	Blood	95240
561711	16-3823	6/9/00	PERFLUOROOCTANOIC ACID	10,000	Blood	95240
561712	23-6225	6/9/00	PERFLUOROOCTANOIC ACID	1,500	Blood	95240
561713	26-5542	6/9/00	PERFLUOROOCTANOIC ACID	670	Blood	95240
561714	19-4793	6/9/00	PERFLUOROOCTANOIC ACID	8,900	Blood	95240

CONFIDENTIAL

Analytical Results of PFOA blood samples

Company	Sampling date	Labor ID	Schiwara results mg/l	NMS results mg/l
Dyneon	5/24/00	1019	0.40	
Dyneon	19.05.2000	1018	0.20	
Dyneon	19.05.2000	1015	0.10	
Dyneon	19.05.2000	1017	0.30	
Dyneon	19.05.2000	1016	0.40	
Dyneon	control + 5 mg/l	10162	4.8	
Dyneon	control + 10 mg/l	10163	9.2	
Dyneon	18.05.2000	1014	0.40	
Dyneon	control + 5 mg/l	10142	4.20	
Dyneon	control + 10 mg/l	10143	8.60	
Dyneon	18.05.2000	1011	0.30	
Dyneon	18.05.2000	1012	0.10	
Dyneon	control + 5 mg/l	10122	4.3	
Dyneon	control + 10 mg/l	10123	8.5	
Dyneon	18.05.2000	1013	0.20	
Dyneon	control + 5 mg/l	10132	4.4	
Dyneon	control + 10 mg/l	10133	8.8	
Dyneon	17.05.2000	1009	1.00	
Dyneon	17.05.2000	1010	0.10	
Dyneon	17.05.2000	1008	0.20	
Dyneon	17.05.2000	1007	0.20	
Dyneon	16.05.2000	1005	0.20	
Dyneon	16.05.2000	1004	0.60	
Dyneon	16.05.2000	1006	0.30	
Dyneon	15.05.2000	1003	0.10	
Dyneon	15.05.2000	1000	0.30	
Dyneon	15.05.2000	1001	0.10	
Dyneon	15.05.2000	1002	0.50	
DuPont		122180	0.70	
DuPont		163023	8.30	
DuPont		102935	1.10	
DuPont		85472	0.80	
DuPont		65970	1.30	
DuPont		412933	0.20	
DuPont		205669	1.00	
DuPont		229213	6.00	
DuPont		265542	0.70	
DuPont		285566	0.30	
DuPont		305155	0.30	
DuPont		324507	1.20	
DuPont		345523	1.00	
DuPont		365165	0.50	
DuPont		373145	0.10	
DuPont		382970	2.40	
DuPont		4011025	<0,1	
DuPont		21530	2.30	
DuPont		425803	0.80	

HIGH RESULTS

2000	
1600	
1400	
2800	
2800	
3100	
9000	GR164
2500	
1100	
1000	
6200	GR164
2100	
1000	FEP163
2300	
1100	
3900	FP 162
4700	FP 162
1300	
1500	
2500	
2600	
4500	FP162
1200	
4900	FP 162
1000	FEP163 ?
1300	FEP163
1000	
1700	GR164
8500	GR 164
3000	FP162
2800	
4300	FP 16[illegible]
1600	
2400	
1300	
1100	
6900	GR164
2000	

Redacted - Privacy

2000 C-8 BLOOD TESTING
DISTRIBUTION OF RESULTS

PPB	NUMBER
0 – 999	87
1000 – 1999	16
2000 – 2999	~~10~~ 11
3000 – 3999	3
4000 – 4999	4
5000 – 5999	0
6000 – 6999	2
7000 – 7999	0
8000 – 8999	1
9000 – 9999	1

< 1000	87
1000 - 1999	16
2000 - 2999	10
3000 - 3999	3
4000 - 4999	4
5000 - 5999	0
6000 - 6999	2
7000 - 7999	0
8000 - 8999	1
9000 - 9999	1

[redacted] [redacted]

[redacted]

[redacted]

[redacted]

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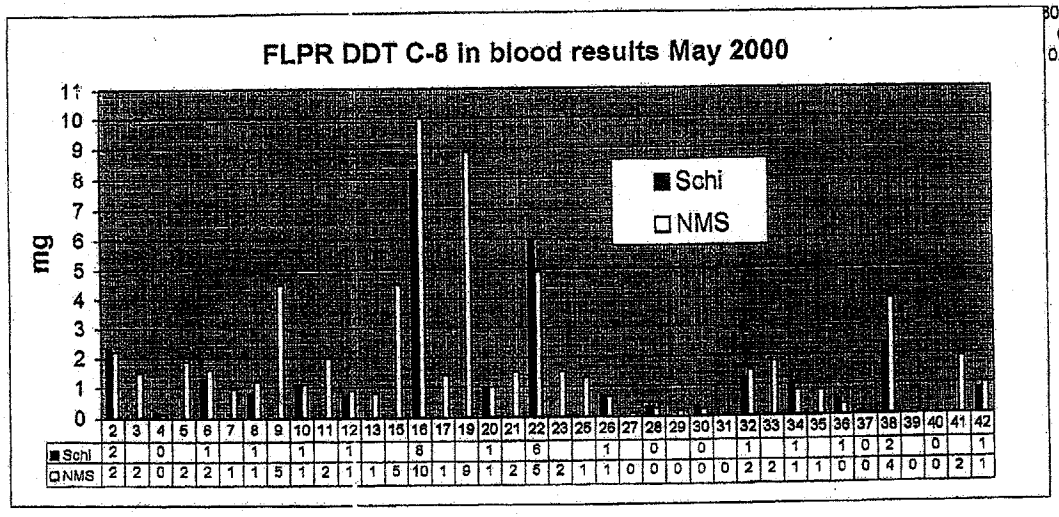


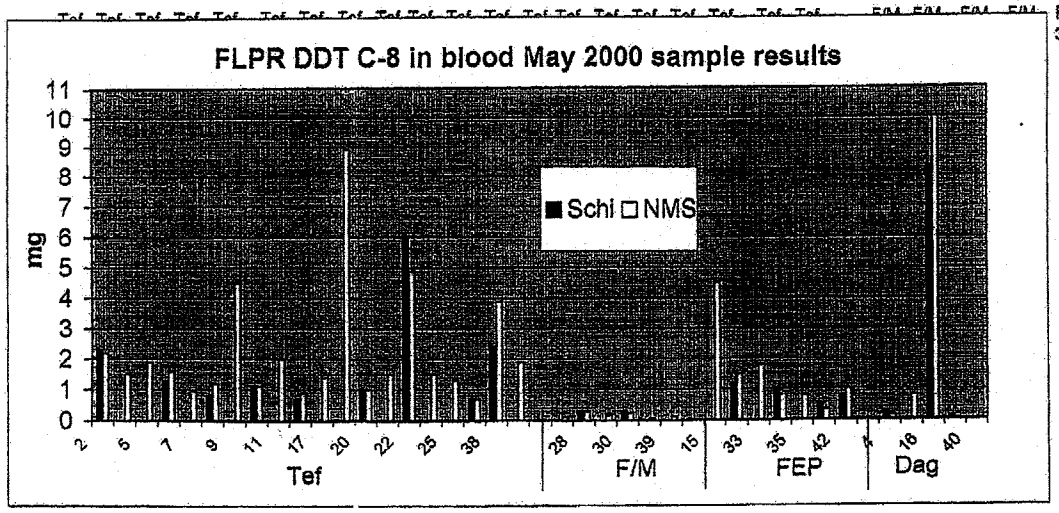
	2	3	4	5	6	7	8	9	10	11	12	13	15	16	17	19	20	21	22	23	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Schi	2		0		1		1		1		1			8			1		6			1		0		0		1		1		1	0	2		0		1
NMS	2	2	0	2	2	1	1	5	1	2	1	1	5	10	1	9	1	2	5	2	1	1	0	0	0	0	0	2	2	1	1	0	0	4	0	0	2	1

30	31	32	33	34	35	36
0.3		1.2		1		0.5
0.23	0.045	1.5	1.8	0.82	0.8	0.33

000264

37	38	39	40	41	42
0.1	2.4		0		0.8
0.068	3.9	0.1	0.038	1.9	1

000265

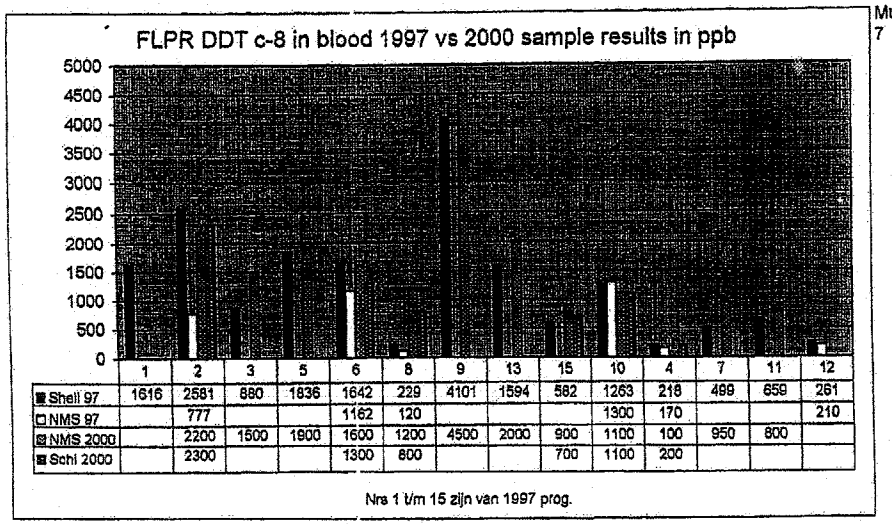


F/M	F/M	Fep	Fep	Fep	Fep	Fep
31	39	15	32	33	34	35
			1.2		1	
0.045	0.1	4.5	1.5	1.8	0.82	0.8

992000

Fep	Fep	Dag	Dag	Dag	Dag	Dag
36	42	4	13	16	37	40
0.5	0.8	0.2		8.3	0.1	0
0.33	1	0.14	0.8	10	0.038	0.038

000267



	1	2	3	5	6	8	9	13	15	10	4	7	11	12
Shell 97	1616	2581	880	1836	1642	229	4101	1594	582	1263	218	499	659	261
NMS 97		777			1162	120				1300	170			210
NMS 2000		2200	1500	1900	1600	1200	4500	2000	900	1100	100	950	800	
Schi 2000		2300			1300	800			700	1100	200			

Nrs 1 t/m 15 zijn van 1997 prog.

Mulder	Heer	Boers
7	11	12
499	659	261
		210
950	800	

000268

AR226-3428

[redacted] 54269

Z-49 REV 12-79

DU PONT

E. I. DU PONT DE NEMOURS & COMPANY
INCORPORATED
WILMINGTON, DELAWARE 19898

POLYMER PRODUCTS DEPARTMENT
EXPERIMENTAL STATION

PPD
NOV 4 1982
EXPR. STATION
INFO CENTER

November 1, 1982

PERSONAL AND CONFIDENTIAL

TO: J. D. DE LAURENTIS, M.D. - CR&DD, BUILDING 301

FROM: S. R. LAAS S.R. Laas

ANALYSIS OF BLOOD SAMPLES FOR PERFLUOROOCTANOATE
(Job No. 820-969, PRAL Nos. 82-4096, 4099, 4100, 5166, 5168, 5172, 5176-77, 5262, 5269, 5573-75, 5578)
Notebook Nos. E29297, E29298

The 14 blood samples, previously reported in letters to you dated 10/19/82 and 10/29/82 as having perfluorooctanoate (C8) concentrations greater than the blank, have been analyzed for C8 by the usual gas chromatographic method ES-567. Results and sample identifications are given in the attached table.

The samples are all very low; indeed 3 of the samples are indistinguishable from the blank and 5 are below the quantitation limit. The estimated uncertainty for these analyses is higher than usual due to the very low levels of C8 and the difficulty in integrating the small C8 peak which elutes between the O5 and O6 peaks.

If you have any questions regarding these analyses, don't hesitate to call me.

Key Words

Perfluorooctanoate
GC
Blood Analysis

SRL:kab
Attach.

Company Sanitized. Does not contain TSCA CBI

There's a world of things we're doing something about

000270

TABLE I

CONCENTRATION OF PERFLUOROOCTANOATE IN BLOOD (a)

Sample PRAL No.	Date Received	Name	GC Analysis Date Analyzed	[C8], µg F/g blood (b)
82-4096	7/21/82	[redacted]	10/25/82	0.009
82-4099	7/21/82	[redacted]	10/25/82	n.d.
82-4100	7/21/82	[redacted]	10/25/82	<0.007
82-5166	9/17/82	[redacted]	10/22/82	<0.007
82-5168	9/17/82	[redacted]	10/22/82	0.010
82-5172	9/17/82	[redacted]	10/22/82	0.007
82-5176	9/17/82	[redacted]	10/22/82	<0.007
82-5177	9/17/82	[redacted]	10/25/82	0.007
82-5262	9/24/82	[redacted]	10/25/82	<0.007
82-5269	9/24/82	[redacted]	10/25/82	0.009
82-5573	10/8/82	[redacted]	10/26/82	0.007
82-5574	10/8/82	[redacted]	10/26/82	<0.007
82-5575	10/8/82	[redacted]	10/26/82	n.d.
82-5578	10/8/82	[redacted]	10/26/82	n.d.

(a) Analysis as described in Lab Method ES-567 ("Determination of Perfluorooctanoic Acid in Blood, Gas Chromatographic Method", S. Stafford, 4/3/81), using the packed column GC analysis with perfluoro-n-octanoic acid as calibration standard.

(b) Although the analysis is specifically for perfluorooctanoate (acid or salts), concentrations are given in ppm fluorine for comparison with the results of total organic fluorine analyses. (ppm F = 0.688 x ppm perfluorooctanoic acid). Estimated uncertainty is ± 20% relative standard deviation. The lower limit for quantitation is 0.007 µg F/g. The detection limit is ~0.004 µg F/g, but concentrations in that range cannot be well quantitated and are reported as <0.007. None detected (n.d) is reported for samples with [C8] ≲0.004 ppm. which cannot be distinguished from reagent background.

Redacted - Privacy

86pp

AR226-3429

33

RECYCLED

000272

AR226-3429

EXPOSURE ASSESSMENT PROTOCOL

Work Request No.: 15076

Service Code No.: 1361

Performing Institution: Haskell Laboratory for Health and Environmental Sciences

Study Title: **Exposure Assessment of Measured Serum Perfluorinated Octanoic Acid Anion in the Manufacture of Ammonium Perfluorooctanoate (APFO) at Fayetteville, NC**

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AUTHORIZATION FOR SERVICES

To:	From:
David M. Rurak SHE Manager Fluoroproducts	Joseph F. Viskocil, Jr. CIH Senior Industrial Hygienist Haskell Laboratory
Requested By:	**Date:** December 12, 2003

Title:

Exposure Assessment of Measured Serum Perfluorinated Octanoic Acid Anion in the Manufacture of Ammonium Perfluorooctanoate (APFO) at Fayetteville, NC

Authority is requested to undertake the study identified above and described as follows:

The primary purpose of this project is to measure worker exposure in the manufacture APFO in Fayetteville, NC. for assessment of the effectiveness of the industrial hygiene controls measures in place to minimize exposure to APFO.

The secondary purpose of this occupational exposure project is to characterize APFO exposure in workers engaged in the manufacture of APFO and to determine 1) whether the major route of exposure is via inhalation or dermal, 2) the length of time required for the compound to reach steady-state, and 3) if there is a sufficient population, determine the length of time for serum levels to return to baseline following cessation of exposure. This will be accomplished by longitudinal sampling and analysis of serum PFOA anion levels according to a repeated samples design, air monitoring, and estimating dermal and oral contributions to overall exposure. Correlations between external and internal measures of exposure will be calculated. The data will be examined for within- and between-subject variation associated with specific tasks on the process line.

AUTHORIZATION FOR SERVICES **Additional Support Required from the Plant:**

Air sampling equipment including pumps, calibrators, battery eliminators, ...
Personnel time – additional IH resources to conduct air sampling and investigate process upsets, data anomalies

INITIATION DATE: Immediately upon approval- Estimated approval date December 15, 2003	**ESTIMATED COMPLETION: December 31, 2009**
ESTIMATED COST: December 15, 2003 to December 31, 2004 cost [redacted]	**GENERAL LEDGER/SUBACCOUNT:** 9350-CVT91601002-89808800

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If this request meets with your approval, enter the general ledger and subaccount, sign below, and return.

AUTHORIZED APPROVAL: David B. Rush DATE: 12/15/03

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REVIEW AND APPROVAL

STUDY DIRECTOR AND COINVESTIGATORS

I attest that, to the best of my knowledge, this protocol is scientifically sound, describes the study and procedures to be used with appropriate regulatory requirements, Good Industrial Hygiene Practices, the research protocol and any amendments thereof.

Submitted:

Joseph F. Viskocil, Jr CIH
Study Director

Date: 12/15/03

Approved:

Janice L. Connell CIH
Operations Manager, Haskell Laboratory

Date: 12/15/03

INTRODUCTION

Abstract

This occupational exposure study will characterize APFO exposure by monitoring PFOA anion in workers engaged in the manufacture of APFO and to determine 1) whether the major route of exposure is via inhalation or dermal, 2) the length of time required for the compound to reach steady-state, and 3) if there is a sufficient population, determine the length of time for serum levels to return to baseline following cessation of exposure. This will be accomplished by sampling and analysis of serum PFOA anion levels according to a repeated samples design, air monitoring, and estimating dermal and oral contributions to overall exposure. Correlations between external and internal measures of exposure will be calculated. The data will be examined for within- and between-subject variation associated with specific tasks on the process line.

Definitions:

APFO – Ammonium Perfluorooctanoate
Biomonitoring –Industrial Hygiene serum samples analyzed for PFOA anion used as an indication of occupational exposure
LC – Liquid Chromatography
MS – Mass Spectrometry
PFOA – Perfluorooctanoic Acid
PFOA Anion –perfluorooctanoate anion, the analyte of both PFOA and APFO by LC/MS/MS

Objective:

The objective of this study is to monitor serum levels of PFOA anion levels in manufacturing and manufacturing support workers of APFO as a measure the effectiveness of industrial hygiene controls.

BACKGROUND

Despite the absence of any persuasive scientific evidence establishing a causal association between exposure to PFOA and specific health effects, there continues to be

questions raised on the health affects of PFOA. Epidemiological studies on the health effects of PFOA exposure have focused on occupational populations. A currently validated analytical method (with a limit of quantification as low as 0.5 ppb) allows increased understanding of background levels.

In Fayetteville APFO production began in the fall of 2003. Prior to start-up baseline blood serun samples were taken. With this background, we have a unique opportunity to monitor exposure as a function of process time.This PFOA anion in serum levels will be measured routinely as an indication of the effectiveness of industrial hygiene controls.

It is our goal to minimize employee exposure to APFO in the AFPO manufacturing process and to assure compliance with the DuPont Acceptable Exposure Limit (AEL) of 0.01 mg/m^3.

SURVEILLANCE METHODS

PARTICIPANT SELECTION

Biological monitoring evaluates the absorption of PFOA/APFO by measuring the chemical or its metabolites in body fluids. Serum sampling is the preferred method for biological monitoring because there is a validated analytical method for measuring PFOA anion, rather than a metabolite or the fluoride ion in this medium. Workers in the APFO manufacturing process are chosen because they are likely to have highest exposures at the Fayetteville Works, we were able to get a pre-start up baseline, and we can track serum levels with time from the process start-up. DuPont's goal is to minimize exposure.

Workers employed in the new APFO production unit at Fayetteville Works and for whom a baseline level of serum PFOA anion was determined before beginning work in the unit will be included in this surveillance study. Participants will be all APFO workers at the DuPont Fayetteville Works site who volunteer for participation in this study, and sign a consent form.

DATA COLLECTION

Every employee assigned to the APFO manufacturing area will asked to participate in the PFOA anion blood monitoring program. The employee will be asked to sign a consent form and a baseline blood sample will be taken before the employee begins work in the APFO manufacturing area. After the baseline sample is collected, the employee will participate in the normal 6-month sampling program. Once in the blood monitoring program, the employee is expected to have blood drawn and analyzed every 6-months for the duration of the study – whether or not they remain in the APFO manufacturing area.

For each participant, date of birth and date of hire will be collected. For each task with potential for exposure to APFO, job title, work area and begin and end dates will be recorded.

A total of 9 job titles and 5 work areas have been identified as having potential for exposure to APFO at the Fayetteville Plant. The number of unique task/work area combinations with potential for APFO exposure will be determined.

Blood Sampling

Standard Operating Procedure: Collecting and Processing Blood Samples – Appendix - 1

Standard Operating Procedure: Process for Analysis of Blood Biomonitoring Samples –Appendix –2

Standard Operating Procedure: Study-Specific Standard Operating Procedure: Documentation, Accountability, and Procedures for Consent Forms, and Collection & Processing of Serum Samples – Appendix – 3

Standard Operating Procedure: Documentation, Accountability, and Sample Chain of Custody Requirements for the Shipping of Serum Samples – Appendix – 4

Blood Collection Checklist – Appendix – 5

Air Sampling

Air Sampling Strategy - Appendix - 6

Standard Operating Procedure: Quality Assurance Procedures: Industrial Hygiene Laboratory and Field Work – Appendix - 7

Standard Operating Procedure: Sample Handling, Chain-of-Custody , Preservation and Shipping – Air Samples – Appendix – 8

Analytical Method for Air Samples – Appendix – 9

Air Monitoring Data Form – Appendix – 10

Wipe Test

Perfluorooctanoic Acid Wipe Test Analysis – Appendix - 11

DATA ANALYSIS

These exposure data will be analyzed as follows:

1. The general statistical procedures described below will be used in the analysis of the data. Analytical results of the regular samples will be analyzed using appropriate statistical methods.
2. Descriptive statistics will be generated on each exposure metric with all measurements pooled.
3. Where there is sufficient data, regression of serum PFOA anion for each individual will be done on gender, age, most frequent task ,
4. Analysis of variance for each time point measurement of serum PFOA anion will determine the between- and within-individual variation, and
5. Where there is sufficient data, estimate blood clearance rates of PFOA anion in workers by continued surveillance following cessation of exposure

EXPOSURE ASSESSMENT

Exposure will be measured by the following parameters:

1. Serum level of PFOA anion, prior to beginning work in the APFO Manufacturing Area and measured every six months (per the unit schedule)
2. Personal air monitoring of each participant, selected to cover all tasks and all shifts with potential for exposure to APFO
3. Area air monitoring for the laboratories, the manufacturing lines, and the packing and shipping of APFO
4. Estimate the dermal contribution to the biomonitoring result for each worker, and
5. If necessary estimate the contribution of other routes of exposure.

The investigators will compile a document for each area that will summarize data related to APFO exposure: (1) descriptions of processes where exposure to APFO may occur, including nature of and dates of engineering controls, changes in operating procedures and potential exposure points, (2) specific tasks performed in work areas where exposure to APFO may occur (3) work area names, job titles and time periods with potential for exposure, (4) documentation of personal protective equipment use, (5) air sampling data and analytical methods employed, (6) plant production records and (7) details on work conditions and practices gained from interviews and observations.

Because dermal contact may be a significant route of exposure, estimates of the amount and frequency of skin contact will be used to estimate a dermal dose using the surface area of the body covered, frequency of contact, length of contact and results of the surface wipe tests.

Personal air monitoring data will be used as a direct measure of inhalation exposure.

FACTORS THAT MAY INFLUENCE THE SURVEILLANCE DESIGN AND ANALYTIC METHODS

Analytic methods are new and recently validated. Only one laboratory is GLP certified to do the blood analysis and only one laboratory is currently AIHA accredited for the air sample analysis. Timing of results could become an issue.

The size of the surveillance population will not be large thus limiting the statistical power.

The wipe test analysis is complex. Sample turn around time will not allow wipe tests to be used as a quick check for contamination or the effectiveness of a decontamination procedure.

HUMAN SUBJECT PROTECTION

Haskell Quality Directive QD007-C-001 requires compliance with the U.S. Federal regulation known as the Health Insurance Probability and Accountability Act of 2003 (HIPAA) and is supported by standard operating procedures that specify privacy and confidentiality requirements.

PROTOCOL AMENDMENTS AND DEVIATIONS

Intended (planned) changes to the protocol will be made by protocol amendment. Unintended or unexpected divergence from this protocol will be documented in the field raw data as a deviation. The Study Director will be notified of all protocol amendments and deviations as soon as possible. All changes in or revisions of the approved protocol and the reasons for the changes will be formally prepared by the Study Director, signed and dated by the Study Director and Sponsor, and maintained with the protocol.

QUALITY CONTROL

Field staff will record observed exposure data on standardized forms and send the observed data to Haskell Laboratory within seven days of collection. Haskell staff will review forms and reconcile missing or discrepant information where appropriate. Sampled workers will be contacted if necessary to resolve discrepant, missing, or inconsistent data. Data will be transmitted electronically along with selected hardcopy data to the Study Director.

REPORTING OF RESULTS

Status reports will be reviewed by the Study Director following the receipt of the quarterly air monitoring results and upon receipt of blood results. A final summary report will be issued at the conclusion of the study. A communication of the final results will be to the site industrial hygienist who will communicate them to the study participants.

RESOURCES TO CONDUCT THE STUDY

Sampling Equipment – 10 Air Sampling Pumps, chargers, battery eliminator, calibrator, and maintenance log
Personal Assistance – An experienced industrial hygienist to conduct air sampling, provide field observations, ensure adherence to this protocol and investigate deviations from the protocol. See Air Sampling Strategy – Appendix 6

ARCHIVING OF STUDY DOCUMENTS

The protocol, amendments to the protocol, raw data, consent forms, analytical results, computer printouts, and final report will be archived through the standard procedures of the Haskell Laboratory Information Services Group.

BIBLIOGRAPHY

Reference Exygen Blood Method
Reference Clayton Air Method
Wipe Test Validation

Appendix-1

Standard Operating Procedure: Blood Collection

1. BLOOD COLLECTION SCHEDULE:

Personal communications will be maintained with each study participant to confirm the dates to begin sampling. Blood samples will be drawn every 6-months. To cover all shifts, blood samples will be collected within a 10-day period. Baseline samples will be collected prior to an employee working in the area. The employee will then join the normal 6-month rotation.

1.1. Field Laboratory for Blood Collection

Blood samples will be collected at Fayetteville Site Medical by the site nurse.

1.2. Aborted Blood Collection:

If an anticipated sampling is canceled, workers will be notified promptly and sampling will be re-scheduled as-soon as-possible after the originally scheduled day. If there are medical or physical reasons that contraindicate the drawing of a blood sample on a scheduled day, then that study subject's sampling will be rescheduled to occur on the next day that the same or similar tasks will be performed.

2. PROCESSING BLOOD SAMPLES:

At the field laboratory, blood samples will not sit ambient for more than 2 hours prior to serum separation.

3. TRAVEL BLANKS:

Travel Blanks will be an unused polypropylene tube supplied by Exygen. This balak will be shipped with collected blood samples to insure that the samples were not contaminated during shipping.

4. SAMPLE IDENTIFICATION:

The site nurse/industrial hygienist will create a sampling identification system that identifies the site and person sampled. The chain-of-custody form will record the shipping date.

6. PROCESSING SAMPLES FOR FROZEN STORAGE AND SHIPMENT:

6.1. SAMPLE STORAGE:

Appendix 3- Standard Operating Procedure: Documentation, Accountability, and Procedures for Consent Forms, and Collection & Processing of Serum Samples

6.2. SAMPLE SHIPMENT:

Appendix 4: Standard Operating Procedure: Documentation, Accountability, and Sample Chain of Custody Requirements for the Shipping of Serum Samples

7. SAMPLE ANALYSIS:

The detailed procedures for analysis of study samples for PFOA are presented in Attachment 3.

8. DATA ANALYSIS AND STATISTICAL METHODS:

Analytical results of the regular samples will be analyzed using appropriate statistical methods.

9. CONTROL OF BIAS:

Bias within the selection process for study participants and in the collection of blood samples should only arise from the voluntary nature of participation. Comparisons of the demographics, work histories, and usual tasks performed of the volunteers and the abstentions will be made in order to identify any systematic differences in the two groups.

10. REQUIRED FIELD DATA RECORDS:

All field notes and data sheets must be filled out promptly, accurately, and in indelible ink by study personnel. All pages must be signed. If more than one individual records data on a page, it must be clear which individual recorded specific data. All entries must be dated on the day of entry and signed or initialed by the person entering the data. The field staff will maintain original documents or legible verified copies of the following information:

1. A description of the tasks performed by the sampled participant, including personal protective equipment used.

2. A record of serum sample handling including time from collection to frozen storage.

3. A copy of the freezer temperature log for the period the serum samples were stored.

4. Personal work habits of each worker during his/her shift such as hand washing, sweating, accidental contamination, etc. Any observation that would provide an understanding of a potential route of exposure should be recorded.

11. PROTOCOL AMENDMENTS AND DEVIATIONS:

Intended (planned) changes to the protocol will be made by protocol amendment. Unintended or unexpected divergence from this protocol will be documented in the field raw data as a deviation. The Study Director will be notified of all protocol amendments and deviations as

soon as possible. All changes in or revisions of the approved protocol and the reasons for the changes will be formally prepared by the Study Director, signed and dated by the Study Director and maintained with the protocol.

12. REPORTING OF DATA:

Upon completion of the analytical and field portions of the study, analytical and field reports will be prepared by the Principal Investigators. Upon completion of these reports, a draft final report will be prepared for review and approval by the Study Director. Upon approval, a final report will be issued.

The report will contain narrative descriptions of the environmental conditions, work practices, worker background and experience, and other pertinent information collected during each replicate (campaign) of the study.

In addition, the final report will include:

1. Name and address of the facilities performing the study and the data on which the study was initiated and completed
2. Objectives and procedures stated in the approved protocol, including any deviations and/or amendments in the original protocol
3. Identification and description of the test and reference substance(s)
4. A description of all methods used
5. A summary of the data generated while conducting the study and a description of all transformation, calculations, statistics, or other operations performed on the data
6. The name and dated signature of the Study Director
7. A description of all conclusions drawn from analysis of the samples
8. Complete description of the test system
9. Location of raw data, final report, and all specimens
10. A verified copy of the study protocol including protocol deviations and amendments
11. Location of the test site

Upon acceptance of the final report, all study specific original raw data will be submitted to the Sponsor along with exact copies of non-study specific support data. Original documents will be the property of the Sponsor. Subsequent support records shall be copied, certified as exact copies, and included with the original raw data and submitted to the Sponsor for archival.

13. QUALITY ASSURANCE:

The field phase of this protocol will be conducted and documented as completely as possible to ensure the quality and integrity of the data generated for this portion of the study.

The analytical portion of this study will be performed in compliance with the Good Laboratory Practice (GLP) as specified in 40 CFR §160. The analytical portion and the final report of this study will be inspected. The findings of these inspections will be made available to the Study Director and Test Facilities Management.

14. RECORDS RETENTION:

Reports, raw data, and records pertaining to this study will be archived by Haskell Information Sciences.

Appendix-2

Process for Analysis of Blood Biomonitoring Samples

Preparation Phase:

1. Plant site handle appropriate communications, scheduling of phlebotomy, and all other pre-sampling arrangements

2. Plant site requests supplies from Exygen at least 4 weeks in advance; estimated number of samples is needed at this time

3. Exygen arranges for supplies to be shipped and schedules samples for analysis

4. Supplies are shipped to plant site with instructions on processing and shipment

Sampling Phase:

5. Blood is sampled and processed into serum at the plant site

6. Serum samples are shipped directly from the plant site to Exygen laboratory with a sample listing and Chain-of-Custody records. The plant will cc S. Mark Kennedy on the sample listing.

Analysis and Analytical Reporting Phase:

7. Exygen analyzes the samples and prepares a draft report to review. The draft report and copies of the raw data are sent to S. Mark Kennedy for review

8. S. Mark Kennedy reviews the analytical data, makes any corrections/upgrades to the draft, and gives the contract lab permission to finalize the analytical report

9. The contract lab finalizes the analytical report and sends it to S. Mark Kennedy. S. Mark Kennedy sends a copy of the report to Study Director ,Joseph F. Viskocil who archives the original report at Haskell and informs the plant site industrial hygienist of the results

Completion Phase:

10. The site handles appropriate communications at the site

11. Upon receipt of the invoice from the contract lab, S. Mark Kennedy will provide the appropriate (plant-site-specific) charge code to have the bill paid against a standing purchase order

12. Samples will be retained for 12 months per the method validation. Samples will be discarded after 12 months upon the Study Director's approval.

Appendix-3

Specific Standard Operating Procedure:
Documentation, Accountability, and Procedures for Consent Forms, and Collection & Processing of Serum Samples

1. SCOPE AND APPLICABILITY

This SOP governs the documentation, accountability, and procedures for consent forms, and collection & processing of serum samples.

2. REPONSIBILITIES

2.1 The Study Director is responsible for conducting the necessary training covering proper documentation, accountability, and procedures for consent forms, and collection & processing of serum samples. .

2.2 The Phlebotomist who performs the blood collection is responsible for ensuring that the Consent Form is completely and correctly filled out by each participant prior to venipuncture.

2.3 The Phlebotomist & Site Industrial Hygienist are responsible for ensuring that forms and the samples are properly collected and labeled.

3. Names

Study Director: Joseph F. Viskocil, Jr CIH

Phlebotomist: Bonnie Wilson, RN- Site Nurse Fayetteville

Site Industrial Hygienist : Jennifer Locklear

4. MATERIALS AND EQUIPMENT

4.1. Consent Forms (duplicate or triplicate)

4.2. Serum Separator tubes (Red top) –(Supplied by Exygen)

4.3. Vacutainers, Needle holders and Needles–(Supplied by Exygen)

4.4. Centrifuges

4.5. Transfer Pipettes and Polypropylene Tubes–(Supplied by Exygen)

5. PROCEDURE

5.1. Have the participant complete the Consent form prior to initiation of venipuncture.

5.2. Ensure that the consent form completed by each participant receives the same code number as the blood sample from that participant.

5.3. Original consent for each participant will be sent to Study Director for storage.

5.4. Access to consent forms to be decided

5.5. Collect blood specimen using usual venipuncture technique. Fill tube completely.

5.6. Gently invert the serum separator tube 5 times to mix.

5.7. Allow blood to clot a minimum of 30 minutes but no longer than 1 hour.

5.8. Centrifuge for 15 minutes at 2500 to 3500 rpm

5.9. Remove from centrifuge

5.10. Serum portion of the collected sample in the SS tube is now ready to be pipetted into the specially provided polypropylene tubes.

5.11. Seal the polypropylene tubes

5.12. The polypropylene tubes (labeled with specimen ID number) are now ready for transport to the lab.

5.13. Please see Appendix 2 for details on how to complete the chain of custody form and prepare the sample for shipping.

5.14. Samples will need to be frozen immediately at –20°C and stored frozen.

5.15. Samples will also need to be shipped frozen. See Appenxix-4

6. REFERENCES – Appendix-4

7. FIGURES

Figure 1. Consent form

CONSENT TO PARTICIPATE IN PFOA EXPOSURE ASSESSMENT PROGRAM

Study title: **Exposure Assessment of Measured Serum Perfluorinated Octanoic Acid Anion in the Manufacture of Ammonium Perfluorooctanoate (APFO) at Fayetteville, NC**

Introduction: **You are being asked to participate in a research study. Your participation is voluntary.**

Your decision whether or not to participate will have no effect on your employment or the services you receive through DuPont's Occupational Health Program or Integrated Health Services, or Benefits Administration. Please ask questions of your site's OH Specialist or Nurse if there is anything you do not understand.

What is the purpose of this study?
The purpose of the program is to learn about the relationship between specific tasks and the exposure level of PFOA that may occur in workers at this plant site, and to identify ways to reduce this exposure to as low a level as possible.

Are there any benefits from participating in this study?
The benefit of participating in this study is that you may gain important knowledge about how exposures may vary depending on the ways certain tasks are carried out. This knowledge will help our OH Specialists, industrial hygienists, and engineers find ways to reduce these potential exposures.

What does this study involve?
Your participation in this study may last up to 5 years.

A blood sample will be drawn every 6-months and analyzed for the serum level of PFOA. No other blood levels will be determined.

Will the study be affected if you do not participate?
The more people that participate in this study, the more accurate and representative the results will be. In addition, we may be able to use these results to control exposures at other sites if we have enough participants to provide a good sample size.

What are the risks involved with being enrolled in this study?
The only risk of participating in this study would be the small risk of a hematoma (bruise) where the blood is drawn.

Other important items you should know:

- **Withdrawal from the study:** You may choose to stop your participation in

this study at any time. Your decision to stop your participation will have no effect on your employment or the services you receive through DuPont's Occupational Health Program or Integrated Health Services, or Benefits Administration.

- **New information:** To the best of our ability, any significant new findings during this research study will be made known to you.
- **Confidentiality:** Every effort will be taken to protect the names of the participants in this study. However, there is no guarantee that the information cannot be obtained by legal process or court order.
- **Funding:** Haskell Laboratory has been provided funding to conduct this study by the DuPont Fluoroproducts business.

Number of participants: We expect Approximately 30 participants.

Who should you call with questions about this study?
Questions about this study may be directed to the site OH Specialist, Jennifer Locklear; or the site Nurse, Bonnie Wilson, RN. You may also contact the Study Director, Joe Viskocil, at Haskell Laboratory: [redacted] during normal business hours.

Will you be paid to participate in this study?
No. Blood samples will be drawn during the work shift.

CONSENT

I have read the above information about (name of study) and have been given an opportunity to ask questions. I agree to participate in this study and I have been given a copy of this consent document for my own records.

Print name:_____ Pass Number:_____

Your signature:_____ Date:_____

Witness: _____ Date: _____

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Appendix-4

TITLE PAGE

Standard Operating Procedure: Documentation, Accountability, and Sample Chain of Custody Requirements for the Shipping of Serum Samples

Analytical Facility:

Exygen Research
3058 Research Drive
State College, PA 16803
[redacted]

Analytical Facility Management:

John Flaherty, Vice President, Operations

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1. SCOPE AND APPLICABILITY

This SOP governs the documentation, accountability, and sample chain of custody requirements for the shipment of serum samples to the analytical facility.

2. REPONSIBILITIES

2.1 The phlebotomist who performs the blood collection is responsible for ensuring that the Chain of Custody/Analysis Request Form (COC) (Figure 1) is completely and correctly filled out and signed by staff members who package and ship the serum samples.

2.2 The Principal Investigator at the analytical facility is responsible for ensuring that the chain of custody remains intact after the samples are received by the analytical facility.

3. DEFINITIONS

Analytical Facility Management: John Flaherty, Vice President of Operations, Exygen Research 3058 Research Drive, State College, PA 16801
[redacted]

Principal Investigator: Emily Decker, Scientist
Exygen Research, 3058 Research Drive, State College, PA 16801[redacted]

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4. MATERIALS AND EQUIPMENT

4.1 Chain of Custody/Analysis Request Forms, triplicate design.

4.2. A readily available source of dry ice pellets. Also, necessary personal protective equipment appropriate for handling dry ice.

4.3 Coolers numbered and coded with a unique identification assigned for this project. They must be purchased from Uline Shipping Supplies Specialists. The Uline part number for the required coolers is S-7888. (This part number corresponds to a package which includes one 19" x 12" x 12.5" cooler and one shipping box).

4.4 Plastic bags for use as secondary sample packaging prior to shipping. These will also be obtained from Uline, part number S-1707 (3" x 5", 4 mil reclosable poly bags, 1000 per carton).

5. PROCEDURE

5.1.Before collecting any blood, the completed and signed consent form must be verified. When each sample is collected a unique alphanumeric identification code will be assigned to each sample. This number will be entered into the "Sample Identification" column of the COC sheet. Likewise, the date and time of each blood sample collection will be recorded, and the date and time that the serum sample preparation is completed will be entered into the appropriate column on the COC sheet.

5.2.Each sample cooler will be assigned a unique alphanumeric identification number, which will be written on the cooler.

5.3.Before packaging, the primary serum sample containers must be placed individually into small plastic bags as secondary packaging. The secondary packaging must have the unique sample code written on it in permanent black ink.

5.4.Before the samples are packed in dry ice, a person other than the packager will verify that the samples documented on the COC form match exactly with those being packed in the cooler. The verifier then initials and dates the "Cooler Contents Verified" prompt.

5.5.Samples are to be dispersed in a cooler full of dry ice pellets, arranged in such a way as to minimize the possibility of impact, and such that they are completely covered with the pellets. The cooler must be completely filled with dry ice pellets. No more than 20 samples are to be placed in one cooler. The cooler will be covered promptly after packing with dry ice pellets to minimize loss of dry ice to sublimation.

5.6. The time between the completion of serum preparation and packaging for shipment must be able to be accounted for on the COC page. **There must not be any unexplained gap in the chain of custody for the samples.**

5.7. After the serum samples are packaged, the Cooler ID# prompt will be completed. Section 2 ("Personnel Involved in Shipment of Samples") of the COC form also will be completed at this time, if it has not been previously. The printed name, signature, initials and date of signature need to be recorded for each person who entered information anywhere on the form. The page number prompts also need to be filled in.

5.8. The person who packaged the samples then completes the first line in the "Relinquished by" section, and verifies that any unused prompts are lined out.

5.9. The COC form is then faxed to Exygen Research Sample Receiving using the fax number at the top of the form. After it is faxed, the pink copy is removed and becomes part of the client's records. The white original and yellow copies are to be placed in an envelope, which is then placed into the shipping carton with the cooler that contains the samples to which the COC form corresponds.

5.10. The serum samples are required to be shipped to Exygen Research Sample Receiving at the address given at the top of the COC form by **FedEx overnight** delivery. This is the only carrier and method of shipment that is acceptable.

5.11. Upon receipt of the samples by Exygen Research, the chain of custody procedure will follow Exygen SOP V401, "Contract Research Sample Handling". After Exygen Sample Receiving completes the "Received by" section, a copy of the COC will be faxed back to the client.

5.12. Any problems with delivery or condition of samples upon arrival at Exygen will be documented. The Exygen Principal Investigator will notify the client of any problems immediately.

5.13. Correction and Clarification of Raw Data

5.13.1. As soon as any information has been entered on the COC form, it becomes raw data. At this point, this form is not to be discarded for any reason. If it becomes damaged, information may be transcribed onto another sheet, but the transcription process will be documented via footnote on the new page. The original damaged sheet must be attached to the transcribed page.

5.13.2. If errors are made in handwritten entries, or if clarifications are to be made, the errant information will be crossed out with a single line, so as not to obscure the original entry. Then, depending upon

the nature of the error, an appropriate error code is chosen (see Figure 2), and the error code is initialed and dated. If the error is more complex than what is covered by the error code list, a detailed explanation will be provided by footnote on the COC page.

6. REFERENCES

Exygen Research SOP V401, "Contract Research Sample Handling"

7. FIGURES

Figure 1. Chain of Custody/Analysis Request Form

Figure 2. List of Error Codes

8. SIGNATURE

John M Flaherty
John M. Flaherty.
Analytical Facility Management

12/3/03
Date

Figure 1. Chain of Custody/Analysis Request Form

Exygen RESEARCH **CHAIN OF CUSTODY**

Exygen Research Sample Receiving • 3048 Research Drive • State College, PA 16801

COLLECTION SITE INFORMATION	STAFF INVOLVED IN SAMPLE SHIPMENT
Collection Site (name & address):	1. (Printed Name) Signature Initials/Date
Phone:	2. (Printed Name) Signature Initials/Date
Fax:	3. (Printed Name) Signature Initials/Date
Email:	

IMPORTANT: Specify AM or PM for time entries. Include month, day, and year for dates. Contents of package must be verified by someone other than the packager, and this verification must be attested to by initialing and dating the prompt.* Thoroughly document the reason for any time gap between the time the serum preparation is completed and the time packaged by adding a footnote to the bottom of the page. Each person who enters information on this form must add their name, signature, initials, and date above. Line out unused prompts.

Sample Identification	Blood Sample Collection Date & Time	Serum Sample Prep. Completed Date & Time

PLEASE FAX THE COMPLETED FORM to Exygen Sample Receiving prior to shipping samples.

Cooler Contents Verified Initial & Date* →

KEEP THE PINK COPY and include the other two with sample shipment. **Cooler ID #:**

Relinquished by	Date	Time

Received by	Date	Time

Note: When samples arrive at Exygen, chain-of-custody procedures follow Exygen SOP V401, "Contract Research Sample Handling." Page ____ of ____

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Figure 2. List of Error Codes

EXPLANATION OF ERROR CODING

Correction of raw data is made by drawing a single line through the erroneous data and/or write-over, and filling in the correct data. Care must be taken not to obscure the original entry. The correction is initialed and dated by the individual making the correction, and an explanation is given for the correction.

The following error codes shall be used to explain corrections:

(wl)	Inadvertently recorded in Wrong Location
(cc)	Changed for greater Clarity
(wo)	Write Over (Technician inadvertently wrote over the error instead of drawing a line through the error)
(sp)	Spelling error
(ir)	Inadvertently not Recorded at time of initial observation
(ce)	Calculation Error
(re)	Recording Error
(ne)	Numerical transcription Error
(ee)	Entry not initialed and dated at time of entry
(te)	Transcription Error
(wd)	Wrong Date entry
(sm)	Stray Marks appearing on data with no other feasible explanation
(le)	Late Entry
(tl)	Technical error

Codes, other than those defined above may be used, if explained or defined by footnote on the COC form. Errors that cannot be explained using an error code must be fully detailed at the time of correction.

Error codes are to be circled and written above or close to the correction. If this is not feasible, the error should be footnoted with an asterisk or other symbol, and explained at the bottom of the page.

Example COC Sheet and Use of Error Codes

Exygen RESEARCH CHAIN OF CUSTODY

Exygen Research Sample Receiving • 3048 Research Drive • State College, PA 16801

CLINIC INFORMATION	STAFF INVOLVED IN SAMPLE SHIPMENT
Clinic (name & address): Name of Clinic, Address (Street, P.O. Box), City, State Zip code	1. B.C. Nurse (Printed Name) — B.C. Nurse (Signature) — BCN 07/18/03 (Initials/Date)
Clinic Identification Code: A	2. John Doe Staff (Printed Name) — John Doe Staff (Signature) — JDS 07/18/03 (Initials/Date)
Phone: (area code) 7-digit #	3. J. Smith (Printed Name) — J. Smith (Signature) — JS 07-18-03 (Initials/Date)
Fax: (area code) 7-digit #	
Email: email@clinic.com	

IMPORTANT: Specify AM or PM for time entries. Include month, day, and year for dates. Contents of package must be verified by someone other than the packager, and this verification must be attested to by initialing and dating the prompt.* Thoroughly document the reason for any time gap between the time the serum preparation is completed and the time packaged by adding a footnote to the bottom of the page. Each person who enters information on this form must add their name, signature, initials, and date above. Line out unused prompts.

Clinic Sample Identification	Blood Sample Collection Date & Time	Serum Sample Prep. Completed Date & Time
A001	07/18/03 11:30 AM	07/18/03 2:00 PM
A002	07/18/03 11:57 AM	07/18/03 2:00 PM
A003	07/18/03 12:25 PM	07/18/03 2:00 PM
~~A003~~ A004 (1) BCN 07/18/03	07/18/03 12:50 PM	07/18/03 2:00 PM
	(1)	

PLEASE FAX THE COMPLETED FORM to Exygen Sample Receiving prior to shipping samples.

Cooler Contents Verified Initial & Date* → JS 07-18-03

KEEP THE PINK COPY and include the other two with sample shipment. Cooler ID #: 1A (1) BCN 07/18/03

Relinquished by	Date	Time
John Doe Staff	07/18/03	2:30 pm

Received by	Date	Time
(Completed at Exygen)		

Note: When samples arrive at Exygen, chain-of-custody procedures follow Exygen SOP V401, "Contract Research Sample Handling." Page 1 of 1

REV 1 7-03

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DRAFT

Appendix-5

BLOOD COLLECTING CHECKLIST

Employees Name _____

Employees Job Title _____

Date and Time Blood Sample taken _____

Collecting Blood Sample

Red Capped Collection Tube Completely Filled	Yes	No
Filled Tube inverted 5 times	Yes	No
Centrifuge for 15 minutes @ 2500-3500 rpm		

Start_____ Stop_____ (military time)

Pipet Serum into Polypropylene tube with specimen ID

Specimen ID Number _____

Complete Chain-of-Custody (COC) Form Yes ____ No____

There must not be any unexplained gap in the COC for the samples.

Serum Placed in –20°C Freezer at _____ (military time) YES ___ NO ___

Serum Samples must be shipped frozen - Sample is frozen YES NO

Sample Shipped to:

Exygen Research
3058 Research Drive
State College, PA 16801
[redacted]

Shipped **FedEx overnight ONLY.** (per Standard Operating Procedure: Documentation, Accountability, and Sample Chain of Custody Requirements for the Shipping of Serum Samples – Appendix – 4)

Phlebotomist (Site Nurse) Name)Print)_____

Signature _____

Date_____

Please Send the Original Blood Collecting Checklist to

Joseph F. Viskocil, Jr. CIH
[redacted]
Stine-Haskell Research Center
PO Box 50, 1090 Elkton Road
Newark, DE 19714-0050

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Appendix – 6

AIR SAMPLING STRATEGY

The goal of exposure assessment is to recognize all exposures and to minimize all exposures. Workers may be exposed while performing tasks, by incidental contact from background contamination, or because of nearby tasks performed by others. Although the highest exposures usually result from a worker's own task, exposures significant can occur from the other two sources.

Serum levels of PFOA anion are an indication of overall exposure.

Air sampling results are an indication of airborne exposure.

The significance of exposure by incidental contact cannot be assessed until the airborne exposure is controlled. Since the number of job assignments at Fayetteville is small, we will sample each job assignment quarterly. Where job assignments extend into evenings and weekends, accommodations will be made to monitor workers at these times.

Two APFO Field/CCR Technicians are on duty for each 12-hour shift. One technician monitors the Control Room and the other technician does the fieldwork. Since the fieldwork technician is more likely to have an exposure, the majority of APFO/CCR technician samples in the field.

Proposed Air Sampling Plan for the first 12-Months

Collect six (6) personal samples Time-Weighted-Average (TWA) quarterly for each 12-hour shift schedule (APFO Field/CCR technician)	24 samples
Collect six (6) personal samples Time-Weighted-Average (TWA) quarterly for 8-hour shift schedule (APFO Lab and Mechanical Technician)	12 samples
Collect three (3) personal samples Time-Weighted-Average (TWA) quarterly for 8-hour shift schedule for APFO Supervisors	3 samples
Collect three (3) personal samples Time-Weighted-Average (TWA) quarterly for 8-hour shift schedule for APFO FLS	3 samples
Collect six (6) personal samples (duration of task) quarterly for technical/professional personnel (chemist and engineers)	6 samples

Total 48 regularly scheduled personal samples per quarter
Sampling Strategy to be re-assessed after 2 -quarters

Sampling will be scheduled to ensure that off-shifts and weekends will be proportionally represented

For an 8-hour shift; a minimum of 6- hours sampling is required to qualify as a 8-hour TWA

For a 12-hour shift; a minimum of 10- hours sampling is required to qualify as a 12-hour TWA

APPENDIX 7

QUALITY ASSURANCE PROCEDURES

INDUSTRIAL HYGIENE LABORATORY AND FIELD WORK

This procedure specifies quality assurance procedures for industrial hygiene field work.

Laboratory Standard Operating Procedures

To minimize the possibility of contamination, external surfaces of adapters, tubing and the air sampling pumps should be wiped down with a 50/50 solution of isopropyl alcohol. The wipe should be assumed to be contaminated and disposed of properly. Minimum personal protective equipment should include safety glasses with side shields and nitrile gloves.

This procedure must be followed to assure equipment calibration and maintenance is done properly.

Relevant quality control procedures are incorporated into this procedure.

Sample Numbering System

Each field sample must be assigned a unique number. The industrial hygienist will assign a number for each survey. The hygienist will add a unique sequential number for each sample taken on a survey.

Example: 82-24-01

82 Year of Survey
24 Survey number
01 Sequential sample number

Field Sampling

Seal the OVS cassettes or other similar sampling devices in plastic bags for transport to and from use site. Calibrate sample pumps before and after each sample. Calibrate sample pumps with counters, or rotometers at least before and after each survey. Before and after flow rates should be within 10%.

Instruct test subjects not to tamper with personal samplers and observe for compliance. Void any samples which are suspect.

Place sampler inlet in downward orientation to prevent contamination.

Immediately after a sample is taken, place caps into filter cassettes.

Pressure and temperature corrections to 25°C and 760 mmHg must be made to actual air sample volumes to calculate ppb concentrations of gases and vapors, for comparison with exposure limits.

Pressure and temperature corrections are not made, but actual air sample volumes are used to calculate mg/m3 of particulates for comparison with exposure limits.

Control, Known and Duplicate Samples

Control, known and duplicate samples must be submitted to the analytical laboratory, along with air samples.

Control samples are collection devices which have been opened at the site, immediately closed and sealed, and assigned a sequential number. They provide a check on the analytical zero.

Known samples are collection devices, which have been spiked with a known quantity of a chemical at Haskell Laboratory (or at the site under the hygienist's direction), carried on the survey, and assigned a sequential number. They provide a check on analytical accuracy. In some cases, it may not be feasible to prepare reliable known samples and they may be omitted upon concurrence of the Study Director.

Duplicate samples are area air samples taken from six to twelve inches apart and assigned sequential numbers. They provide a check on sampling and analytical precision.

Results of control, known and duplicate samples must be evaluated with the chemist in view of the specific analytical method used to determine adequacy. Generally, known sample results should be within 25% of the spiked amount and duplicate sample values should be 25% or less apart. Reasons for deviations should be determined and corrective actions taken.

Control results should be less than 5% of the exposure limit dose on the collection device at the average survey sample volume or non-detectable (whichever is less stringent). Sample results should be corrected for control sample results. Reasons for deviations should be determined and corrective actions taken.

Minimum required numbers of control, known and duplicate samples which must be submitted, are given in the following table.

Number of Samples

Field	<10	11-20	21-40	>41
Control	1	3	3	4
Known	2*	2	4**	4****
Duplicate Pairs	0	1	2***	2****

Two at one level **
Two at each of two levels ***
One pair at each of two levels ****
Additional pairs may be needed if a wide range of concentrations is expected.

INDUSTRIAL HYGIENE SURVEY RECORDS -

Quantitative Survey Data

Air Sampling Data - All air sampling data must be entered on Air Monitoring Data Form which must be sent to the Study Director for permanent retention.

Other Quantitative Survey Data - Other data, such as ventilation, room and equipment dimensions, or other data which will be used in a quantitative manner for calculations, must be entered on the Air Monitoring Data Form.

Survey Field Notes (other than quantitative data)

These notes are taken only as an informal key to memory. Significant information will be summarized in the survey report. These field notes may be discarded when no longer needed. However, if in the industrial hygienist's judgment, original non-quantitative notes need to be retained, the information should be attached to Air Monitoring Data Form for permanent retention.

Analysis and Analytical Reporting Phase:

Clayton analyzes the samples and prepares a draft report to review. The draft report and copies of the raw data are sent to Mary A. Kaiser, Ph.D. for review.

1. Mary A. Kaiser, PhD reviews the analytical data, makes any corrections/upgrades to the draft, and gives the contract lab permission to finalize the analytical report

2. The contract lab finalizes the analytical report and sends it to Mary A. Kaiser, PhD

3. Mary A. Kaiser, PhD sends a copy of the report to Study Director, Joseph F. Viskocil who archives the original report at Haskell and informs the plant industrial hygienist of the results

Appendix – 8

SAMPLE HANDLING, CHAIN-OF-CUSTODY, PRESERVATION and SHIPPING – AIR SAMPLES

The person collecting the sample should wear nitrile disposable lab or exam gloves and should limit his/her contact with the samples.

Sample tubes (OVS) will be provided by the contracted laboratory and should be stored in a clean, dry location. Sample tubes and collected samples are not required to be chilled, however sample tubes and collected samples should not be subjected to temperature extremes.

In order to minimize the possibility of introducing APFO contamination into samples, the following protocol should be followed:

- ❑ Avoid polytetrafluoroethylene (PTFE).
- ❑ Avoid aluminum foil.
- ❑ Do not use self-stick memo notes.
- ❑ Avoid blue ice (the OVS tubes are shipped at ambient temperature).
- ❑ Avoid pre-wrapped foods or snacks.
- ❑ Wear clothing that has been washed at least six times.
- ❑ Use only containers supplied by contract laboratory.

Following sample collection, the OVS tubes are capped and placed in a zip-loc bag. Seal the zip-loc bag.

Complete the sample label and chain-of custody (COC) form, including the volume of air sampled through the tube. The completed sample label is attached to the outside of the zip-loc bag.

Pack the samples in a small box or cooler with bubble wrap. Include the completed COC form.

Complete a mailing label and airbill and ship by overnight carrier to:

Clayton Group Services

22345 Roethel Drive

Novi, MI 46375

Contact at the laboratory is Karen Coonan [redacted]

[redacted]

Samples should be stored and shipped refrigerated to the laboratory.

Company Sanitized. Does not contain TSCA CBI

Appendix – 9

December 4, 2003

Mary A. Kaiser, Ph.D.
Research Fellow
Corporate Center for Analytical Services
Dupont Central Research & Development
DUPONT
Experimental Station
P.O. Box 80302
Wilmington, DE 19880-0302

Clayton Work Order No. 03010080
Clayton Proposal No. 03DETLAB015.REV1

Dear Dr. Kaiser:

We are pleased to provide the following **Draft** report on the sampling and analytical method conditions followed for the method validation for [redacted]. This draft report is based on our proposal dated July 18, 2003.

The sampling parameters may change as we progress with the method validation. Not all of the parameters outlined in this report have been fully validated.

If you have any questions, please call me at (248) 344-1770.

Sincerely,

Kem Charron
Program Manager-Special Projects
Laboratory Services

KC
Enclosure

22345 Roethel Drive
Novi, MI 48375
248.344.1770
Fax 248.344.2654

Clayton GROUP SERVICES

Clayton Group Services, Inc.

Perfluorooctanoic Acid (PFOA)

Empirical Formula: $CF_3(CF_2)_6CO_2H$
Molecular Weight: 414.06
CAS Number: 335-67-1

Clayton Work Order No.: 03070834
Draft Report Date: February 9, 2004

OSHA: None
NIOSH: None
ACGIH: None
AEL: 0.56 ppb (9.48 $\mu g/m^3$)

Properties
Appearance: White Powder
Melting Point: 55-56 °C

Synonyms: Pentadecafluorooctanoic acid

Sampling and Storage

Sampler: OSHA Versatile Sampler, SKC Cat. No. 226-30-16

Flow Rate: Area or personal monitoring: 1.0 L/min for up to 480 minutes for a sample volume of 480 L.
Fence line monitoring: 15 L/min for up to 480 minutes for a sample volume of 7200 L.

Storage: Refrigerated or ambient temperatures

Shipping: Samples can be shipped at ambient temperature

Sample Stability: 60 days at refrigerated or ambient temperatures

Equipment

1. SKC OSHA Versatile Sampler (OVS) Cat. # 226-30-16
2. HPLC System: LC pump with automated gradient controller, autosampler, optional tunable UV absorbance detector
3. Mass Spectrometer: Triple quadrupole mass spectrometer 2 – 1000 amu mass range minimum, API interface with Electrospray probe, negative and positive ionization mode capability, and data acquisition/reduction software
4. Column: Agilent Hypersil ODS, 2.1 × 100 mm, 3 µm particle size, Cat. #.79916OD-352, or equivalent
5. 16 mL amber glass vial with screw cap and polytetrafluorethylene/rubber liner. The polytetrafluorethylene side of the liner is positioned in the cap towards the sample
6. 4 mL amber glass vial with screw cap and polytetrafluorethylene/rubber liner. The polytetrafluorethylene side of the liner is positioned in the cap towards the sample
7. Waters total recovery glass autosampler vials with polytetrafluorethylene/rubber liner. The polytetrafluorethylene side of the liner is positioned in the cap towards the sample
8. Syringe: 10, 25, 50, & 100 µL
9. Disposable glass test tube, 16 × 125 mm with caps

Reagents and Standards

1. Perfluorooctanoic Acid (PFOA), Aldrich 171468-5G, Lot # 04702MA
2. 1,2-di-^{13}C-Perfluorooctanoic Acid (^{13}C-PFOA), Internal Standard, Dupont, date of synthesis January 2, 2003
3. Water (H_2O), Direct-Q
4. Methanol (MeOH), HPLC grade, B&J Cat. # 230-4
5. Ammonium Acetate, Reagent grade, J.T. Baker Cat. # 0599-08
6. 2 mM Ammonium Acetate: dissolve 0.1388 g Ammonium Acetate in 900 mL H_2O
7. Extraction Solvent: 100% MeOH
8. Stock Analytical Standard Solution (SAS):
   Dissolve 56.9 mg ± 0.1 mg of PFOA (corrected for material purity) in 10 mL of MeOH
   Concentration: ~ 5690 µg/mL
9. Calibration Standards:
   Dilutions of SAS in MeOH resulting in PFOA concentrations of 11.4, 28.4, 45.5, 56.9, 114, and 227 ng/mL
10. Stock Spike Standard Solution (SSS):
    Dissolve 56.8 mg ± 0.1 mg of PFOA (corrected for material purity) in 10 mL of MeOH
    Concentration: ~ 5680 µg/mL
11. Spiking Standard Solutions:
    Dilutions of SSS in MeOH resulting in PFOA concentrations of 568 and 56.8 µg/mL
12. Stock Internal Standard Solution:
    Dissolve 7.2 mg ± 0.1 mg 1,2-di-^{13}C-Perfluorooctanoic Acid (corrected for material purity) in 10 mL of MeOH
    Concentration: ~ 720 µg/mL
13. Internal Standard Solution: Added to calibration standards and samples prior to analysis.
    Dilution of the Stock Internal Standard Solution in MeOH resulting in a ^{13}C-PFOA concentration of 1.4 µg/mL

Measurement

Technique: High Performance Liquid Chromatography (HPLC) coupled with Tandem Mass Spectrometry

Detectors: Triple Quadrupole Mass Spectrometer (Micromass Quattro LC, or equivalent)

Extraction: 4 mL of extraction solvent with shaking for 60 minutes on a flatbed mechanical shaker

Instrument Conditions

HPLC Conditions

Column: Agilent Hypersil ODS, 2.1 × 100 mm, 3 µm particle size

Column Temp:	30 °C
Flow Rate:	0.3 mL/minute
Injection Volume:	5 µL
Run Time:	14 minutes
Retention Time:	6.4 minutes

Mobile Phase: Gradient

Time (min)	%A	%B	Curve
0	90	10	-
5	10	90	-
9	10	90	-
10	90	10	-
14	90	10	-

A = 2 mM Ammonium Acetate
B = Methanol

Wavelength (UV): Not Applicable

Mass Spectrometer Conditions

Ionization Mode: Electrospray Negative

Nebulizer Gas (L/hr):	96
Desolvation Gas (L/hr):	690
Source Block Temperature (°C):	120
Desolvation Temperature (°C):	350
Collision Gas Pressure (mBar):	3.1e-3
Multiplier:	650

	ES -Ion
Source Settings	
Capillary Voltage (kV):	1.5
Extractor (V):	1
RF Lens (V):	0.5
Analyzer Settings	
MS1 LM&HM Resolution:	14
MS1 Ion Energy (V):	0.5
MS2 LM&HM Resolution:	15
MS2 Ion Energy (V):	1.5
Entrance (V):	0
Exit (V):	0

Mass Spectrometer Method

MS Function: Multiple Reaction Monitoring (MRM) ESP-
Inter Channel Delay for MRM (s): 0.1
Span (Daltons): 0.5
Start time: 0 min End time: 14 min

Analyte Specific Settings:	Transition (amu)	Dwell (s)	Cone Voltage (V)	Collision Energy (eV)
PFOA	412.9 – 368.9 (Q)	0.5	10	10
Internal Standard (^{13}C-PFOA)	414.9 – 369.9 (Q)	0.5	10	10

(Q) = Transition used for quantitation

Sampling

1. Samplers (SKC 226-30-16) are received from the manufacturer (SKC).

2. Calibrate each sampling pump with a representative collection device in line.

3. Depending on the application, there are two flow rate options:

   (1) For area or personal monitoring, sample at a flow rate of 1.0 L/min for up to 480 minutes to obtain a sample volume of 480 L.
   (2) For fence line monitoring, sample at a flow rate of 15 L/min for up to 480 minutes to obtain a sample volume of 7200 L.

4. Label the sample with appropriate sample identification.

5. At the completion of sampling, re-calibrate each pump with a representative collection device in line.

6. Cap the ends of each sampler.

7. Samples are stored at ambient temperature.

8. A chain of custody form is filled out and sent with the samplers under ambient conditions to the Laboratory for analysis.

Sample Preparation

Note: Samples are extracted just prior to analysis.

1. Extract each OVS sampling tube in three separate sections. Place each section in a separate disposable glass test tube.
   Section 1: GFF Filter
   Section 2: XAD-2 Front portion of media plus foam plug
   Section 3: XAD-2 Back portion of media

2. Add 4 mL of Methanol to each test tube and shake for 60 minutes on a mechanical flatbed shaker set at ~2 cycles per second.

3. Transfer approximately 3.5 mL of each extract to a 4 mL amber glass vial by filtering through a Gelman 13-mm GHP Acrodisc. Extracts should be stored at refrigerated temperatures (2 to 6 °C).

4. For LC/MS/MS analysis, transfer 200 µL each sample extract to a glass autosampler vial. Add 10 µL of a 1.4 µg/mL internal standard solution (1,2-di-^{13}C-Perfluorooctanoic Acid).

Calibration and Quality Control

1. Calibrate daily with six working standards over the range of 11.4 to 227 ng/mL for PFOA.

   a) Calibration standards are prepared by transferring 200 µL each PFOA standard solution to a glass autosampler vial. Add 10 µL of a 1.4 µg/mL internal standard solution (1,2-di-^{13}C-Perfluorooctanoic Acid).

   b) Analyze standards together with samples and blanks. A calibration curve is analyzed at the beginning and end of each run, and Continuing Calibration Verification (CCV) standards are analyzed a minimum of every ten samples. Acceptance criteria for a CCV is ± 20%.

   c) Generate an internal standard, linear calibration curve from the observed peak area response factors and standard concentrations, applying 1/X weighting. The correlation coefficient (R) for the calibration curve must be ≥ 0.992 ($R^2 \geq 0.985$).

2. Determine the Extraction Efficiency (EE) at least once with each lot of samplers. Prepare at least one level in duplicate within the expected sampling range. Include one media blank per lot.

   a) Inject µL amounts of PFOA spiking standard solution onto the GFF portion of an OVS tube.

   b) Allow the tube to air-dry at ambient temperature.

   c) Cap the tube and store at **refrigerated** temperatures (2 to 6 °C) until extraction.

   d) Extract the PFOA-spiked and blank tubes as described in Sample Preparation. Analyze an aliquot from each sample along with standards. Transfer 200 µL each extract solution to a glass autosampler vial. Add 10 µL of a 1.4 µg/mL Internal Standard solution (1,2-di-^{13}C-Perfluorooctanoic Acid).

   e) Calculate the ratio for the ng of PFOA found on the media spike to the theoretical amount spiked. The concentrations found in each of the three sections must be summed to obtain the total amount of PFOA found.

   The ratio reflects the recovery of PFOA from the media. The mean recovery of the replicates equals the EE for PFOA.

Measurement

1. Set the liquid chromatograph and mass spectrometer conditions in accordance with those specified on page 3, or with suitable adjustments to optimize chromatography and sensitivity.

2. Inject the specified aliquot of each standard and sample.

3. Record the peak area response factor for PFOA and Internal Standard peaks. The observed retention time is 6.4 minutes for both PFOA and ^{13}C-PFOA.

Calculations

1. Calculate the response factor (RF) for PFOA.

   RF = (PFOA Area / ^{13}C-PFOA Area)

2. Determine the mass (ng) of PFOA collected using a first order linear regression curve plotting RF versus PFOA concentration.

   a) Analyte found: ng = (ng/mL × FV)

   Where: ng/mL = obtained by interpolation of the PFOA peak RF on the calibration curve

   FV = the Extraction Final volume (mL)

   b) Concentration (mg/m^3) = (μg_{Sample} - μg_{Blank}) /V

   Where: μg_{Sample} = µg amount found in the sample (ng found / 1000 ng/µg)

   μg_{Blank} = µg amount found in the blank sample (ng found / 1000 ng/µg)

   V = air sample volume (L)

This report prepared by:

Kristine Kurtz, Ph.D.
Supervisor, Method Validations
Laboratory Services

This report reviewed by:

Robert Lieckfield, Jr., CIH
Senior Vice President
Director, Laboratory Services

February 9, 2004

Clayton Group Services, Inc.

[redacted]

Empirical Formula: [redacted]
Molecular Weight: [redacted]
CAS Number: [redacted]

Clayton Work Order No.: 03070834
Draft Report Date: December 4, 2003

OSHA: None
NIOSH: None
ACGIH: None
AEL: 0.56 ppb

Properties
Appearance: White Powder
Odor:
Melting Point: [redacted]

Synonyms: Pentadecafluorooctanoic acid

Sampling and Storage

Sampler: OSHA Versatile Sampler SKC Cat. No. 226-30-16
Storage: To be determined
Shipping: Samples should be shipped at **refrigerated** temperatures (2-6 °C)
Sample Stability: To be determined

Equipment

1. SKC OSHA Versatile Sampler (OVS) Cat. No. 226-30-16

2. HPLC System: LC pump with automated gradient controller, autosampler, optional tunable UV absorbance detector

6. Mass Spectrometer: Triple quadrupole mass spectrometer 2 – 1000 amu mass range minimum, API interface with Electrospray probe, negative and positive ionization mode capability, and data acquisition/reduction software

7. Column: Agilent Hypersil ODS, 2.1 × 100 mm, 3 µm particle size, Cat. # 79916OD-352 or equivalent

8. 16 mL amber glass vial with screw cap and polytetrafluorethylene/rubber liner. The polytetrafluorethylene side of the liner is positioned in the cap towards the sample

9. 4 mL amber glass vial with screw cap and polytetrafluorethylene/rubber liner. The polytetrafluorethylene side of the liner is positioned in the cap towards the sample

10. Waters total recovery glass autosampler vials with polytetrafluorethylene/rubber liner. The polytetrafluorethylene side of the liner is positioned in the cap towards the sample

12. Syringe: 10, 25, 50, & 100 µL

13. Disposable glass test tube, 16 x 125 mm with caps

Measurement

Technique: High Performance Liquid Chromatography (HPLC) coupled with Tandem Mass Spectrometry

Detectors: Triple Quadrupole Mass Spectrometer (Micromass Quattro LC, or equivalent)

Extraction: 4 mL of extraction solvent with shaking for 60 minutes on a flatbed mechanical shaker

Instrument Conditions:

HPLC Conditions

Column: Agilent Hypersil ODS, 2.1 × 100 mm, 3 µm particle size

Column Temp: 30 °C
Flow Rate: 0.3 mL/minute
Injection Volume: 5 µL
Run Time: 14 minutes
Retention Time: 6.4 minutes

Mobile Phase: Gradient

Time (min)	%A	%B	Curve
0	90	10	-
5	10	90	-
9	10	90	-
10	90	10	-
14	90	10	-

A = 2 mM Ammonium Acetate
B = Methanol

Wavelength (UV): Not Applicable

Mass Spectrometer Conditions

Ionization Mode: Electrospray Negative

Nebulizer Gas (L/hr): 96
Desolvation Gas (L/hr): 690
Source Block Temperature (°C):120
Desolvation Temperature (°C):350
Collision Gas Pressure (mBar):3.1e-3
Multiplier: 650

	ES -Ion
Source Settings	
Capillary Voltage (kV):	1.5
Extractor (V):	1
RF Lens (V):	0.5
Analyzer Settings	
MS1 LM&HM Resolution:	14
MS1 Ion Energy (V):	0.5
MS2 LM&HM Resolution:	15
MS2 Ion Energy (V):	1.5
Entrance (V):	0
Exit (V):	0

Mass Spectrometer Method

MS Function: Multiple Reaction Monitoring (MRM) ESP-
Inter Channel Delay for MRM (s): 0.1
Span (Daltons): 0.5
Start time: 0 min End time: 14 min

Analyte Specific Settings:	Transition (amu)	Dwell (s)	Cone Voltage (V)	Collision Energy (eV)
[redacted]	[redacted] (Q)	0.5	10	10
Internal Standard ([redacted])	[redacted] (Q)	0.5	10	10

(Q) = Transition used for quantitation

Sampling

1. Samplers (SKC 226-30-16) are received from the manufacturer (SKC).

2. Calibrate each sampling pump with a representative collection device in line.

3. Depending on the application, there are two flow rate options:

   (1) For area or personal monitoring, sample at a flow rate of 1.0 L/min for up to 480 minutes to obtain a sample volume of 960 L.
   (2) For fence line monitoring, sample at a flow rate of 15 L/min for up to 1440 minutes to obtain a sample volume of 21600 L.

4. Label the sample with appropriate sample identification.

5. At the completion of sampling, re-calibrate each pump with a representative collection device in line.

6. Cap the ends of each sampler.

7. Samples are stored at refrigerated temperatures (2 to 6 °C).

8. A chain of custody form is filled out and sent with the samplers under refrigerated conditions to the Laboratory for analysis

Sample Preparation

Note: Samples are extracted just prior to analysis.

1. Extract each OVS sampling tube in three separate sections. Place each section in a separate disposable glass test tube.
   Section 1: GFF Filter
   Section 2: XAD-2 Front portion of media plus foam plug
   Section 3: XAD-2 Back portion of media

2. Add 4 mL of Methanol to each test tube and shake for 60 minutes on a mechanical flatbed shaker set at ~2 cycles per second.

3. Transfer approximately 3.5 mL of each extract to a 4 mL amber glass vial by filtering through a Gelman 13-mm GHP Acrodisc. Extracts should be stored refrigerated temperatures (2 to 6 °C).

4. For LC/MS/MS analysis, transfer 200 µL each sample extract to a glass autosampler vial. Add 10 µL of a 1.4 µg/mL Internal Standard solution ([redacted]).

Calibration and Quality Control

1. Calibrate daily with six working standards over the range of 11.4 to 227 ng/mL for [redacted].

   a) Calibration standards are prepared by transferring 200 µL each [redacted] standard solution to a glass autosampler vial. Add 10 µL of a 1.4 µg/mL Internal Standard solution ([redacted]).

b) Analyze standards together with samples and blanks. A calibration curve is analyzed at the beginning and end of each run, and Continuing Calibration Verification (CCV) standards are analyzed a minimum of every ten samples. Acceptance criteria for a CCV is ± 20%.

c) Generate an internal standard, linear calibration curve from the observed peak area response factors and standard concentrations.

2. Determine the Extraction Efficiency (EE) at least once with each lot of samplers. Prepare at least one level in duplicate within the expected sampling range. Include one media blank per lot.

a) Inject µL amounts of [redacted] spiking standard solution onto the GFF portion of an OVS tube.

b) Allow the tube to air-dry at ambient temperature.

c) Cap the tube and store at **refrigerated** temperatures (2 to 6 °C) until extraction.

d) Extract the PFOA-spiked and blank tubes as described in Sample Preparation. Analyze an aliquot from each sample along with standards. Transfer 200 µL each extract solution to a glass autosampler vial. Add 10 µL of a 1.4 µg/mL Internal Standard solution ([redacted]).

e) Calculate the ratio for the ng of [redacted] found on the media spike to the theoretical amount spiked. The concentrations found in each of the three sections must be summed to obtain the total amount of [redacted] found.

The ratio reflects the recovery of [redacted] from the media. The mean recovery of the replicates equals the EE for [redacted].

Measurement

1. Set the liquid chromatograph and mass spectrometer conditions in accordance with those specified on page 2, or with suitable adjustments to optimize chromatography and sensitivity.

2. Inject the specified aliquot of each standard and sample.

3. Record the peak area response factor for [redacted] and Internal Standard peaks. The observed retention time is 6.4 minutes for both [redacted] and Internal Standard.

DU PONT

Appendix-10 **Air Monitoring Data Form**

Sample Number	Date	Monitoring Type ___ Personal ___ Area
Chemical Agent(s)		
Sample Type ___ Personal ___ Source ___ Bulk		
Sample Duration ___ TWA ___ STEL ___ Ceiling		
PPE* – Respirator Air Supplied ,Full Face Air Purifying w/ov/acid gas/high Efficiency Particulate Filter, none - Full Acid Suit : nitrile or laytex gloves ; other		
Type of Control ___ Closed System ___ Local Exhaust ___Mechanical Exhaust ___ Natural Ventilation		

Employee Information

Name		SSN/Employee Number
Unit	Area	Job Name
Shift	Supervisor	

Sample Information

Building	Floor	Area
Description of Location		
Tasks- See Personal Monitoring Log		

Sample Collection Information

Pump Manufacturer	Pump Model	Pump Number
Start Time	Stop Time	Total Time (min)

Initial Flow Rate	Final Flow Rate	Average Flow Rate	Sample Volume
Sample Media		Lot Number	

Environmental Data

Temperature (F)	Humidity (%)	Wind Direction	Wind Speed (mph)

Results

Agent	Analytical Result	Final Result
Method		Limit of Detection
Sample Analyzed By		Sample Collected By

* Standard PPE includes Safety Glasses, Hard Hat, Steel Toe Acid Suit Boots

FAYETTEVILLE WORKS PERSONNEL AIR MONITORING ACTIVITY INFORMATION WORKSHEET

Date:

Employee Name:

Work Area:

Sample Number:

Pump Number:

Time	Comments

Appendix – 11 Wipe Test Procedure

Materials:

- WYPALL L40 disposable wipers; Kimberly-Clark #05701, VWR #21908-000
- Cheesecloth wipes; VWR PK-200 4X4 #21910-107
- Cotton Pads; VWR PK-100 4X4 #21902-985
- Templates for Wipe Sampling 10 X 10cm paper; SKC Inc. #225-2415
- Isopropyl alcohol Omnisolv 4L 99.9%; VWR #EM-PX1834-1
- Water Omnisolv 4L; VWR #EM-WX0004-1
- Scintillation vials, 20 mL, disposable, glass w/polyethylene cap VWR #66020-326

Safety:

- The minimum PPE for this procedure is safety eyewear with sideshields and nitrile gloves. All generated waste is to be disposed in an appropriate manner.

Procedure:

1. Make 1 L of mopping solvent (MS) by mixing 500 mL of isopropyl alcohol (IPA) with 500 mL of water (MILLI-Q or other water purification system water may be substituted for EM Omnisolv water). MS is stored in a 1 L Nalgene® volumetric flask.
2. Identify the area to be wipe tested, Using the 10 X 10 cm Template for Wipe Sampling to define the 100 square centimeter area to be tested.
3. Fill a transfer pipette with MS from the 1 min. scintillation vial. Evenly drip half of the contents (~0.75 mL) on a folded cheesecloth wipe and return the balance of the MS to the vial. Remove the paper template and mop the test area with the wipe. Insert wipe into the vial, gently push the wipe to the bottom with the transfer pipette and close the cap tightly. Dispose of the pipette in the waste jug.
4. In order to minimize the possibility of introducing APFO contamination into samples, the following protocol should be followed:
   Avoid polytetrafluoroethylene (PTFE).
   Avoid aluminum foil.
   Do not use self-stick memo notes.
   Avoid blue ice (the samples are shipped at ambient temperature).
   Avoid pre-wrapped foods or snacks.
   Wear clothing that has been washed at least six times.
5. Following sample collection, the vials are capped and placed in a zip-loc bag. Seal the zip-loc bag.
6. Complete the sample label . The completed sample label is attached to the outside of the zip-loc bag.
7. Pack the samples in a small box or cooler with bubble wrap.

TITLE

Method of Analysis for the Determination of Perfluorooctanoic Acid (PFOA) in Serum and Plasma by LC/MS/MS

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1. SUMMARY

This report details a method of analysis for perfluorooctanoic acid (PFOA) in serum and plasma.

PFOA is extracted from serum and plasma by protein precipitation in acetonitrile by means of a robotic liquid sample handler. Quantification of PFOA is accomplished by liquid chromatography/tandem mass spectrometry (LC/MS/MS) analysis using selected reaction monitoring (SRM). The chemical formula of PFOA is given in section 2 of this method.

The lower limit of quantitation (LLOQ) for this method is 0.5 ppb for PFOA in serum and plasma.

Quantification is performed using extracted calibration standards containing an internal standard.

This method was developed using rabbit serum and rabbit plasma. The overall percent recovery ± standard deviation for PFOA in rabbit serum at 0.5, 3, and 40 ppb was 95% ± 8.5% **(Table I)**. The overall percent recovery ± standard deviation for PFOA in rabbit plasma at 0.5, 3, and 40 ppb was 99% ± 6.3% **(Table II)**.

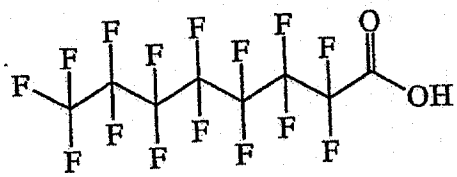
A representative calibration curve for PFOA in rabbit serum is shown in **Figure 1.** Representative chromatograms for PFOA in rabbit serum are shown in **Figures 2 to 4.** A representative calibration curve for PFOA in rat plasma is shown in **Figure 5.** Representative chromatograms for PFOA in rat plasma are shown in **Figures 6 to 8.**

2. EXPERIMENTAL COMPOUNDS

The structure of perfluorooctanoic acid (PFOA) and the internal standard are given below.

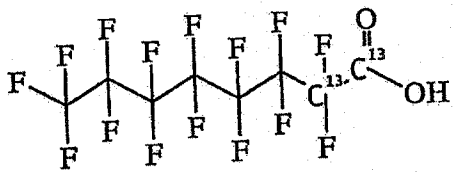
PFOA

Chemical Name	=	perfluorooctanoic acid
Molecular weight	=	414



^{13}C – PFOA

Chemical Name	=	perfluorooctanoic acid, [1,2-di-^{13}C]
Molecular weight	=	416



3. CHEMICALS AND SUPPLIES

3.1. CHEMICALS

Chemical	Grade	Source	Catalog No.
Methanol (MeOH)	HPLC	EM Science	JT9093-2
Acetonitrile (ACN)	HPLC	EM Science	AX0145-1
Ammonium Acetate	Reagent	Sigma-Aldrich	A-7330
OmniSolv Water	HPLC	EM Science	WX0004-1

3.2. STANDARDS

Standard	Lot Number	Purity (%)	Source
perfluorooctanoic acid (PFOA)	21002	97	Oakwood Products
perfluorooctanoic acid, [1,2-di-^{13}C]	NA	96.35	DuPont

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3.3. EQUIPMENT AND SUPPLIES

Equipment	Supplier
Balance, analytical (display at least 0.0001 g)	Mettler
Disposable micropipets (50-100uL, 100-200uL)	Drummond (VWR)
Class A pipets and volumetric flasks	various suppliers
Hypercarb drop-in guard column (4 mm) (part # 844017-400)	Keystone
Stand-alone drop-in guard cartridge holder	Keystone
125-mL LDPE narrow-mouth bottles	Nalgene
2 mL clear HPLC vial kit	VWR
Standard lab equipment (graduated cylinders, disposable tubes etc.)	various suppliers
Mulitprobe II Ex, Robotic liquid handling system	Packard
MBP Disposable Conductive Tips (1 mL) - (part #6000655)	Packard
Array protein precipitation columns, 2 mL (part #120-2020-T)	Argonaut
Isolute array collection plate, 1 mL (part #121-5202)	Argonaut
12x75 mm disposable culture tubes	VWR
LC/MS/MS and HPLC systems	As described in section 4.5.

Note: Equivalent materials may be substituted for those specified in this method if they can be shown to produce satisfactory results.

Notes:

1. In order to avoid contamination, the use of disposable labware is highly recommended (tubes, pipets, etc.).
2. PTFE or PTFE lined containers or equipment, including PTFE-lined HPLC vials for the HPLC autosampler must <u>not</u> be used.
3. It is necessary to check the solvents (methanol) for the presence of contaminants by LC/MS/MS before use. Certain lot numbers have been found to be unsuitable for use.
4. Use disposable micropipets or pipets to aliquot standard solutions to make calibration standards and sample fortifications.
5. The hypercarb cartridges should be changed when the system contaminants (elevated baseline) move to within 1 minute from the elution of PFOA.

3.4. SOLUTIONS

(1) 2 mM ammonium acetate solution is prepared by weighing 0.15 g of ammonium acetate and dissolving in 1 L of water.

Note: The aforementioned example is provided for guidance, alternative volumes may be prepared as long as the ratios of the solvent to solute are maintained.

3.5. PREPARATION OF STANDARDS AND FORTIFICATION SOLUTIONS

Analytical standards are used for three purposes:

1. Calibration Standards – These standards are prepared in control rabbit serum or rabbit plasma and are used to calibrate the response of the detector used in the analysis.
2. Laboratory Control Spikes – These fortifications are usually prepared at concentrations corresponding to the LLOQ and 10x LLOQ and are used to determine analytical recovery. Laboratory control spikes are prepared in control rabbit serum or rabbit plasma.
3. Matrix Spikes – These fortifications are prepared by spiking into the field samples at known concentrations. Matrix spikes are used to evaluate the effect of the sample matrix on analytical recovery.

The absolute volumes of the standards may be varied by the analyst as long as the correct proportions of solute to solvent are maintained.

3.5.1. Stock solution

Prepare individual stock solutions of 100 µg/mL of PFOA and ^{13}C-PFOA by weighing out 10 mg of analytical standard (corrected for purity) and dilute to 100 mL with methanol in a 100-mL volumetric flask. Each stock solution (in 125-mL LDPE bottles) is to be stored in a refrigerator at 2°C to 6°C and is stable for a maximum period of 1 year from the date of preparation.

3.5.2. Fortification Solutions

a. Prepare a fortification standard of 1.0 µg/mL (1000 ng/mL) for PFOA by diluting 1.0 mL of the fortification solution described in 3.5.1 to 100 mL with acetonitrile in a volumetric flask.
b. Prepare a fortification standard of 1.0 µg/mL for ^{13}C-PFOA by diluting 1.0 mL of the ^{13}C-PFOA solution described in 3.5.1 to 100 mL with acetonitrile in a volumetric flask.
c. Prepare a fortification standard of 0.1 µg/mL (100 ng/mL) for PFOA by diluting 10.0 mL of the fortification solution described in 3.5.2.a to 100 mL with acetonitrile in a volumetric flask.
d. Prepare a fortification standard of 0.005 µg/mL for PFOA containing 0.001 µg/mL of ^{13}C-PFOA by diluting 5.0 mL of the PFOA solution

described in 3.5.2.c and 0.1 mL of the ^{13}C-PFOA solution described in 3.5.2.b to 100 mL with acetonitrile in a volumetric flask.

e. Prepare a fortification standard of 0.002 µg/mL for PFOA containing 0.001 µg/mL of ^{13}C-PFOA by diluting 2.0 mL of the PFOA solution described in 3.5.2.c and 0.1 mL of the ^{13}C-PFOA solution described in 3.5.2.b to 100 mL with acetonitrile in a volumetric flask.

f. Prepare a fortification standard of 0.001 µg/mL for PFOA containing 0.001 µg/mL of ^{13}C-PFOA by diluting 1.0 mL of the PFOA solution described in 3.5.2.c and 0.1 mL of the ^{13}C-PFOA solution described in 3.5.2.b to 100 mL with acetonitrile in a volumetric flask.

g. Prepare a fortification standard of 0.0005 µg/mL for PFOA containing 0.001 µg/mL of ^{13}C-PFOA by diluting 0.5 mL of the PFOA solution described in 3.5.2.c and 0.1 mL of the ^{13}C-PFOA solution described in 3.5.2.b to 100 mL with acetonitrile in a volumetric flask.

h. Prepare a fortification standard of 0.0001 µg/mL for PFOA containing 0.001 µg/mL of ^{13}C-PFOA by diluting 0.1 mL of the PFOA solution described in 3.5.2.c and 0.1 mL of the ^{13}C-PFOA solution described in 3.5.2.b to 100 mL with acetonitrile in a volumetric flask.

i. Prepare a fortification standard of 0.00005 µg/mL for PFOA containing 0.001 µg/mL of ^{13}C-PFOA by diluting 0.05 mL of the PFOA solution described in 3.5.2.c and 0.1 mL of the ^{13}C-PFOA solution described in 3.5.2.b to 100 mL with acetonitrile in a volumetric flask.

j. Prepare a fortification standard of 0.001 µg/mL of ^{13}C-PFOA by diluting 0.1 mL of the ^{13}C-PFOA solution described in 3.5.2.b to 100 mL with acetonitrile in a volumetric flask.

Store all fortification standard solutions in a refrigerator (in 125-mL LDPE bottles) at 2°C to 6°C for a maximum period of 1 year from the date of preparation, after which time it is necessary to make new standards using the stock solution.

3.5.3. *Calibration Standards*

The calibration standards are processed through the extraction procedure, identical to the samples. The fortification of the standards before extraction is done according to the following table:

Conc. Of Mixed Fortification Solution (ng/mL)	Fortification Volume (µL)	Volume of Control Sample (mL)	Conc. of Extracted Calibration Standard (ppb)
0.05	500	0.05	0.5
0.1	500	0.05	1
0.5	500	0.05	5
1.0	500	0.05	10
2.0	500	0.05	20
5.0	500	0.05	50

4. METHOD

4.1. FLOW DIAGRAM

The flow diagram of the method is given below, followed by a detailed description of each step.

<u>Method Flow Diagram</u>

Measure 0.05 mL of sample (using disposable micropipette) into protein precipitation column

↓

↓

Protein precipitation in acetonitrile using Multiprobe

↓

↓

LC/MS/MS analysis

4.2. SAMPLE PROCESSING

No sample processing is needed for serum or plasma samples. However, frozen samples must be allowed to completely thaw, un-aided, at room temperature. Samples stored refrigerated should also be allowed to equilibrate to room temperature. All samples must be thoroughly mixed before being sampled for extraction.

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4.3. Sample Preparation

a. Each batch of samples analyzed (typically 35 or less) must include at least one reagent control (acetonitrile blank), one matrix control (method blank), two matrix controls fortified at known concentrations to verify procedural recovery for the batch.
b. At least one sample per batch should be extracted in duplicate
c. At least one sample extracted should be separately fortified at a known concentration and carried through the procedure to verify recovery. Additional matrix spikes may be performed at the sponsor's request.

4.4. Extraction

a. Configure the Multiprobe deck with the following labware:
   1. 1000 µL disposable tips
   2. 12 x 75 mm test tube rack
   3. SPE manifold with protein precipitation columns and 1 mL collection tray (plug any unused holes in the SPE manifold)
   4. Tip chute with disposal bag.
b. Load 0.05 mL of sample into the appropriate protein precipitation column.
c. Place at least 1 mL of Acetonitrile containing the appropriate concentration of analyte and internal standard into a disposable 12 x 75 mm test tube.
d. Using the Multiprobe's control software, Winprep, create a program that performs the following steps in sequence:
   1. Get clean pipette tip(s).
   2. Go to the appropriate 12 x 75 mm test tube(s) and aspirate an air plug followed by 500 µL of ACN solution followed by a transport air plug.
   3. Go to the appropriate protein precipitation column(s) on the SPE manifold and dispense the ACN solution.
   4. Go to the tipchute and drop the tip(s).
   5. Repeat Multiprobe procedure steps 1-4 until ACN solutions have been added to all required protein precipitation columns.
   6. Activate the SPE manifold vacuum system in 10 to 20 second cycles until all ACN solution has been drawn through the protein precipitation column (usually 10 to 15 cycles). *Note: Additional vacuum cycles can be initiated by opening the vacuum node of the Winprep method and selecting the vacuum step "Preview."*
e. Transfer ~ 400µL to an autosampler vial with a pipette for analysis.

4.5. Quantitation

4.5.1. LC/MS/MS System and Operating Conditions

Instrument:	PE SCIEX API 4000 Biomolecular Mass Analyzer SCIEX Turbo Ion Spray Liquid Introduction Interface
Computer:	Dell OptiPlex GX 110

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Software: PE Sciex Analyst 1.2

HPLC Equipment: Hewlett Packard (HP) Series 1100
Quatpump G1311A
Vacuum Degasser G1322A
Autoinjector G1313A
Column Compartment G1316A

Note: Two 4 × 10 mm hypercarb drop-in guard cartridge (Keystone, part # 844017-400) are attached in-line after the purge valve and before the sample injector port to trap any residue contaminants that may be in the mobile phase and/or HPLC system.

HPLC Column: Genesis C_8 (JonesChromatography), 2.1 mm x 50 mm, 4µ
Column Temperature: 30° C
Injection Volume: 5 µL
Mobile Phase (A): 2 mM Ammonium Acetate in Water
Mobile Phase (B): Methanol

Time	% A	% B	Flow (mL/min)
0.0	40	60	0.3
3	40	60	0.3
3.5	0	100	0.3
3.7	0	100	0.5
7	0	100	0.5
7.5	40	60	0.5
9	40	60	0.5
9.5	40	60	0.3
12	40	60	0.3

It may be necessary to adjust the HPLC gradient in order to optimize instrument performance.

Ions monitored:

Analyte	Mode	Transition Monitored	Approximate Retention Time
PFOA	Negative	413 → 369	~2.8 min.
^{13}C-PFOA	Negative	415 → 370	~2.8 min.

The retention times may vary, on a day-to-day basis, depending on the column, batch of mobile phase, etc. Drift in retention times is acceptable within an analytical run, as long as the drift continues through the entire analysis and the standards are interspersed throughout the analytical run.

Note: An alternative LC/MS/MS system may be used once demonstrated to be equivalent.

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4.5.2. *Tune File Parameters*

The mass spectrometer is tuned for each analyte by infusing a ~ 1 µg/mL standard solution of PFOA (at 10 µL/min, using an infusion pump) via a "T" into a stream of mobile phase containing 60% methanol and 40% 2mM ammonium acetate in water at 0.3 mL/min flow rate. The analyte is initially tuned for the parent ion and then tuned for the product ion. Once the instrument is tuned, the optimized parameters are saved as a tune file. This tune file is then used during routine analysis.

4.5.3. *Calibration Procedures*

a. Inject the same aliquot (5 µL) of each calibration standard into the LC/MS/MS.

b. Use linear standard curves for quantitation. Linear standard curves are generated for each analyte by linear regression using 1/x weighting of the ratio analyte peak area/internal standard peak area versus the ratio of the concentration of analyte/concentration of internal standard using Analyst 1.2 (or equivalent) software system. Any calibration standard found to be a statistical outlier by using the appropriate outlier test (e.g. Huge Outlier Test), may be excluded from the calibration curve. However, the total number of calibration standards that could be excluded must not exceed 20% of the total number of standards injected and at least one calibration standard at the LLOQ must be retained.

c. The correlation coefficient (R) for calibration curves generated must be ≥0.9925 (R^2 ≥0.985). If calibration results fall outside these limits, then appropriate steps must be taken to adjust instrument operation, and the standards or the relevant set of samples should be reanalyzed.

4.5.4. *Sample Analysis*

a. Inject the same aliquot (5 µL) of each standard, sample, recovery, control, etc. into the LC/MS/MS system.

b. Standards corresponding to at least five or more concentration levels must be included in an analytical set.

c. An entire set of calibration standards should be injected at the beginning of a set followed by calibration standards interspersed every 5-10 samples (to account for a second set of standards). As an alternative, an entire set of calibration standards may be included at the beginning and at the end of a sample set. In either case, calibration standards must be the first and last injection in a sample set.

d. The concentration of each sample/fortification/control is determined from the standard curve, based on the peak area of each analyte. The standard responses should bracket responses of the residue found in each sample set.

If necessary, dilute the samples in 50:50 methanol: water containing 1 ng/mL of ^{13}C-PFOA to give a response within the standard curve range

e. Fortification recoveries falling within 85 to 115% (80 to 120% for levels at the LLOQ) are considered acceptable.

f. Extracted samples must be stored refrigerated between 2°C to 6°C until analysis.

g. Samples in which no peaks are detected (i.e. signal : noise ratio < 3:1) at the corresponding analyte retention times will be reported as ND (not detected). Samples in which peaks are detected at the corresponding analyte retention times but are less than the lowest concentration of the calibration standards (0.5 ppb where LLOQ = 0.5 ppb) will be reported as < 0.5 ppb.

4.6. Acceptance Criteria

The following criteria must be met to ensure the presence of PFOA and ^{13}C-PFOA:

1. The chromatograms must show the following peaks:
   PFOA: a daughter ion at 369 amu from a parent of 413 amu
   ^{13}C-PFOA: a daughter ion at 370 amu from a parent of 415 amu

2. Any analyte present in method blanks must be at least 3-fold lower than the LLOQ. Any analyte present in the reagent blank must be at least 5-fold lower than the LLOQ.

3. Recoveries of lab control spikes and matrix spikes must be between 85-115% (80-120% for levels at the LLOQ) of their known values. Any method fortification (lab control spike) falling outside the acceptable limits warrants re-extraction of the entire analytical set. Any matrix spike outside the acceptable range should be evaluated by the analyst to determine if re-extraction is warranted.

4. Any calibration standard found to be a statistical outlier by using an appropriate outlier test, may be excluded from the curve. However, the total number of calibration standards that could be excluded must not exceed 20% of the total number of standards injected and at least one calibration standard at the LLOQ must be retained.

5. The correlation coefficient (R) for calibration curves generated must be ≥0.9925 (R^2 ≥0.985). If calibration results fall outside these limits, then appropriate steps must be taken to adjust instrument operation, and the standards or the relevant set of samples should be reanalyzed.

000340

4.7. Performance Criteria

The following two criteria must be performed as a system suitability test, before the commencement of analysis, when using an instrumentation set-up that has not been used for this method.

First Criterion:
Run a standard solution on LC/MS/MS corresponding to the estimated LLOQ and obtain a signal-to-noise ratio of at least 9:1, compared to a reagent blank. If this criterion cannot be met, optimize and change instrument operating parameters.

Second Criterion:
Run a set of standards of five or more concentration levels, spanning a range starting at or below the LLOQ up to the highest concentration level to be included in the analysis. Generate a calibration curve for the analyte and obtain a linear regression with a coefficient of determination (R^2) of at least 0.985. Once this criterion is met, samples may be analyzed with standards interspersed.

4.8. Time Required for Analysis

A set of 35 samples (1 reagent control, 1 matrix control, 1 laboratory spike, 2 laboratory control spikes, and 30 samples) can be taken through the extraction procedure in approximately 2 hours by one person. The LC/MS/MS analysis (standards and 35 samples) will take approximately 9 hours.

5. CALCULATIONS

a. Use Equation 1 to calculate the amount of analyte found (in ng/mL, based on peak area) using the standard curve (linear regression parameters) generated by the Mass Lynx software program.

Equation 1:

$$\text{Analyte found (ppb)} = \frac{(\text{Analyte Peak area/IS peak area}) - \text{intercept})}{\text{slope}} \times \text{IS conc. (ppb)}$$

b. For samples fortified with known amounts of analyte prior to extraction, use Equation 2 to calculate the percent recovery.

Equation 2:

$$\text{Recovery (\%)} = \frac{\text{Analyte found (ppb)} - \text{avg. Analyte found in the corresponding sample (ppb)}}{\text{Amount Analyte added (ppb)}} \times 100\%$$

000341

6. SAFETY

The analyst should read the material safety data sheets for all standards and reagents before performing this method. Use universal precautions when handling standards and reagents, including working in fume hoods and wearing laboratory coats, safety glasses, and gloves. Use blood-borne pathogen handling precautions when handing serum and plasma.

Table I. Recovery of PFOA from Fortifications In Rabbit Serum

Summary of PFOA Recoveries for 0.5 ppb Fortification in Rabbit Serum

Exygen ID	Sponsor ID	Extraction Date	Analysis Date	Fort. Level (ppb)	% Recovery
0300808 Fort. 1	Lot 99H8400	05/22/03	05/23/03	0.5	95
0300808 Fort. 2	Lot 99H8400	05/22/03	05/23/03	0.5	85
0300808 Fort. 3	Lot 99H8400	05/22/03	05/23/03	0.5	88
				AVERAGE:	89
				STANDARD DEVIATION:	5.1
				RELATIVE STANDARD DEVIATION:	5.7

Summary of PFOA Recoveries for 3 ppb Fortification in Rabbit Serum

Exygen ID	Sponsor ID	Extraction Date	Analysis Date	Fort. Level (ppb)	% Recovery
0300808 Fort. 4	Lot 99H8400	05/22/03	05/23/03	3	108
0300808 Fort. 5	Lot 99H8400	05/22/03	05/23/03	3	102
0300808 Fort. 6	Lot 99H8400	05/22/03	05/23/03	3	107
				AVERAGE:	106
				STANDARD DEVIATION:	3.2
				RELATIVE STANDARD DEVIATION:	3.0

Summary of PFOA Recoveries for 40 ppb Fortification in Rabbit Serum

Exygen ID	Sponsor ID	Extraction Date	Analysis Date	Fort. Level (ppb)	% Recovery
0300808 Fort. 7	Lot 99H8400	05/22/03	05/23/03	40	90
0300808 Fort. 8	Lot 99H8400	05/22/03	05/23/03	40	91
0300808 Fort. 9	Lot 99H8400	05/22/03	05/23/03	40	90
				AVERAGE:	90
				STANDARD DEVIATION:	0.6
				RELATIVE STANDARD DEVIATION:	0.6
				OVERALL AVERAGE:	**95**
				OVERALL STANDARD DEVIATION:	**8.5**
				OVERALL RELATIVE STANDARD DEVIATION:	**8.9**

Table II. Recovery of PFOA from Fortifications In Rabbit Plasma

Summary of PFOA Recoveries for 0.5 ppb Fortification in Rabbit Plasma

Exygen ID	Sponsor ID	Extraction Date	Analysis Date	Fort. Level (ppb)	% Recovery
0300922 Fort. 1	Lot 40K7400	05/22/03	05/23/03	0.5	99
0300922 Fort. 2	Lot 40K7400	05/22/03	05/23/03	0.5	100
0300922 Fort. 3	Lot 40K7400	05/22/03	05/23/03	0.5	100
				AVERAGE:	**100**
				STANDARD DEVIATION:	**0.6**
				RELATIVE STANDARD DEVIATION:	**0.6**

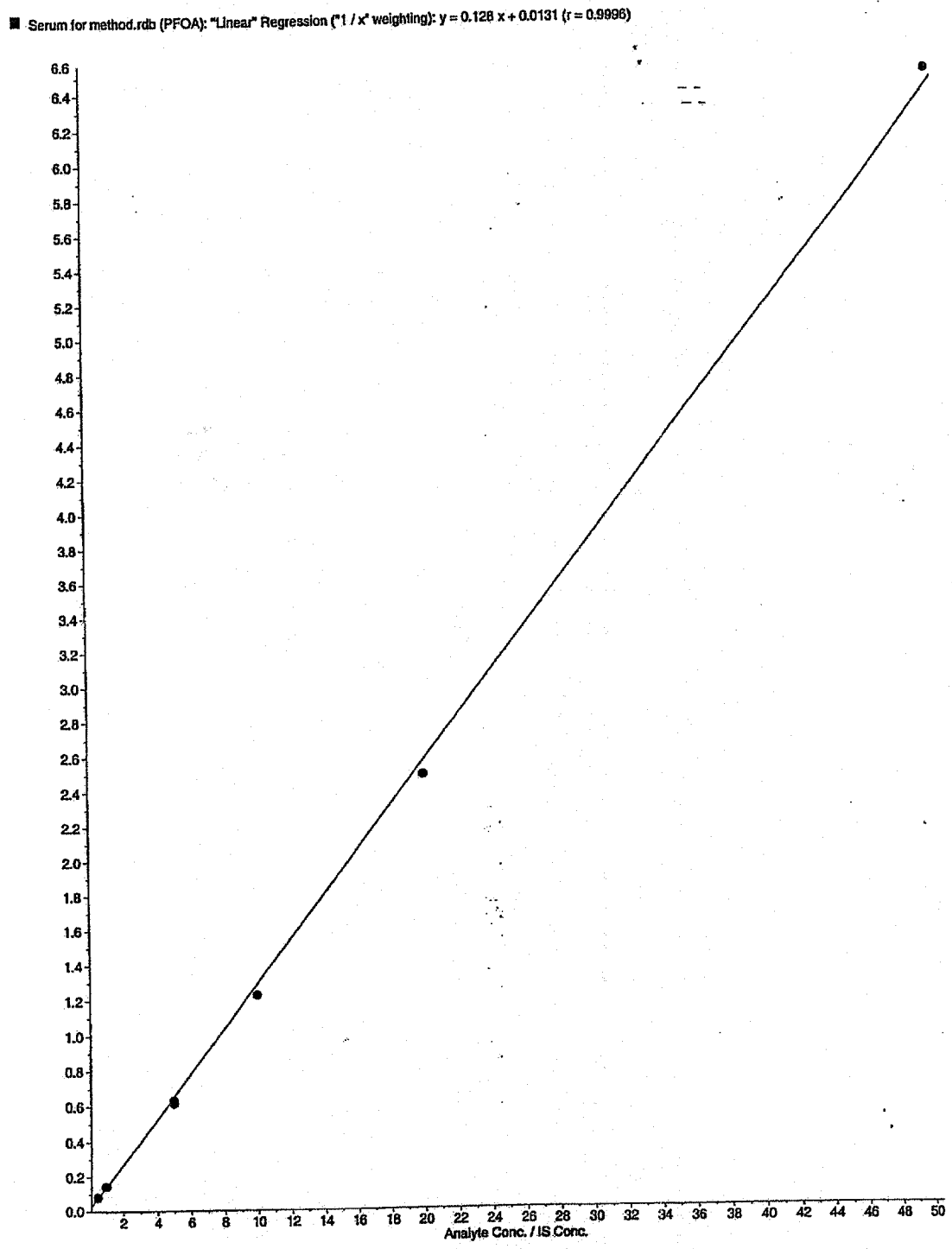
Summary of PFOA Recoveries for 3 ppb Fortification in Rabbit Plasma

Exygen ID	Sponsor ID	Extraction Date	Analysis Date	Fort. Level (ppb)	% Recovery
0300922 Fort. 4	Lot 40K7400	05/22/03	05/23/03	3	107
0300922 Fort. 5	Lot 40K7400	05/22/03	05/23/03	3	106
0300922 Fort. 6	Lot 40K7400	05/22/03	05/23/03	3	105
				AVERAGE:	**106**
				STANDARD DEVIATION:	**1.0**
				RELATIVE STANDARD DEVIATION:	**0.9**

Summary of PFOA Recoveries for 40 ppb Fortification in Rabbit Plasma

Exygen ID	Sponsor ID	Extraction Date	Analysis Date	Fort. Level (ppb)	% Recovery
0300922 Fort. 7	Lot 40K7400	05/22/03	05/23/03	40	91
0300922 Fort. 8	Lot 40K7400	05/22/03	05/23/03	40	92
0300922 Fort. 9	Lot 40K7400	05/22/03	05/23/03	40	92
				AVERAGE:	**92**
				STANDARD DEVIATION:	**0.6**
				RELATIVE STANDARD DEVIATION:	**0.6**
				OVERALL AVERAGE:	**99**
				OVERALL STANDARD DEVIATION:	**6.3**
				OVERALL RELATIVE STANDARD DEVIATION:	**6.3**

Figure 1. Calibration curve for PFOA in Control Rabbit Serum



000345

Figure 2. Representative Chromatogram of a Control Rabbit Serum Sample for PFOA with ~ 1 ng/mL of ^{13}C-PFOA

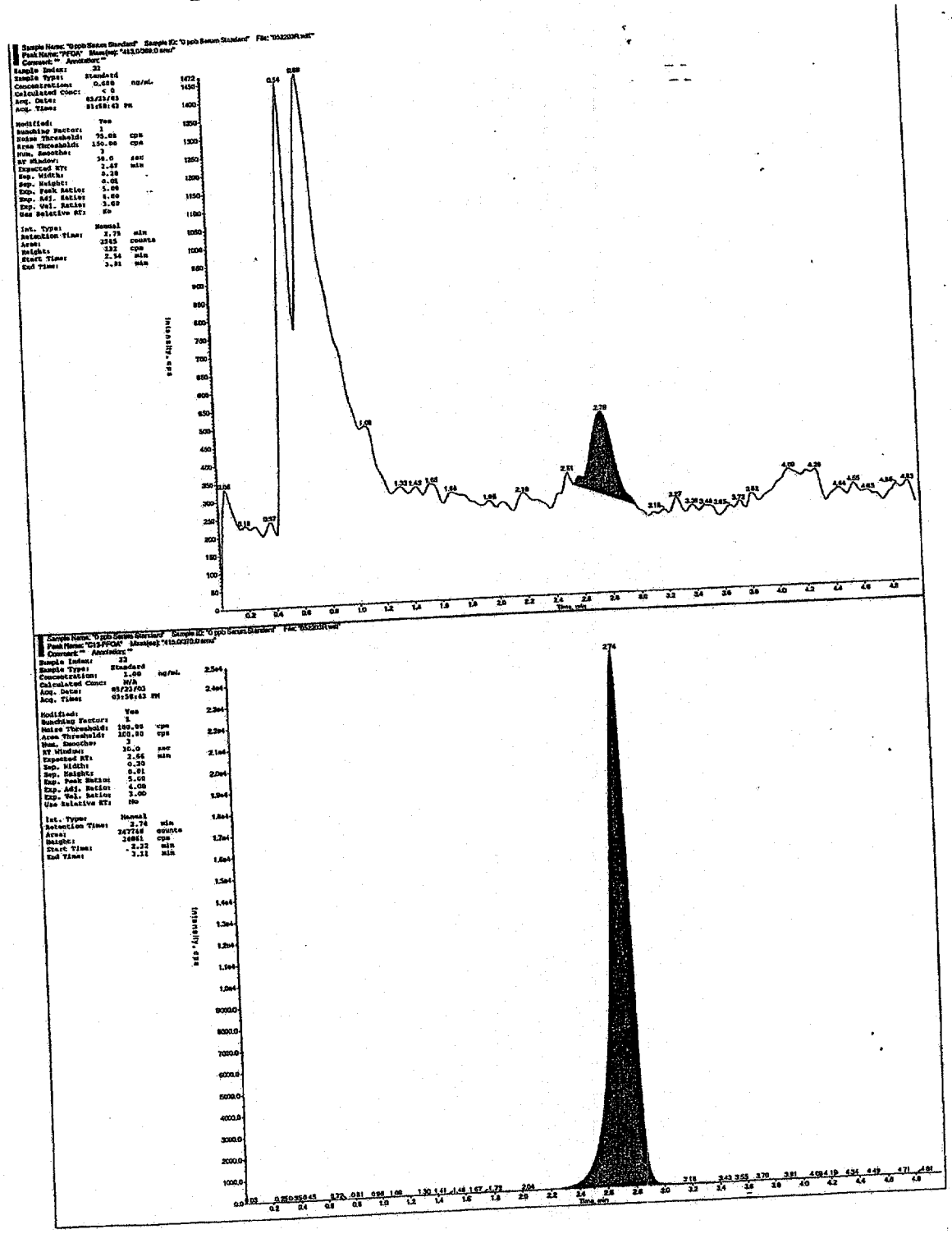


Figure 3. Representative Chromatogram of a 0.5 ppb Standard for PFOA in Control Rabbit Serum with ~ 1 ng/mL of ^{13}C-PFOA

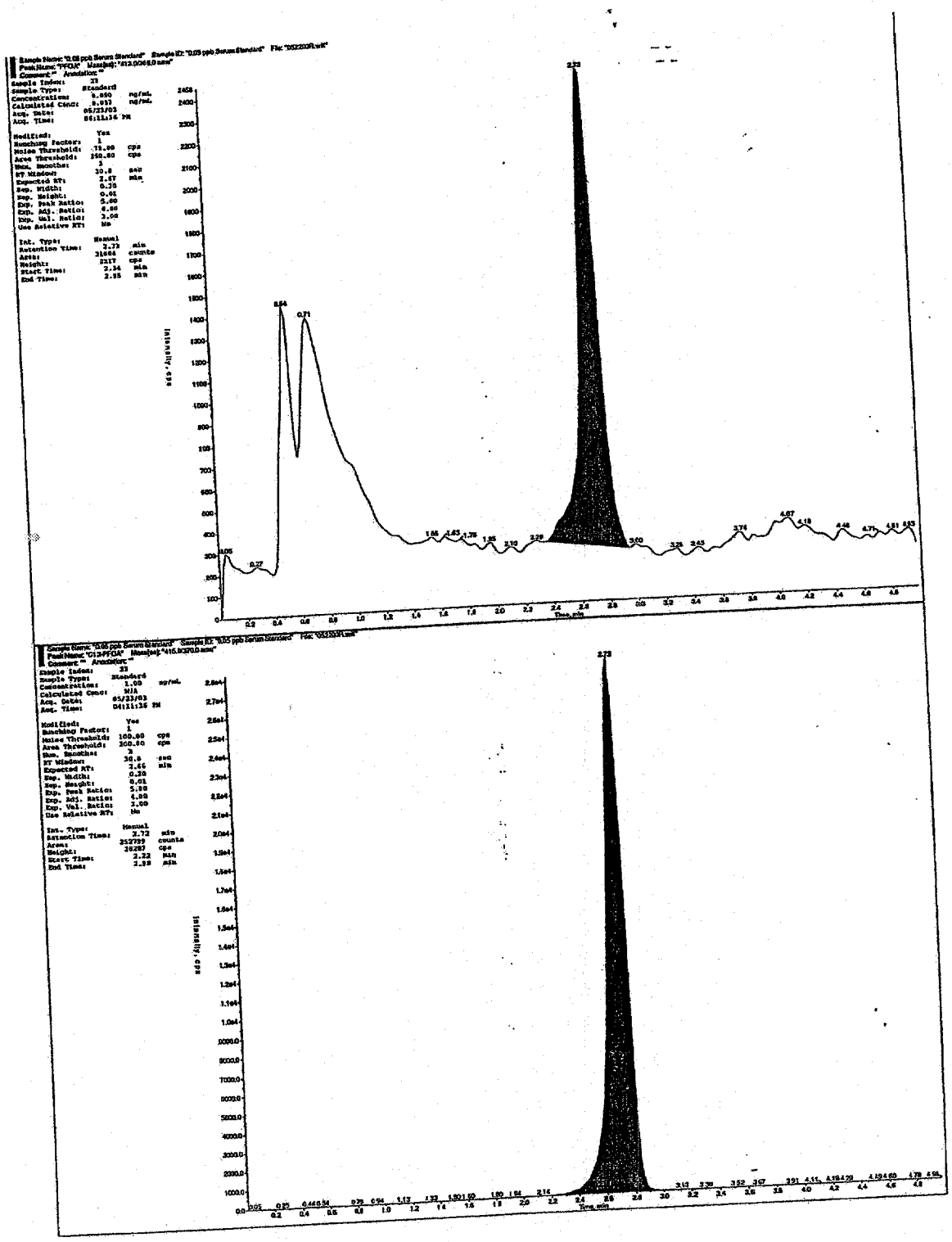


Figure 4. Representative Chromatogram of Control Rabbit Serum Fortified at 0.5 ppb with PFOA and with ~ 1 ng/mL of ^{13}C-PFOA

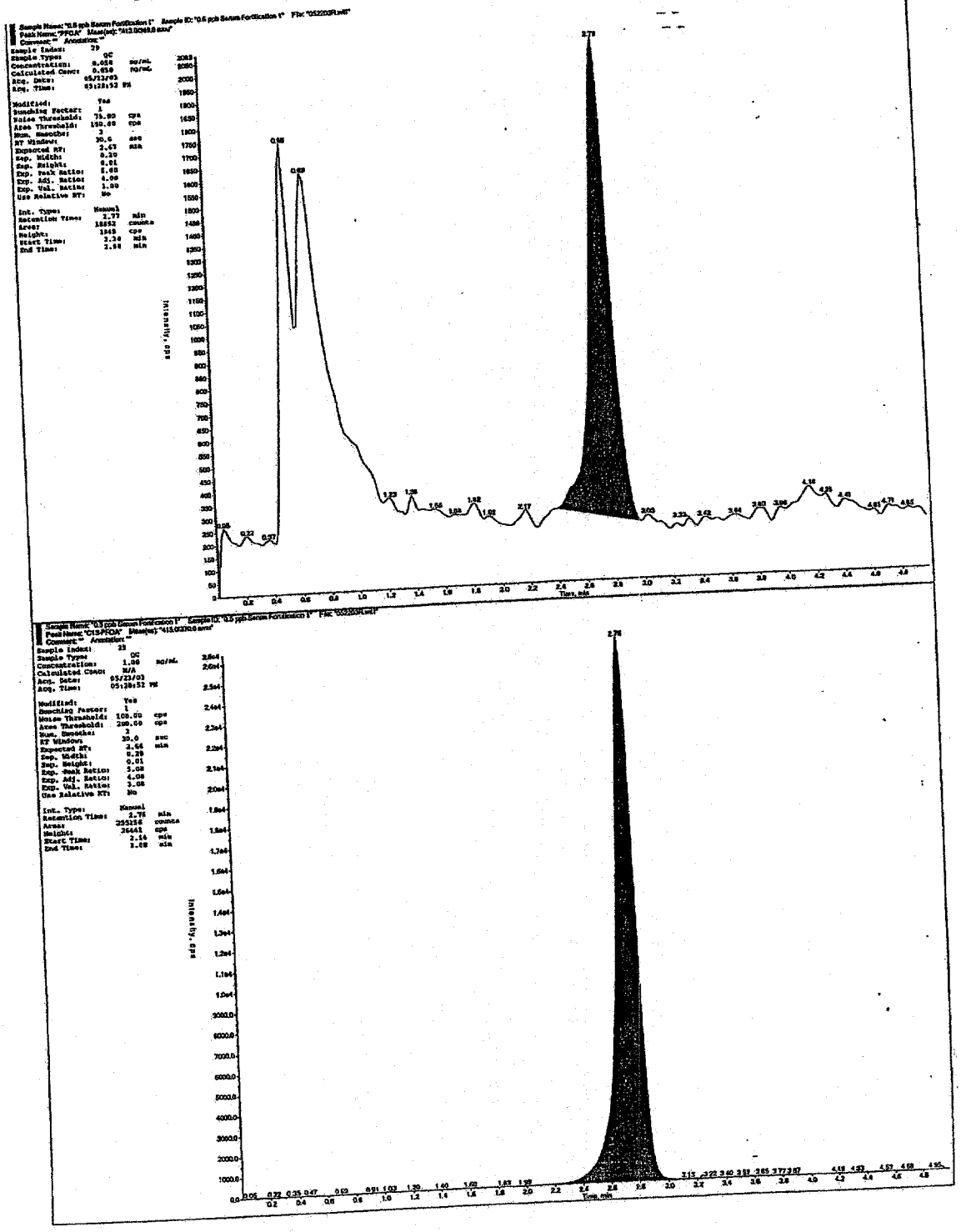


Figure 5. Calibration curve for PFOA in Control Rabbit Plasma

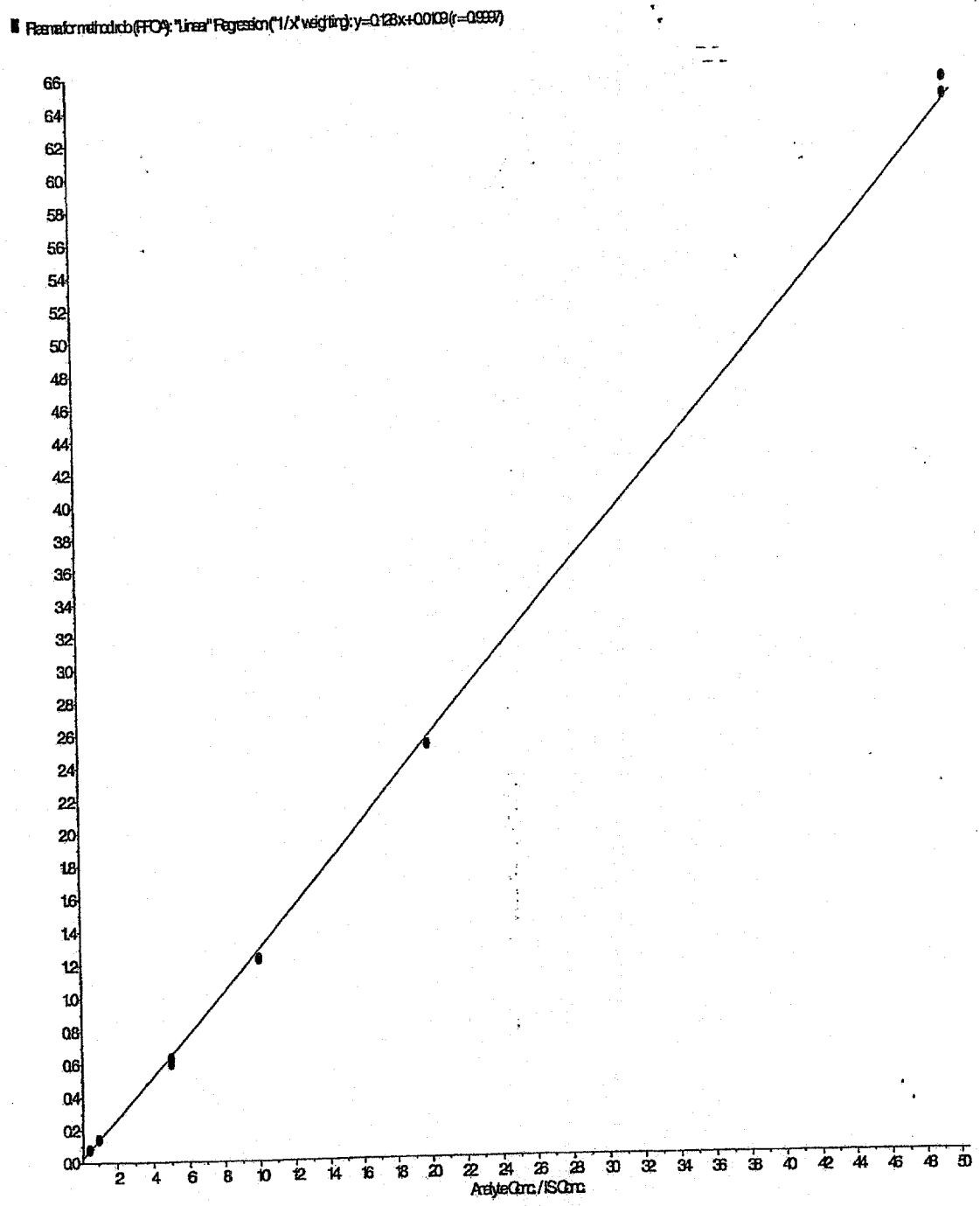


Figure 6. Representative Chromatogram of a Control Rabbit Plasma Sample for PFOA with 1 ng/mL of ^{13}C-PFOA

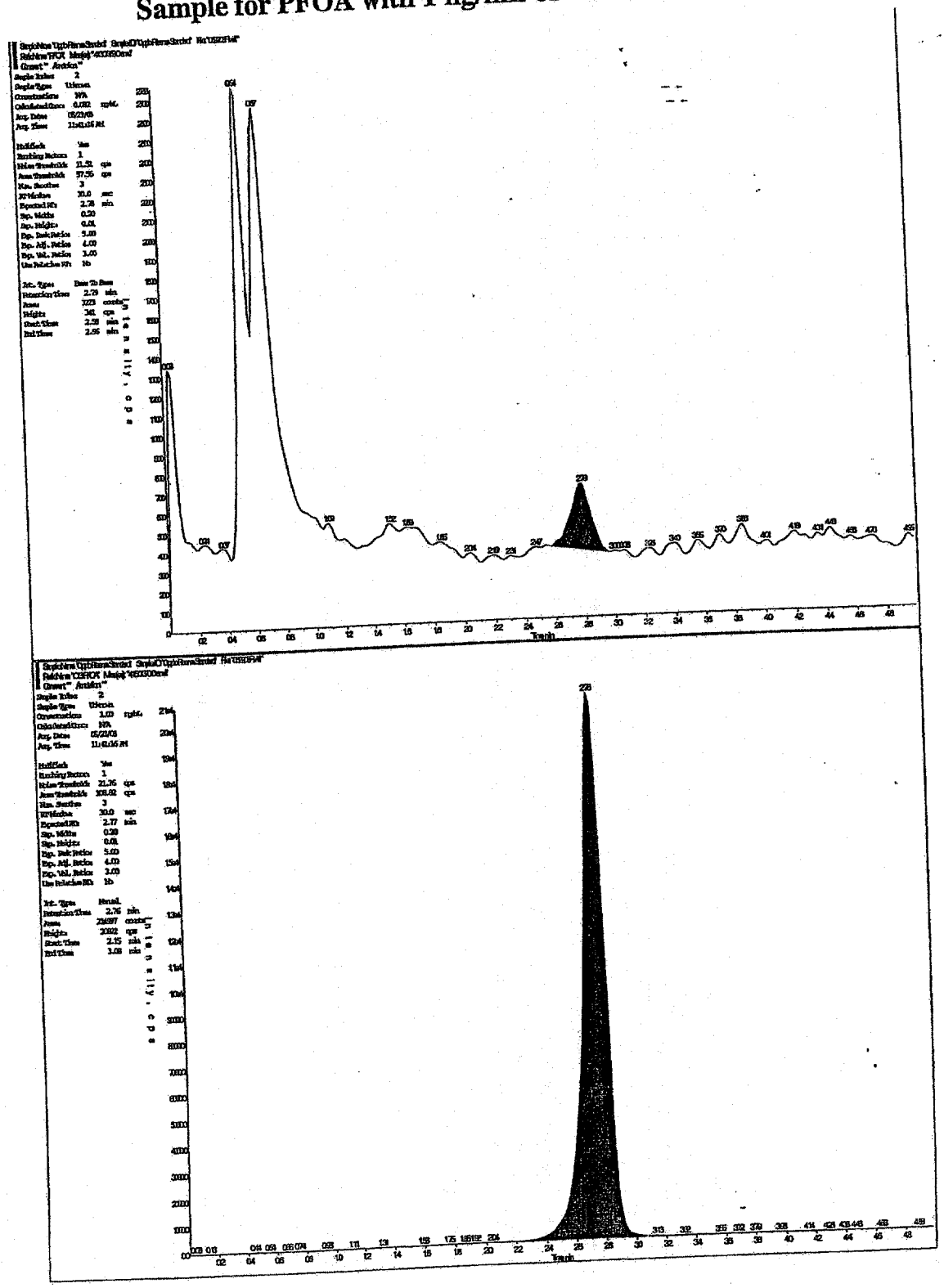


Figure 7. Representative Chromatogram of a 0.5 ppb Standard for PFOA in Control Rabbit Plasma with ~ 1 ng/mL of ^{13}C-PFOA

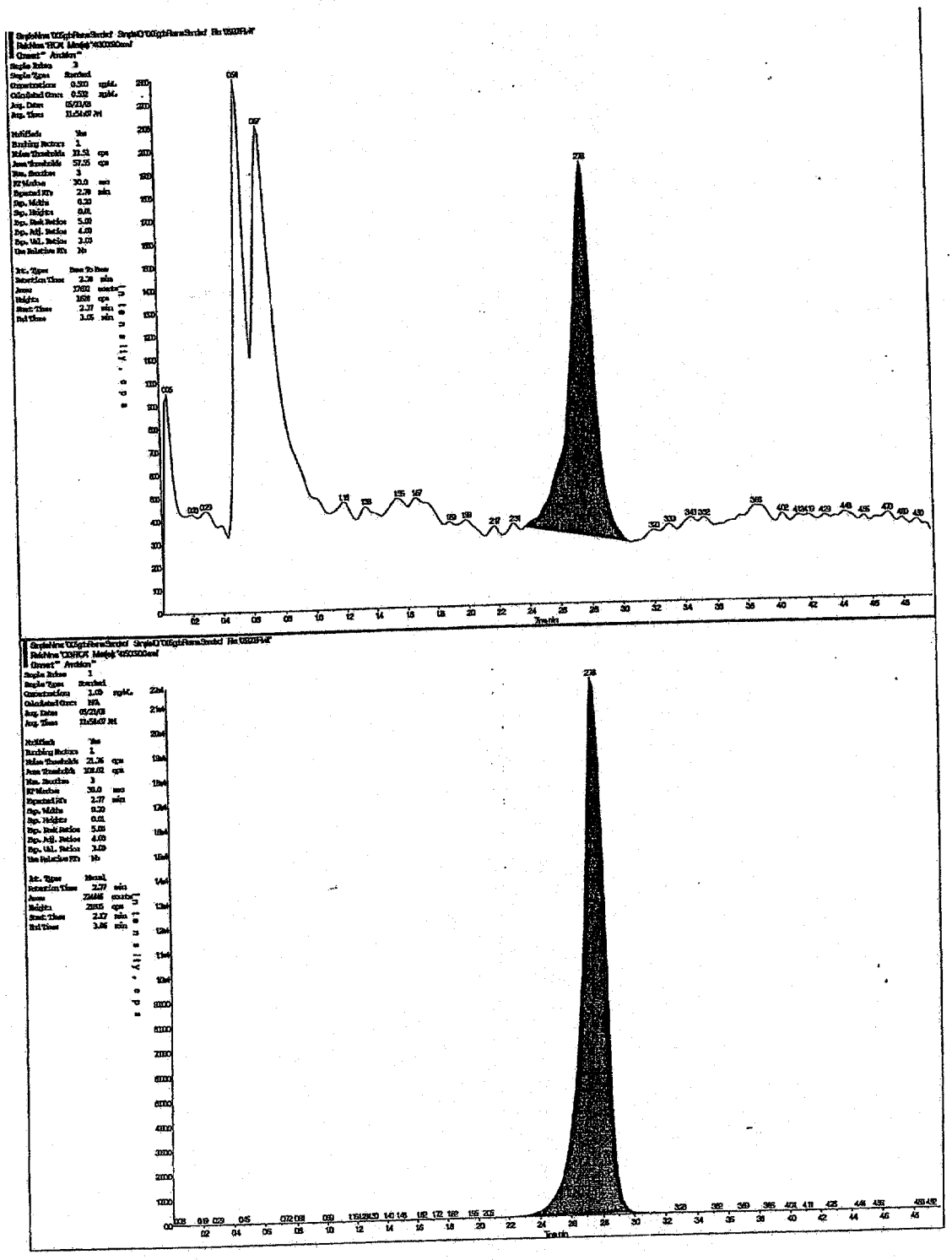
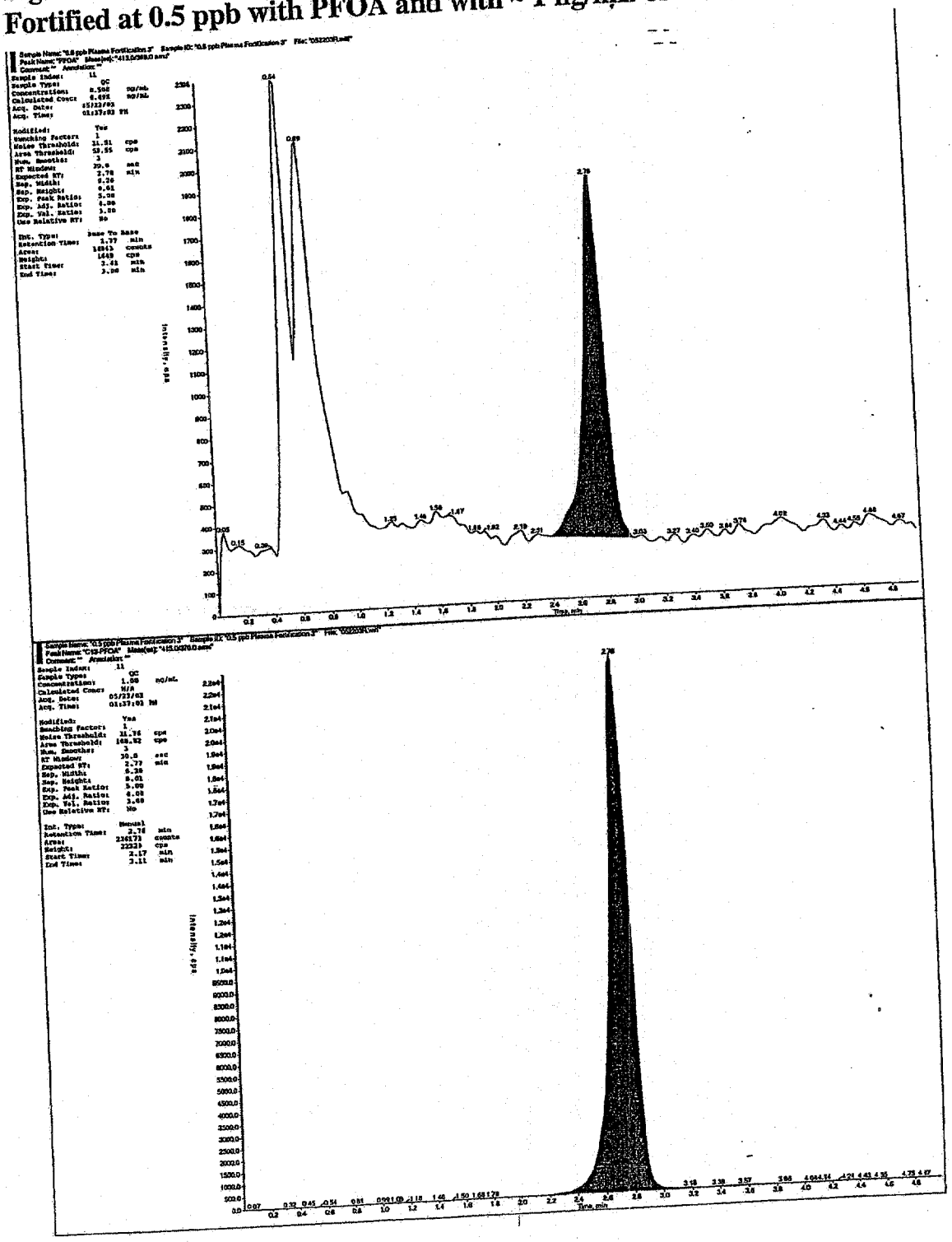


Figure 8. Representative Chromatogram of Control Rabbit Plasma Fortified at 0.5 ppb with PFOA and with ~ 1 ng/mL of ^{13}C-PFOA



December 4, 2003

Mary A. Kaiser, Ph.D.
Research Fellow
Corporate Center for Analytical Services
Dupont Central Research & Development
DUPONT
Experimental Station
P.O. Box 80302
Wilmington, DE 19880-0302

Clayton Work Order No. 03010080
Clayton Proposal No. 03DETLAB015.REV1

Dear Dr. Kaiser:

We are pleased to provide the following **Draft** report on the sampling and analytical method conditions followed for the method validation for [redacted]. This draft report is based on our proposal dated July 18, 2003.

The sampling parameters may change as we progress with the method validation. Not all of the parameters outlined in this report have been fully validated.

If you have any questions, please call me at (248) 344-1770.

Sincerely,

Kem Charron
Program Manager-Special Projects
Laboratory Services

KC
Enclosure

Clayton Group Services, Inc.

[redacted]

Empirical Formula: [redacted]
Molecular Weight: [redacted]
CAS Number: [redacted]

Clayton Work Order No.: 03070834
Draft Report Date: December 4, 2003

OSHA: None
NIOSH: None
ACGIH: None
AEL: 0.56 ppb

Properties
Appearance: White Powder
Odor:
Melting Point: [redacted]

Synonyms: Pentadecafluorooctanoic acid

Sampling and Storage

Sampler: Osha Versatile Sampler SKC Cat. No. 226-30-16

Storage: To be determined

Shipping: Samples should be shipped at refrigerated temperatures

Sample Stability: To be determined

Equipment

1. SKC OSHA Versatile Sampler (OVS) Cat. No. 226-30-16

2. HPLC System: LC pump with automated gradient controller, autosampler, optional tunable UV absorbance detector

6. Mass Spectrometer: Triple quadrupole mass spectrometer 2 – 1000 amu mass range minimum, API interface with Electrospray probe, negative and positive ionization mode capability, and data acquisition/reduction software

7. Column: Agilent Hypersil ODS, 2.1 × 100 mm, 3 µm particle size, Cat. # 79916OD-352 or equivalent

8. 16 mL amber glass vial with screw cap and Teflon/rubber liner

9. 4 mL amber glass vial with screw cap and Teflon/rubber liner

10. Waters total recovery glass autosampler vials with Teflon/rubber liner

12. Syringe: 10, 25, 50, & 100 µL

13. Disposable glass test tube, 16 x 125 mm with caps

Measurement

Technique: High Performance Liquid Chromatography (HPLC) coupled with Tandem Mass Spectrometry

Detectors: Triple Quadrupole Mass Spectrometer (Micromass Quattro LC, or equivalent)

Extraction: 4 mL of extraction solvent for 60 minutes

Instrument Conditions:

HPLC Conditions

Column: Agilent Hypersil ODS, 2.1 × 100 mm, 3 µm particle size

Column Temp: 30 °C
Flow Rate: 0.3 mL/minute
Injection Volume: 5 µL
Run Time: 14 minutes
Retention Time: 6.4 minutes

Mobile Phase: Gradient

Time (min)	%A	%B	Curve
0	90	10	-
5	10	90	-
9	10	90	-
10	90	10	-
14	90	10	-

A = 2 mM Ammonium Acetate
B = Methanol

Wavelength (UV): Not Applicable

Mass Spectrometer Conditions

Ionization Mode: Electrospray Negative

Nebulizer Gas (L/hr): 96
Desolvation Gas (L/hr): 690
Source Block Temperature (°C):120
Desolvation Temperature (°C):350
Collision Gas Pressure (mBar):3.1e-3
Multiplier: 650

	ES -Ion
Source Settings	
Capillary Voltage (kV):	1.5
Extractor (V):	1
RF Lens (V):	0.5
Analyzer Settings	
MS1 LM&HM Resolution:	14
MS1 Ion Energy (V):	0.5
MS2 LM&HM Resolution:	15
MS2 Ion Energy (V):	1.5
Entrance (V):	0
Exit (V):	0

Mass Spectrometer Method

MS Function: Multiple Reaction Monitoring (MRM) ESP-
Inter Channel Delay for MRM (s): 0.1
Span (Daltons): 0.5
Start time: 0 min End time: 14 min

Analyte Specific Settings:	Transition (amu)	Dwell (s)	Cone Voltage (V)	Collision Energy (eV)
[redacted]	412.9 – 368.9 (Q)	0.5	10	10
Internal Standard [redacted]	414.9 – 369.9 (Q)	0.5	10	10

(Q) = Transition used for quantitation

Sampling

1. Samplers (SKC 226-30-16) are received from the manufacturer (SKC).

2. Calibrate each sampling pump with a representative collection device in line.

3. Depending on the application, there are two flow rate options:

   (1) For area or personal monitoring, sample at a flow rate of 1.0 L/min for up to 480 minutes to obtain a sample volume of 960 L.
   (2) For fence line monitoring, sample at a flow rate of 15 L/min for up to 1440 minutes to obtain a sample volume of 21600 L.

4. Label the sample with appropriate sample identification.

5. At the completion of sampling, re-calibrate each pump with a representative collection device in line.

6. Cap the ends of each sampler.

7. Samples are stored at refrigerated temperatures.

8. A chain of custody form is filled out and sent with the samplers under refrigerated conditions to the Laboratory for analysis

Sample Preparation

Note: Samples are extracted just prior to analysis. Samples are stable for X days at X temperatures.

1. Extract each OVS sampling tube in three separate sections. Place each section in a separate disposable glass test tube.
   Section 1: GFF Filter
   Section 2: XAD-2 Front portion of media plus foam plug
   Section 3: XAD-2 Back portion of media

2. Add 4 mL of Methanol to each test tube and shake for 60 minutes on a mechanical shaker.

3. Transfer approximately 3.5 mL of each extract to a 4 mL amber glass vial by filtering through a Gelman 13-mm GHP Acrodisc. Extracts should be stored refrigerated.

4. For LC/MS/MS analysis, transfer 200 µL each sample extract to a glass autosampler vial. Add 10 µL of a 1.4 µg/mL Internal Standard solution ([redacted]).

Calibration and Quality Control

1. Calibrate daily with six working standards over the range of 11.4 to 227 ng/mL for [redacted].

   a) Calibration standards are prepared by transferring 200 µL each [redacted] standard solution to a glass autosampler vial. Add 10 µL of a 1.4 µg/mL Internal Standard solution ([redacted]).

b) Analyze standards together with samples and blanks. A calibration curve is analyzed at the beginning and end of each run, and Continuing Calibration Verification (CCV) standards are analyzed a minimum of every ten samples. Acceptance criteria for a CCV is ± 20%.

c) Generate an internal standard, linear calibration curve from the observed peak area response factors and standard concentrations.

2. Determine the Extraction Efficiency (EE) at least once with each lot of samplers. Prepare at least one level in duplicate within the expected sampling range. Include one media blank per lot.

a) Inject µL amounts of [redacted] spiking standard solution onto the GFF portion of an OVS tube.

b) Allow the tube to air-dry at ambient temperature.

c) Cap the tube and store at **refrigerated** temperatures until extraction.

d) Extract the [redacted]-spiked and blank tubes as described in Sample Preparation. Analyze an aliquot from each sample along with standards. Transfer 200 µL each extract solution to a glass autosampler vial. Add 10 µL of a 1.4 µg/mL Internal Standard solution [redacted].

e) Calculate the ratio for the ng of [redacted] found on the media spike to the theoretical amount spiked. The concentrations found in each of the three sections must be summed to obtain the total amount of [redacted] found.

The ratio reflects the recovery of [redacted] from the media. The mean recovery of the replicates equals the EE for [redacted].

Measurement

1. Set the liquid chromatograph and mass spectrometer conditions in accordance with those specified on page 2, or with suitable adjustments to optimize chromatography and sensitivity.

2. Inject the specified aliquot of each standard and sample.

3. Record the peak area response factor for [redacted] and Internal Standard peaks. The observed retention time is 6.4 minutes for both [redacted] and Internal Standard.

AR226-3430

7ff

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RECYCLED

000358

AR 226_3430

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Fayetteville Works

Date of Monitoring: October 2002

Matrix: Blood Serum

Operation: PFOA Production

Job Title	Number Sampled	Minimum Concentration (ppb)	Mean (ppb)	Median (ppb)	Maximum Concentration (ppb)	Standard Deviation
Entire Cohort	20	4.15	10.83	8.86	20.3	5.07
Males	17	5.3	11.72	9.5	20.3	4.93
Females	3	4.15	5.78	4.91	8.28	2.20
Operators	8	5.3	9.97	9.5	16.4	4.27
Males	8	5.3	9.97	9.5	16.4	4.27
Females	0	-	-	-	-	-
Mechanics	1	8.56	8.56	8.56	8.56	-
Males	1	8.56	8.56	8.56	8.56	-
Females	0	-	-	-	-	-
Laboratorians	2	4.15	4.53	-	4.91	0.54
Males	0	-	-	-	-	-
Females	2	4.15	4.53	-	4.91	0.54
Supervision	9	8.28	13.24	16.7	20.3	5.22
Males	8	8.54	13.86	10.2	20.3	5.22
Females	1	8.28	8.28	8.28	8.28	-

Comments:
Samples analyzed by Exygen
Data set includes duplicate samples which appear as separate results.

Prepared by: Barbara J. Dawson, CIH
Date of Preparation: November 19, 2004

000359

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Fayetteville Works

Date of Monitoring: December 2003

Matrix: Blood Serum

Operation: PFOA Production

Job Title	Number Sampled	Minimum Concentration (ppb)	Mean (ppb)	Median (ppb)	Maximum Concentration (ppb)	Standard Deviation
Entire Cohort	26	8.15	298.16	120	2280	490.58
Males	23	15.8	280.21	120	2280	469.90
Females	3	8.15	435.76	9.14	1290	739.79
Operators	11	66.6	267.57	224	664	208.76
Males	11	66.6	267.57	224	664	208.76
Females	0	-	-	-	-	-
Mechanics	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Laboratorians	3	69.9	1213.30	1290	2280	1107.04
Males	2	69.9	1174.95	-	2280	1562.78
Females	1	1290	1290	1290	1290	-
Supervision	12	8.15	97.41	87.3	364	105.9
Males	10	15.8	115.16	88.4	364	107.73
Females	2	8.15	8.65	-	9.14	0.70

Comments:
Samples analyzed by Exygen
Data set includes duplicate samples which appear as separate results.

Prepared by: Barbara J. Dawson, CIH
Date of Preparation: November 19, 2004

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Fayetteville Works

Date of Monitoring: March 2003

Matrix: Blood Serum

Operation: PFOA Production

Job Title	Number Sampled	Minimum Concentration (ppb)	Mean (ppb)	Median (ppb)	Maximum Concentration (ppb)	Standard Deviation
Entire Cohort	20	8.34	92.25	89	244	73.21
Males	18	11.2	94.03	89	244	73.59
Females	2	8.34	76.17	-	144	95.93
Operators	8	22	89.48	77.3	202	61.44
Males	8	22	89.48	77.3	202	61.44
Females	0	-	-	-	-	-
Mechanics	1	12.5	12.5	12.5	12.5	-
Males	1	12.5	12.5	12.5	12.5	-
Females	0	-	-	-	-	-
Laboratorians	1	144	144	144	144	-
Males	0	-	-	-	-	-
Females	1	144	144	144	144	-
Supervision	10	8.34	97.26	98.2	244	85.67
Males	9	11.2	107.14	98.2	244	84.61
Females	1	8.34	8.34	8.34	8.34	-

Comments:
Samples analyzed by Exygen
Data set includes duplicate samples which appear as separate results.

Prepared by: Barbara J. Dawson, CIH
Date of Preparation: November 19, 2004

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Fayetteville Works, Fayetteville, North Carolina

Date of Monitoring: June 2004

Matrix: Blood Serum

Operation: PFOA Production

Job Title	Number Sampled	Minimum Concentration (ppb)	Mean (ppb)	Median (ppb)	Maximum Concentration (ppb)	Standard Deviation
Entire Cohort	27	4.08	422.12	188	1870	554.66
Males	24	4.08	410.46	196	1870	528.54
Females	3	6.28	515.39	9.9	1530	878.68
Operators	11	62.6	569.79	402	1440	532.55
Males	11	62.6	569.79	402	1440	532.55
Females	0	-	-	-	-	-
Mechanics	1	188	188	188	188	-
Males	1	188	188	188	188	-
Females	0	-	-	-	-	-
Laboratorians	3	63.7	1154.57	1530	1870	959.89
Males	2	63.7	966.85	-	1870	1277.25
Females	1	1530	1530	1530	1530	-
Supervision	12	4.08	123.15	85.2	610	176.62
Males	10	4.08	146.17	108	610	185.99
Females	2	6.28	8.09	-	9.9	2.56

Comments:

- Samples analyzed by Exygen
- Data set includes duplicate samples which appear as separate results.

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: November 19, 2004

DuPont Company
Fayetteville Works
PFOA in Blood

Job Assignment	Baseline 10-2002 (ppb)	2nd Sample 3-2003 (ppb)	3rd Sample 12-2003 (ppb)	4th Sample 6-2004 (ppb)
APFO Field/CCR Tech	12.4 ppb, 16.4 ppb	77.3	135	136
APFO Field/CCR Tech	5.3 ppb	27.4	66.6	261
APFO Field/CCR Tech	15.3 ppb	91	92.2	93.1
APFO Field/CCR Tech	7.76 ppb	66.7	74.6	62.6
APFO Field/CCR Tech	5.63 ppb	156	664	1440
APFO Field/CCR Tech	7.45 ppb	202	349	415
APFO Field/CCR Tech	no sample	73.4	357	358
APFO Field/CCR Tech	9.5 ppb	22	no sample	no sample
APFO Field/CCR Tech	no sample	no sample	580	1290
APFO Field/CCR Tech	no sample	no sample	322	1390
APFO Field/CCR Tech	no sample	no sample	78.9	420
APFO Field/CCR Tech	no sample	no sample	224	402
APFO Mech. Tech	8.56 ppb	12.5 ppb	no sample	188 ppb
APFO Lab Tech	4.15 ppb, 4.91 ppb	144	1290	1530
APFO Analytical Tech	no sample	no sample	2280 ppb	1870 ppb
Nafion VE Lab Tech	no sample	no sample	69.9 ppb	63.7 ppb
APFO Supt.	20.3 ppb	98.2 ppb	88.4 ppb	85.2 ppb
APFO Supt.	no sample	11.2 ppb	19.8 ppb	21.1 ppb
APFO Supt.	16.7 ppb	89 ppb	no sample	no sample
Plant Manager	no sample	no sample	120 ppb	no sample
Area Resource	no sample	no sample	no sample	4.08 ppb (5-2004)
Contract Physician	no sample	no sample	no sample	8.90 ppb
Chemist	no sample	no sample	8.15 ppb (1-2004)	6.28 ppb
APFO FLS	8.54 ppb, 8.76 ppb	244 ppb	364 ppb	610 ppb
APFO Eng.	18.2 ppb	125 ppb	222 ppb	196 ppb
APFO Eng.	10.2 ppb	34.9 ppb	60.2 ppb	159 ppb
APFO Eng.	no sample	no sample	15.8 ppb	no sample

Prepared November 18, 2004
Barbara J. Dawson, CIH, CSP

000363

DuPont Company
Fayetteville Works
PFOA in Blood

Job Assignment	Baseline 10-2002 (ppb)	2nd Sample 3-2003 (ppb)	3rd Sample 12-2003 (ppb)	4th Sample 6-2004 (ppb)
APFO Eng.	no sample	no sample	no sample	5.38 ppb
APFO Chemist	19.3 ppb	236 ppb	87.3 ppb	264 ppb
APFO Chemist	8.86 ppb	101 ppb	142 ppb	108 ppb
APFO Chemist	no sample	25 ppb	32.1 ppb	no sample
Site Industrial Hygiene	8.28 ppb	8.34 ppb	9.14 ppb	9.90 ppb

Prepared November 18, 2004
Barbara J. Dawson, CIH, CSP

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R-12003-R REV. 3-77

DU PONT

E. I. DU PONT DE NEMOURS & COMPANY
INCORPORATED

SPRUANCE PLANT
P.O. BOX 27001
RICHMOND, VIRGINIA 23261

TEXTILE FIBERS DEPARTMENT

[redacted]

February 25, 1980

RECEIVED
FEB 28 1980
JANN A. BREWSTER, M.D.

PERSONAL & CONFIDENTIAL

TO: G. L. WATTS

FROM: E. R. PURCHASE

FC-143 FLUOROSURFACTANT

(Ref.: Letter, A. A. Wright to M. R. Warden, same subject, 10/29/79)

The reference letter reviews information on FC-143, a 3M Company product, used at Parkersburg in Teflon® dispersion which in turn is used in Teflon® operations at Spruance. Blood tests on employees who work with FC-143 showed up to 70 ppm of organic fluorine in 3M employees and up to 22 ppm in Parkersburg employees compared to a general background level of less than 1 ppm. No adverse health effect has been detected in any of the exposed people. Tests at Haskell Laboratory revealed that FC-143 readily penetrates the skin of animals and causes liver damage and in heavy doses may cause death. In view of this information, a decision was made to analyze blood samples from a small group of Spruance employees with potential FC-143 exposure in Spinning and Finishing and a control group.

The analyses of blood samples were carried out at Jackson Laboratory by the same group that analyzed samples from Parkersburg. The results are shown below:

Employee	Age	Area	Fluorine, ppm Total (1)	Inorganic	Organic (2)
[redacted]	37	Spin.	0.34	0.21	0.13
	58	Spin.	0.41	0.12	0.29
	25	Spin.	0.18	0.11	0.07
	28	Spin.	0.23	0.15	0.08
	37	Fin.	0.35	0.15	0.20
	32	Fin.	0.18	0.18	0.00
	31	Control	0.21	0.20	0.01
	24	Control	0.18	0.14	0.04
	35	Control	0.18	0.15	0.03

(1) Non-volatile
(2) By difference

Redacted - Privacy

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

Company Sanitized. Does not contain TSCA CBI

These results indicate that there is no significant exposure to FC-143. This view is supported by personnel from Haskell Laboratory, Jackson Laboratory and the Parkersburg plant, who consider that blood levels of organic fluorine below 1 ppm are not significant. Therefore, we plan no further analysis of blood samples from Spruance employees.

To ensure continued protection of personnel against exposure to FC-143, operating procedures will continue to be based on no skin contact with Teflon® dispersion. No special precautions are required for yarn handling. In routine periodic audits of operating area conditions and practices, special attention will be given to those factors which protect employees against exposure to FC-143.

ERP:fsg

TABLE II

GC PRECISION

SAMPLE	GC COUNTS/THOUSANDS
5 ppm FC-143	232.5, 241.0, 234.1
1.0 ppm FC-143	63.2, 62.3, 65.2, 61.6, 59.0
0.5 ppm	33.4, 34.3, 38.8, 39.5
0.25 ppm	17.5, 15.5, 19.1, 18.4

BLOOD SAMPLES

ILC with PPD/S. Stafford

SAMPLE	SPIKED LEVEL (ppm F)	MEASURED LEVEL (ppm F)
1	.50	.56
2	1.5	1.9
3	Blank	.01
4	.027	0.026
5	0.17	0.145
6	1.0	1.2
7	Blank	.009
8	.054	.047
9	.34	.314
10	.054	.059

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6PP

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PERSONAL AND CONFIDENTIAL

ORGANIC FLUORIDES IN BLOOD SAMPLES

NAME	P.R. NO.	ZONE	ORGANIC FLUORIDE PPM	COMMENTS
GRANULAR OPERATORS				
Polymerization				
[redacted]	501	6	0.47	8/60-6/71, 12/72 to present
[redacted]	3520	6	2.33	Exposure since 1968, granular polymerization since 2/74.
[redacted]	598	6F	0.52	Special job. Relief on granular polymerization about 1 day/week 2/69 to present.
[redacted]	3097	6	3.54	F.P. P.O. 8/62 to 3/69, FEP polymerization 8/69 to 7/70, polymerization 12/71 to present
[redacted]	380	6	5.61	12/72 to present, others jobs since 5/55
[redacted]	3120	6	3.91	9/71 to present.
[redacted]	3417	6	6.84	FP, P.O. 9/65 to 12/72, polymerization 9/73 to present
[redacted]	3278	6	2.23	3/76 to present.
Finishing				
[redacted]	3720	4	2.06	Disp. P.O. 9/71 to 7/72, details to polymerization 5/76 to present.
[redacted]	4335	4	0.69	Detailed to polymerization 65 days in past 5 months.
[redacted]	4278	4	0.72	Detailed to granular polymerization 8 of last 10 weeks as of 9/13/79.
FINE POWDER/DISPERSION OPERATOR				
Polymerization				
[redacted]	4214	6	4.39	F.P. Dryers and Disp. P.O. 9/76 to 4/79, Polymerization 4/79 to present.
[redacted]	1484	6(22.17)	21.22	Service operator jobs 6/56 to 6/60, polymerization since 2/63.

( ) Previous blood samples taken in June.

Redacted - Privacy

NAME	P.R. NO.	ZONE	ORGANIC FLUORIDE PPM	COMMENTS
Polymerization (Cont.)				
[redacted]	3352	6	0.17	8/76 to present.
[redacted]	953	6	(9.53) 8.25	4/62 to present, others job previous 6 years.
[redacted]	3522	6	1.52	F.P. P.O. and Dryer 6/66 to 3/72, polymerization 2/74 to present.
[redacted]	1482	6F	0.59	3/63 to present, except monomer operator 10/77-4/79.
[redacted]	426	6	20.81	1960 to present.
[redacted]	1508	6F	$\bar{x}$ = 9.63 (10.56) 8.70	11/75 to present.
[redacted]	943	6	$\bar{x}$ = 14.4 (15.02) 13.75	4/62 to present. Service operator jobs previous 4 years.
[redacted]	3564	6	1.60	11/75 to present.
[redacted]	3994	6	3.55	3/76 to 8/78 F.P. dryer, polymerization 8/78 to present.
[redacted]	1951	6	5.90	5/65 to present, service operator jobs additional 5 years.
[redacted]	4146	6	0.38	3/79 to present.
[redacted]	3485	6	6.91	4/77 to present, FEP service operator 2/75 to 4/77
[redacted]	3854	6	16.89	F.P. dryer 10/75 to 4/77, polymerization 8/78 to present.
[redacted]	3568	6	0.98	F.P. dryer and P.O. 2/75-5/76, some granular polymerization. F.P./disp. polymerization 4/79 to present.
[redacted]	3987	6	3.81	Service operator jobs 9/72-11/77. Polymerization 11/77 to present.
[redacted]	3424	6	3.23	8/76 to present

( ) Previous blood samples taken in June.

0-1	4
1-5	5
5-10	4
10-15	1
15-20	1
>20	1

Redacted - Privacy

NAME	P.R. NO.	ZONE	ORGANIC FLUORIDE PPM	COMMENTS
Service Operator				
[redacted]	3613	4	4.97	F.P. dryer and P.O. 6/66 to 12/69, Polymerization 10/77 to 10/78.
[redacted]	4390	4	1.98	F.P. Dryer since 11/78.
[redacted]	4153	4	4.84	F.P. Dryer and Disp. P.O. 9/76 to present.
[redacted]	1591	4F	2.24	Service Operator jobs 5/57 to present.
[redacted] *	4300	4	1.03	
[redacted] *	4111	4	2.92	12/78 to present F.P. Dryer, detailed to polymerization.
[redacted]	4452	4	0.50	3/79 to present all 3 jobs.
[redacted]	4216	4	1.04	
[redacted] *	4331	4	1.80	F.P. packout.
[redacted]	1498	4	2.97	F.P. Dryer 12 years, F.P. P.O 8 years, other 3 years.
[redacted]	3490	4	3.89	12/72 to present F.P. Dryer and P.O.
[redacted]	4266	4	2.30	1/79 to present Disp. and Polymerization.
[redacted] *	4299	4	1.78	F.P. packout.
[redacted]	4202	4	1.81	F.P. P.O. 11/76 to present, Details to polymerization.
MONOMER OPERATORS				
[redacted]	370	7	0.35	
[redacted]	432	7	0.39	
[redacted]	932	7	0.08	
[redacted]	858	6E	0.54	
[redacted]	1447	7	0.17	
[redacted]	625	7	0.37	
[redacted]	864	7	0.52	

Redacted - Privacy

NAME	P.R. NO.	ZONE	ORGANIC FLUORIDE PPM	COMMENTS
FEP OPERATORS				
Polymerization				
[redacted]	1743	6	(1.36) 0.99	1976 to present. Additional exposure in homopolymers
	707	6F	1.72	1976 to present. Additional exposure in homopolymers
	3223	6	2.71	Disp. 1964-1971; polymerization 1976 to present.
	1920	6	0.91	1976 to present.
	1510	6	2.10	1976 to present.
	1572	6	4.64	Disp. 10/60-11/63; polymerization 1976 to present.
	1978	6	3.70	1976 to present. Additional exposure to homopolymers
	1761	6	(3.61) 1.99	1976 to present.
	1928	6	1.95	1976 to present.
	1619	6	1.47	1976 to present.
	1744	6	4.96	1976 to present. Additional exposure in homopolymers.
	1426	6	4.52	10/77 to present. Additional exposure in homopolymers.
	889	6	4.14	12/76 to present. Additional exposure in homopolymers.
Dispersion				
[redacted]	4329	4	1.31	6/78 to present.
RESEARCH				
Research Chemists				
[redacted]	W/S		0.43	
	W/S		0.45	

( ) Previous blood samples taken in June.

Redacted - Privacy

NAME	P.R. NO.	ZONE	ORGANIC FLUORIDE PPM	COMMENTS
Semiworks Laboratorians				
[redacted]	870	6	0.44	5/70 to present.
	3793	6	1.50	8/77 to present. Finishing operator 9/68 to 11/69, service operator 5/72 to 12/72, homopoly service operator 12/72 to 7/74, 8/75 to 11/7
	3904	6F	0.24	4/77 to present.
	911	6	0.70	2/75 to present.
	560	6 (0.46)	0.26	4/77 to present.
	3133	6	0.30	7/69 to 10/72, 5/79 to present.
	3690	6F	0.24	8/77 to present. Service operator 2/75 to 9/75.
	1592	6 (0.72)	0.59	10/72 to present. Teflon exposure 9/59-4/62, service operator 3/63-2/6
MONOMER OPERATORS WITH LAST FINE POWDER/DISP. POLYMERIZATION EXPOSURE				
[redacted]	939	7	6.66	Polymerization 1/62 to 10/78 Monomer operator 11 months.
	3044	7	5.29	Exposure 5/62 to 5/77. Monomer operator 28 months.
	1633	7	5.64	Exposure 9/62 to 11/77. Monomer operator 22 months.
			$\bar{X}$ = 5.81	
FOREMAN VOLUNTEER				
[redacted]	W/S		0.69	Various jobs with C-8 10/56 to 3/63. Monomer operator 3/63 to 2/69. Foreman 2/69 to present.

Total 12

0 - 1 8
1 - 5 1
5 - 10 3
10 - 15
15 - 20

( ) Previous blood samples taken in June.

JFDoughty:mps
10/10/79

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ORGANIC FLUORIDES IN BLOOD SAMPLES (1)

COMPLETE RESULTS

AREA	ZONE	NUMBER SAMPLED	RANGE ppm	AVERAGE ppm
MONOMER				
Long Service	7	7	0.1 – 0.5	0.35
Short Service (1)	7	3	5.3-6.7	5.86
Foreman	–	1	–	0.69
RESEARCH PROFESSIONALS		2	0.43-0.45	0.44
SEMIWORKS LABORATORIANS		8	0.2-1.5	0.56
FEP				
Polymerization	6	13	0.9 – 5.0	2.83
Dispersion	4	1	–	1.31
GRANULAR				
Polymerization	6	8	0.5-6.8	3.18
Finishing	4	3	0.7-2.1	1.16
FINE POWDER				
Polymerization	6	18	0.2-21.7	6.96
Finishing	4	14	0.5-5.0	2.43

(1) 1 - 2 years in monomer.
Previously worked in polymer areas

10/16/79

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AR 226 - 3435

- C-8 Level - Current Washington Works Female Employees

Number of Samples 56

Range .0.013 - 5.1

Average 0.92 ppm C-8

Number	Above	0.05	ppm	C-8	53
"	"	0.10	"	"	46
"	"	0.20	"	"	35
"	"	0.30	"	"	29
"	"	0.40	"	"	28

RDI:ldr

C-8 BLOOD LEVELS IN FEMALES TRANSFERRED OUT OF TEFLON®

AGE	C-8 LEVEL WHEN LEAVING TEFLON®	C-8 LEVEL AFTER LEAVING TEFLON®	NUMBER OF DAYS BETWEEN SAMPLES	% CHANGE IN C-8 BLOOD LEVELS
32	0.140	0.086	143	-38.6
27	0.192	0.120	127	-37.5
27	0.570	0.390	140	-31.6
33	1.300	0.980	126	-24.6
24	0.110	0.086	128	-21.8
27	0.110	0.091	133	-17.3
27	0.078	0.065	148	-16.7
37	2.400	2.000	139	-16.7
27	5.100	4.400	126	-13.7
23	0.061	0.053	128	-13.1
29	0.270	0.240	130	-11.1
31	0.190	0.170	127	-10.5
26	0.045	0.041	96	- 8.9
32	0.450	0.410	127	- 8.9
27	0.230	0.210	127	- 8.7
25	0.092	0.092	126	0.0
33	0.019	0.019	133	0.0
28	2.500	2.600	126	+ 4.0
		AVERAGE =	129 days	-15.3 ± 11.7*

* The downward trend is statistically significant at 0.05 level using the paired-t test.

12/1/81
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RECYCLED

AR226-3437

E-37 REV. 1-79

[redacted]

E. I. DU PONT DE NEMOURS & COMPANY
INCORPORATED
P. O. Box 1217
PARKERSBURG, W. VA. 26101

POLYMER PRODUCTS DEPARTMENT

February 12, 1982

PERSONAL & CONFIDENTIAL

TO: R. D. INGALLS
WILMINGTON

FROM: J. F. DOUGHTY
WASHINGTON WORKS
John F. Doughty

WORK HISTORIES OF FEMALES

Attached is the information you requested on work histories. I have rearranged the information in the table you used to talk to John Smith to show highest to lowest organic fluorine levels. This makes the correlation with time clearer.

Company Sanitized. Does not contain TSCA CBI

JFD:mah
Attachment

"TEFLON"® WORK HISTORIES OF FEMALES

ppm Organic Fluorine	TEFLON® Work History	
5.1	TFE Service Operator	1511 days
2.5	" " "	1243 days
2.4	" " "	1085 days
1.3	" " "	1692 days
0.57	" " "	121 days
0.45	" " "	882 days
	Research Laboratorian	31 days
0.27	TFE Service Operator	354 days
0.23	" " "	91 days - last date 4/1/77
0.192	" " "	50 days
0.19	FEP Service Operator	293 days
0.14	TFE Service Operator	335 days
0.11	" " "	31 days
	Telomer "A" Operator	444 days
0.11	TEFLON® Engineer	301 days
0.092	" "	315 days
0.078	TFE Service Operator	358 days
0.061	TEFLON® Engineer	224 days
0.045	" "	269 days
0.019	TFE Service Operator	50 days

JFD:mah
2/12/82

10 pp

AR226-3438

AR226-3438

[redacted]

July 14, 1982

PERSONAL AND CONFIDENTIAL

TO: R. J. BURGER

FROM: J. G. LOSCHIAVO J.G.L.

TRENDS IN BLOOD C-8 LEVELS FOR VARIOUS TEFLON® EMPLOYEE GROUPS

SUMMARY

Comparison of data for sample results obtained up to October, 1981 with corresponding data up to June, 1982 shows:

- For 40 FEP Operators, blood C-8 levels decreased an average 23%.
- For 85 Fine Powder and Granular Operators, blood C-8 levels decreased an average 18%.
- New TEFLON® employees are accumulating C-8 at a lower rate than in previous years.
- Fine Powder Zone 6 Operators still have the highest blood C-8 levels.
- Blood C-8 levels in females transferred out of TEFLON® are continuing to decrease.

0835W-1

Company Sanitized. Does not contain TSCA CBI

DISCUSSION

The attached Tables contain C-8 in blood data for various employee groups in the TEFLON® Divisions. Blood C-8 data were obtained from the FLAIR program. The FLAIR program has proven itself as a valuable tool in aiding in the analysis of blood C-8 data. All blood samples were analyzed by the C-8 specific method. Data recorded in FLAIR by 6/24/82 are used in this summary. Comparisons are made between the data recorded in FLAIR up to October, 1981 with corresponding data up to June, 1982. The following observations are made:

- FEP Operators are experiencing an overall drop in blood C-8 levels of 23%. The decrease for those Operators with over 700 days of service is statistically significant at the 0.05 level using the paired t-test.

- Fine Powder Operators are experiencing an overall drop in blood C-8 levels of 12%. Granular Operators are experiencing a drop of 22%. The decreases for Operators with over 700 days of service is not yet statistically significant.

- Blood C-8 levels in new TEFLON® employees (those with less than 700 days of service) are increasing. However, their levels are increasing at a slower rate than they were in previous years. The average rate of increase for TEFLON® Fine Powder Zone 4 Operators using data collected up to October, 1981 was 0.0019 ppm/day, Using only 1982 data, the average rate of increase has dropped to 0.0004 ppm/day.

- Fine Powder Zone 6 Operators continue to have the highest blood C-8 levels. They average 8 ppm and range as high as 26 ppm. TEFLON® Zone 6 Operators have higher blood C-8 levels than TEFLON® Zone 4 Operators. This is because C-8 accumulates in the body over time. Zone 6 Operators have worked in TEFLON® much longer than Zone 4 Operators. Operators from four other Divisions at Washington Works have very low but measurable quantities of C-8 in their blood.

- Blood C-8 levels in females transferred out of TEFLON® dropped an average 19% over an average 161-day period. This includes only females with 0.1 ppm or more C-8 in their blood. The rate of C-8 elimination in females with less than 0.1 ppm is very slow. It is essentially zero for this group.

0835W-2

CONCLUSION

The diligent efforts on the part of TEFLON® Production and Technical to reduce C-8 air levels are paying off. Significant decreases in employee blood C-8 levels are now being seen. Efforts must be continued in the TEFLON® Divisions to control C-8. Both air and blood sampling programs should continue at their present rates. It is important to prevent overconfidence which could lead to overlooking items and thus minimizing effectiveness of current programs.

Attachments

JGL/nsw
0835W-3

LE 1

BLOOD C-8 LEVELS IN FEMALES TRANSFERRED OUT OF TEFLON®

A. FEMALES WITH BLOOD C-8 LEVELS AT OR ABOVE 0.1 ppm

AGE AT LATEST BLOOD TEST	C-8 LEVEL WHEN LEAVING TEFLON® (ppm)	C-8 LEVEL AFTER LEAVING TEFLON® (ppm)	NO. OF DAYS SINCE LEAVING TEFLON®	% CHANGE IN C-8 LEVELS
33	0.14	0.086	143	- 38.6
42	1.9	1.2	288	- 36.8
26	1.0	0.65	282	- 35.0
27	0.57	0.39	140	- 31.6
33	1.3	0.98	114	- 24.6
24	0.11	0.086	107	- 21.8
35	0.10	0.080	178	- 20.0
27	2.4	2.0	126	- 16.7
32	0.83	0.70	113	- 15.7
28	0.11	0.093	106	- 15.5
35	0.14	0.12	303	- 14.3
26	5.1	4.4	112	- 13.7
30	0.19	0.17	176	- 10.5
25	0.13	0.12	161	- 7.7
38	4.5	4.2	125	- 6.7
28	2.5	2.6	108	+ 4.0*
			AVERAGE = 161	- 19.1 ± 11.5

B. FEMALES WITH BLOOD C-8 LEVELS BELOW 0.1 ppm

27	0.078	0.067	321	- 14.1
22	0.061	0.053	107	- 13.1
25	0.045	0.041	96	- 8.9
24	0.092	0.092	106	0.0
33	0.019	0.019	296	0.0
			AVERAGE = 185	- 7.2 ± 6.1

* This is probably due to analytical error.

JGL/nsw
7/13/82
0835W-4

000389

TABLE 2

SUMMARY OF WASHINGTON WORKS EMPLOYEES' C-8 IN BLOOD LEVELS

GROUP	NO. OF SAMPLES	RANGE (ppm)*	AVERAGE (ppm)*
Fine Powder/Dispersion Zone 6 Operators	21	1.3 - 26.0	8.0
FEP Zone 6 Operators	15	0.3 - 9.6	3.0
Granular Zone 6 Operators	10	0.2 - 9.1	2.7
Fine Powder/Dispersion Zone 4 Operators	37	0.02 - 6.9	1.9
TEFLON® Polymers Production Foremen	23	0.1 - 2.8	1.2
TEFLON® Monomer Operators	31	0.2 - 6.5	1.1
Granular Zone 4 Operators	17	0.01 - 4.3	0.6
Laboratory**	67	0.01 - 3.2	0.6
TEFLON® Copolymers Production Foremen	19	0.03 - 2.1	0.5
TEFZEL®/Telomer "A" Operators	26	0.02 - 1.8	0.5
FEP Zone 4 Operators	25	0.01 - 1.6	0.5
Mechanics	98	0.04 - 1.6	0.4
Research (Engineers & Chemists)	8	0.09 - 0.6	0.3
TEFLON® Polymers Technical	29	0.03 - 0.6	0.2
TEFLON® Polymers Maintenance Supervision	15	0.06 - 0.4	0.2
TEFLON® Copolymers Maintenance Supervision	2		0.2
TEFLON® Copolymers Technical	16	N.D.***- 0.5	0.1
LUCITE® Zone 4 Operators	4	0.02 - 0.2	0.08
DELRIN® Zone 6 Operators	2	0.02 - 0.1	0.07
Filaments Zone 4 Operators	3	N.D. - 0.09	0.05
ZYTEL® Zone 6 Operators	2	0.02 - 0.04	0.03

* Only the most current blood C-8 sample result for each employee was used to determine ranges and averages.

** The Laboratory group includes Trainees, Senior Laboratorians, Lab Analysts, Research Analysts, and Lab Supervision.

*** N.D. = None Detected (< 0.007 ppm).

JGL/nsw
7/13/82
0835W-5

TABLE 3

TRENDS IN BLOOD C-8 AVERAGES FOR TEFLON® ZONE 4 AND ZONE 6 OPERATING GROUPS

GROUP	AVG. C-8 LEVEL USING DATA RECORDED IN FLAIR BY 10/19/81 (ppm)	NO. OF SAMPLES	AVG. C-8 LEVEL USING DATA RECORDED IN FLAIR BY 6/24/82 (ppm)	NO. OF SAMPLES	% CHANGE IN C-8 LEVELS
Fine Powder - Zone 6	9.8	16	8.0	21	-18
FEP - Zone 6	4.4	10	3.0	15	-32
Granular - Zone 6	3.3	9	2.7	10	-18
Fine Powder - Zone 4	2.0	16	1.9	37	- 5
Granular - Zone 4	0.8	14	0.6	17	-25
FEP - Zone 4	0.6	10	0.5	25	-17

JGL/nsw
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0835W-6

TABLE 4

TEFLON® FINE POWDER SERVICE OPERATORS - ZONE 4

REFERENCE NUMBER	DATE OF FIRST SAMPLE	C-8 IN BLOOD (ppm)	DAYS IN JOB AT SAMPLE DATE	DATE OF SECOND SAMPLE	C-8 IN BLOOD (ppm)	DAYS IN JOB AT SAMPLE DATE	WORKED OTHER TEFLON® JOB(S) BEFORE THIS JOB (YES/NO)	AVG. DAILY RATE OF C-8 DECREASE OR INCREASE (ppm/Day)
	4/27/81	0.420	0	10/14/81	1.400	170	YES	+ 0.0058
	4/14/81	1.100	317	9/10/81	1.500	466	NO	+ 0.0027
	4/27/81	0.031	2	7/1/81	0.200	67	NO	+ 0.0026
	8/25/81	0.610	121	1/13/82	0.920	262	NO	+ 0.0022
	7/24/81	0.760	73	2/3/82	1.100	267	YES	+ 0.0018
	4/7/81	3.600	462	3/11/82	3.900	800	NO	+ 0.0009
	10/7/81	0.039	3	12/18/81	0.099	75	NO	+ 0.0008
	8/28/81	0.300	124	1/14/82	0.350	263	YES	+ 0.0004
	10/7/81	0.007	3	12/4/81	0.021	61	NO	+ 0.0002
	8/24/81	1.500	601	2/9/82	1.500	770	NO	0.0000
	4/8/81	3.500	738	8/19/81	3.500	871	NO	0.0000
	8/28/81	0.650	124	12/9/81	0.640	227	YES	- 0.0001
	10/14/81	0.740	531	2/3/82	0.700	643	NO	- 0.0004
	8/31/81	1.700	1,065	1/19/82	1.600	1,206	NO	- 0.0007
	4/6/81	4.300	461	8/26/81	4.000	603	NO	- 0.0021
	5/4/81	3.900	1,310	3/11/82	2.600	1,621	NO	- 0.0042
	5/7/81	4.800	725	12/30/81	3.600	962	NO	- 0.0051

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JGL/nsw
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TABLE 5

TEFLON® TFE PROCESS OPERATORS - FINE POWDER - ZONE 6

REFERENCE NUMBER	DATE OF FIRST SAMPLE	C-8 IN BLOOD (ppm)	DAYS IN JOB AT SAMPLE DATE	DATE OF SECOND SAMPLE	C-8 IN BLOOD (ppm)	DAYS IN JOB AT SAMPLE DATE	WORKED OTHER TEFLON® JOB(S) BEFORE THIS JOB (YES/NO)	AVG. DAILY RATE OF C-8 DECREASE OR INCREASE (ppm/Day)
	8/20/80	24.000	8,846	1/14/82	26.000	9,358	NO	+ 0.0039
	4/6/81	4.300	857	9/1/81	4.400	1,005	NO	+ 0.0007
	8/18/80	29.000	9,726	3/19/82	20.000	10,314	NO	- 0.0153
	7/6/81	32.000	2,105	2/18/82	24.000	2,332	NO	- 0.0352

TABLE 6

TEFLON® COPOLYMERS FEP SERVICE OPERATORS - ZONE 4

	4/29/81	0.009	1	9/10/81	0.150	135	NO	+ 0.0011
	9/22/81	0.100	295	4/7/82	0.230	492	NO	+ 0.0007
	10/7/81	0.021	3	2/5/82	0.053	124	NO	+ 0.0003
	10/13/81	0.013	2	3/25/82	0.052	165	NO	+ 0.0002
	10/13/81	0.039	2	1/14/82	0.051	95	NO	+ 0.0001
	4/21/81	1.250	732	10/9/81	1.200	903	NO	- 0.0003
	4/30/81	0.760	115	9/28/81	0.660	266	NO	- 0.0007
	4/7/81	1.700	827	8/18/81	1.600	960	NO	- 0.0008

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JGL/nsw
7/13/82
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TABLE 7

TEFLON® COPOLYMERS POLYKETTLE FEP OPERATORS - ZONE 6

REFERENCE NUMBER	DATE OF FIRST SAMPLE	C-8 IN BLOOD (ppm)	DAYS IN JOB AT SAMPLE DATE	DATE OF SECOND SAMPLE	C-8 IN BLOOD (ppm)	DAYS IN JOB AT SAMPLE DATE	WORKED OTHER TEFLON® JOB(S) BEFORE THIS JOB (YES/NO)	AVG. DAILY RATE OF C-8 DECREASE OR INCREASE (ppm/Day)
	8/29/80	4.000	6,846	10/14/81	4.500	7,257	NO	+ 0.0012
	8/29/80	1.900	8,733	1/27/82	1.800	9,249	NO	- 0.0002
	8/19/80	7.800	7,729	9/25/81	7.500	8,131	YES	- 0.0007
	8/29/80	1.500	7,760	8/13/81	1.200	8,109	NO	- 0.0009
	4/1/81	1.300	5,449	3/31/82	0.950	5,813	YES	- 0.0010
	8/26/80	6.600	7,757	8/7/81	5.300	8,103	NO	- 0.0038
	8/26/80	5.500	9,112	8/5/81	4.200	9,456	NO	- 0.0038
	8/20/81	13.000	7,940	7/17/81	9.600	8,271	YES	- 0.0103
	8/27/81	5.800	9,279	2/2/82	3.100	9,438	NO	- 0.0170

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7/13/82
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PERSONAL AND CONFIDENTIAL

[redacted]

July 29, 1982

TO: R. J. ZIPFEL

FROM: J. G. LOSCHIAVO J.G.L.

RETENTION OF AMMONIUM PERFLUOROOCTANOATE (C-8) IN BLOOD OF TEFLON® EMPLOYEES

Using data from the FLAIR* program and from air sampling records, it is estimated that 40% of inhaled C-8 vapor is retained in the blood (see attachment). This estimate is rough since it is based on only four data points. Also, the rate of C-8 absorption varies by individual. Air C-8 levels are also variable.

Data on males only were used due to potential sex differences in C-8 absorption and elimination as observed in rat studies. Data on Fine Powder/Dispersion employees only were used to eliminate the variable of particle size. In areas where a significant portion of airborne C-8 is contained in polymer particles, blood retention should be less than 40% of inhaled C-8. This reduced blood C-8 retention is due to the airborne particle size distribution. Large particles (i.e., particles > 5 microns in diameter) will not likely reach the lung alveolar region. It is in the alveolar region where inhaled gases and vapors are absorbed into the blood. Probably for this reason, TEFLON® FEP Operators have significantly lower blood C-8 levels than Fine Powder/Dispersion Operators.

According to G. L. Kennedy, Haskell Laboratory Toxicologist, not more than 20% of inhaled C-8 accumulates in body tissues besides blood. Rat studies indicate that 10 to 20% of inhaled C-8 is pooled or accumulated by other body tissues.

*FLAIR - Fluoropolymers Laboratory Analysis Information Retrieval.

0885W-1

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The remaining 40% of inhaled C-8 has 3 potential fates:

- It is exhaled back out.
- It is inhaled but not absorbed into the body.
- It is eliminated by the kidneys or intestines.

The following additional information is needed to determine more accurately the fate of inhaled C-8:

- More blood C-8 data on males who left TEFLON®.
- More blood C-8 data on new male TEFLON® employees.
- More blood C-8 data on new female TEFLON® employees.
- Data on amount of C-8 excreted over a 24-hour period following exposure.
- Particle-size distribution of airborne polymer particles containing C-8.
- Perform a Haskell Laboratory study using radiolabelled C-8 to determine where and how much C-8 is stored in the body immediately after exposure.
- Data on C-8 content in exhaled air during exposure.

Attachment

JGL/nsw
0885W-2

CALCULATIONS AND DATA

Blood C-8 accumulation rates in four male Fine Powder/Dispersion Operators with less than 550 days of service are as follows:

0.0093 ppm C-8 in blood/workday
0.0080 ppm C-8 in blood/workday
0.0043 ppm C-8 in blood/workday
0.0022 ppm C-8 in blood/workday

$\bar{X}$ = 0.0060

Personal air sample results in moles per billion (mpb) C-8 on these Operators during the same period are:

<0.03, 0.09, 0.12, 0.12, 0.15, 0.24, 0.24, 0.66, 0.69, 0.73, 0.75, and 1.39

$\bar{X}$ = 0.46 mpb or 8.2 ug./m3

Average male has 5,500 gm. of blood in his body and inhales 10 m^3 of air over an 8-hour shift doing light work.(1)

At a C-8 concentration of 0.46 mpb (8.1 ug./m^3), an average male would inhale 81 ug. of C-8 during an 8-hour shift.

If all C-8 inhaled was retained in the blood, an average male would accumulate C-8 in blood at a rate of:

$$\frac{81 \text{ ug. C-8/workday}}{5.5 \times 10^9 \text{ ug. blood}} \times 10^6 = 0.0147 \frac{\text{ppm C-8 in blood}}{\text{workday}}$$

However, the average daily C-8 accumulation rate we observe in new employees is only 0.0060 $\frac{\text{ppm C-8 in blood}}{\text{workday}}$. Therefore, of the total C-8 inhaled, about $\left(\frac{0.0060}{0.0147} \times 100 = 40\%\right)$ 40% is retained in blood.

(1) Radiological Health Handbook, U.S. Department of Health, Education, and Welfare; Revised Edition, January, 1970, (pp. 215 and 216).

JGL/nsw
D885W-3

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WASHINGTON WORKS
TEFLON® DIVISION

(1) Bob Taylor thoughts?

[redacted]

September 28, 1982

TO: R. J. ZIPFEL

FROM: J. G. LOSCHIAVO J.G.L.

AMMONIUM PERFLUOROOCTANOATE (C-8) IN BLOOD OF TEFLON® EMPLOYEES

References: (1) Letter, T. P. Pastoor to J. G. Loschiavo, 8/25/82, this subject, attached.
(2) Letter, J. G. Loschiavo to R. J. Zipfel, 7/29/82, this subject, attached.

The purpose of this letter is to summarize and comment on the two reference letters. I initially estimated that 40% of inhaled C-8 vapor is retained in the blood. The remaining 60% of inhaled vapor has four fates:

- It is immediately exhaled.
- It is inhaled but not absorbed into the body.
- It is eliminated by the kidneys, intestines, and sweat glands.
- It is retained in other body tissues besides blood.

I asked T. P. Pastoor, a Haskell Laboratory Toxicologist, to review my calculations. He used a somewhat different approach but came up with similar results. He estimated the fraction of inhaled C-8 vapor that is retained in the entire body. I, on the other hand, estimated the fraction of inhaled C-8 retained only in the blood.

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1044W-1

It has been estimated from data collected on female employees transferred out of TEFLON®, that it takes about 420 days for the body to eliminate half of accumulated C-8 (t 1/2 = 420 days). Using the formula listed on page two of Pastoor's letter, it is estimated that 47% of inhaled C-8 is retained in the entire body. Since I estimated C-8 retention in blood, which contains a fraction of total body water, it is not surprising that Pastoor's estimation is somewhat higher. Most importantly, both approaches indicate that much less than 100% of inhaled C-8 vapor is retained in the blood. Pastoor estimated that only about one-half of inhaled C-8 vapor is retained in the entire body. This is indeed encouraging. These estimations are rough since they are based on data from only four employees. Pastoor recommends that more human blood C-8 data be collected in order for more accurate estimations to be made. A greater effort is now being made to gather such data.

Attachments

JGL/nsw
1044W-2

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AR226-3441

[redacted]

August 11, 1983

PERSONAL AND CONFIDENTIAL

TO: T. M. KEMP

FROM: J. G. LOSCHIAVO J.G.L.

UPDATE ON THE C-8 BLOOD SAMPLING PROGRAM

An overall drop in blood C-8 levels is observed in TEFLON® Fine Powder/Dispersion and FEP Operators. This drop in blood C-8 levels is statistically significant. In Table 1, it can be noted that 16 out of 22 Fine Powder/Dispersion Operators experienced a drop in blood C-8 levels. An additional two Operators experienced no change. The four remaining Operators experienced increases.

In Table 2, it can be noted that 14 out of 15 FEP Operators experienced a drop in blood C-8 levels. The significant downward trends experienced by both groups of Operators are very encouraging.

Data on individuals who left TEFLON® indicate that the biological half-life of C-8 in the blood (i.e., the time it takes to reduce blood C-8 level by 50%) is approximately two years.

DISCUSSION

The attached Tables contain blood C-8 data for TEFLON® Fine Powder/Dispersion and FEP Operators. Blood C-8 data were obtained from the FLAIR (Fluoropolymers Laboratory Analysis Information Retrieval) program. All blood samples were analyzed by the C-8 specific method. Data recorded in FLAIR up to 7/14/83 are included in this report. Only data on Operators who have worked in TEFLON® at least 730 days as of the first of the two listed sample dates are included since new Operators will experience increasing blood C-8 levels until an equilibrium level is reached.

83B-2604B-1

Blood C-8 levels for Fine Powder/Dispersion Operators range from 1.1 ppm to 25.0 ppm and average 5.5 ppm (see Table 1). These Operators experienced an overall 13% drop in blood C-8 levels over the past two years. Blood C-8 levels for FEP Operators range from 0.36 ppm to 3.7 ppm and average 1.2 ppm (see Table 2). These Operators experienced an overall 14% drop in blood C-8 levels over the past two years.

A paired-t test was performed on the blood C-8 data to determine if the blood C-8 decrease experienced by most of the Operators is statistically significant. As a result, the decreases were found to be statistically significant at the $p = 0.05$ level. These significant blood C-8 reductions are no doubt due to efforts made by TEFLON® Copolymers and Polymers business teams to reduce C-8 in air levels.

Although many of the Fine Powder/Dispersion Operators are experiencing blood C-8 decreases, there are four Operators whose blood C-8 levels have increased. Interestingly, all four Operators are involved with weighing C-8 in the ingredients hood. Levels of C-8 in air outside this hood have been found to exceed the AEL. Two samples recently collected in this area were analyzed at 0.79 mpb and 0.84 mpb. Housekeeping and work habits in this area are less than adequate. A large amount of powder was observed around the outside of the hood. For this reason, it's recommended that work habits be improved and Safety and Health Rules involving the weighing of C-8 be reviewed with all employees concerned, namely Autoclave Operators and Dispersion Processors. It's also recommended that a liquid C-8 solution be considered as a replacement for the C-8 powder.

Blood C-8 data were obtained on five individuals who left TEFLON® due to transfer or retirement (see Table 3). Data on these individuals indicate that on the average it takes approximately two years to reduce blood C-8 levels by 50%. This is called the biological half-life.

JGL:sdc

Attachments

83B-2604B-2

TABLE 1

TEFLON® FINE POWDER/DISPERSION OPERATORS

C-8 BLOOD SAMPLE RESULTS

DATE OF FIRST SAMPLE	C-8 IN BLOOD (PPM)	DAYS IN JOB AT SAMPLE DATE	DATE OF SECOND SAMPLE	C-8 IN BLOOD (PPM)	DAYS IN JOB AT SAMPLE DATE
1/14/82	26.0	9,358	1/12/83	20.0	9,721
2/18/82	24.0	2,332	2/17/83	25.0	2,696
10/8/81	11.0	9,260	11/3/82	8.2	9,651
8/7/81	9.4	2,379	8/6/82	7.9	2,743
10/1/81	8.2	5,813	9/29/82	6.5	6,176
2/11/82	7.0	1,989	2/10/83	7.7	2,353
8/12/81	6.9	1,743	7/15/82	5.9	2,080
4/2/82	5.6	8,311	3/2/83	4.2	8,645
1/7/82	4.4	5,765	1/7/83	4.9	6,130
4/6/81	4.3	857	5/12/82	5.6	1,258
3/11/82	3.9	800	3/10/83	3.6	1,164
12/30/81	3.6	962	12/27/82	2.7	1,324
8/19/81	3.5	871	8/17/82	2.1	1.234
3/26/82	2.9	8,242	3/18/83	2.8	8,599
12/2/81	2.8	2,256	12/2/82	2.8	2,621
3/11/82	2.6	1,621	4/6/83	2.4	2,012
7/16/81	2.5	5,652	6/17/82	1.8	5,988
7/16/81	2.5	1,705	6/30/82	2.5	2,054
4/6/81	2.1	918	1/19/82	1.6	1,206
3/3/82	1.6	5,880	3/22/83	1.5	6,264
2/9/82	1.5	770	2/10/83	1.2	1,136
10/9/81	1.3	1,803	10/6/82	1.1	2,165
	$\bar{X}$ = 6.3 ppm			$\bar{X}$ = 5.5 ppm	

16 out of 22 employees experienced decreased blood C-8 levels.
2 out of 22 employees experienced no change in blood C-8 levels.
4 out of 22 employees experienced increased blood C-8 levels.

Decrease in C-8 in blood levels is statistically significant at $p = 0.05$ level.

83B-2604B-3

TABLE 2

TEFLON® FEP OPERATORS

C-8 BLOOD SAMPLE RESULTS

DATE OF FIRST SAMPLE	C-8 IN BLOOD (PPM)	DAYS IN JOB AT SAMPLE DATE	DATE OF SECOND SAMPLE	C-8 IN BLOOD (PPM)	DAYS IN JOB AT SAMPLE DATE
4/7/81	4.5	1,284	4/22/82	3.7	1,664
2/2/82	3.1	9,438	2/21/83	2.8	9,822
4/15/82	2.1	8,917	4/14/83	1.5	9,281
1/27/82	1.8	9,249	1/26/83	1.1	9,613
12/16/81	1.8	1,977	1/12/83	1.6	2,369
4/7/81	1.7	827	9/15/82	1.4	1,353
4/21/81	1.25	732	10/9/81	1.20	903
3/31/82	0.95	5,813	4/26/83	0.79	6,204
10/28/81	0.86	899	5/16/83	0.75	1,464
10/15/81	0.75	1,807	10/14/82	0.72	2,171
3/17/82	0.52	5,417	3/17/83	0.44	5,782
8/26/81	0.51	891	7/29/82	0.48	1,228
2/25/82	0.42	2,387	5/16/83	0.39	2,832
8/28/81	0.41	861	8/26/82	0.46	1,224
10/28/81	0.38	1,927	10/26/82	0.36	2,290
	$\overline{X}$ = 1.4 ppm			$\overline{X}$ = 1.2 ppm	

14/15 employees experienced decreased blood C-8 levels.

Decrease in C-8 in blood levels is statistically significant at $p = 0.05$ level.

83B-2604B-4

TABLE 3

EMPLOYEES WHO LEFT TEFLON® JOBS

C-8 IN BLOOD WHEN LEFT TEFLON® (PPM)	C-8 IN BLOOD AT A LATER DATE (PPM)	DAYS ELAPSED BETWEEN SAMPLES	REASON FOR LEAVING TEFLON®
19.0	16.0	128	Retired from Company
3.8	2.2	780	Retired from Company
2.1	2.2*	333	Retired from Company
0.57	0.14	730	Transferred to another WW Division
0.14	0.08	759	Transferred to another WW Division

*This 5% increase in C-8 blood levels is likely due to analytical error and will be considered as a 0% drop in blood C-8.

Biological half-life of C-8 in blood based on these 5 data points is 2.1 years.

83B-2604B-5

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Date of Sample	C-8 In Blood (PPM)	Date of Second Sample	C-8 In Blood (PPM)	Date of Third Sample	C-8 In Blood (PPM)	Location Between Samples
4/24/81	0.079	8/18/81	0.090			(B-251) Filaments
4/24/81	0.007	8/21/81	< 0.007			(B-257) Filaments
5/28/81	0.057	2/1/82	0.069			(B-3) Central Lab.
3/7/81	0.062	8/11/81	0.075	8/7/82	0.083	(B-21) Research Lab.

J. B. Loschiavo
10/10/83

Joe,
I could only find four individuals from outside of Teflon with C-8 in blood results. 3 of the four persons show increases over time.

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TEFLON® FINE POWDER/DISPERSION OPERATORS

C-8 BLOOD SAMPLE RESULTS

C-8 in Blood (ppm)			Days Between Samples	% Per Year Change
First Sample	Second Sample	Change		
26.0	20.0	-6.0	363	-23
24.0	25.0	+1.0	364	+4
11.0	8.2	-2.8	391	-24
9.4	7.9	-1.5	364	-16
8.2	6.5	-1.7	363	-21
7.0	7.7	+0.7	364	+10
6.9	5.9	-1.0	337	-16
5.6	4.2	-1.4	334	-27
4.4	4.9	+0.5	365	+13
4.3	5.6	+1.3	401	+27
3.9	3.6	-0.3	364	-8
3.6	2.7	-0.9	362	-25
3.5	2.1	-1.4	363	-40
2.9	2.8	-0.1	357	-3
2.8	2.8	0.0	365	0
2.6	2.4	-0.2	391	-7
2.5	1.8	-0.7	336	-28
2.5	2.5	0.0	349	0
2.1	1.6	-0.5	288	-30
1.6	1.5	-0.1	384	-6
1.5	1.2	-0.3	366	-20
1.3	1.1	-0.2	362	-15

JWR:ldr/10/19/83

TEFLON® FEP OPERATORS

C-8 BLOOD SAMPLE RESULTS

C-8 in Blood (ppm)			Days Between Samples	% Per Year Change
First Sample	Second Sample	Change		
7.5	6.6	-.9	362	-12
4.5	3.7	-.8	380	-17
3.1	2.8	-.3	384	-9
2.1	1.5	-.6	364	-29
1.8	1.1	-.7	364	-39
1.8	1.6	-.2	392	-10
1.6	1.4	-.2	393	-12
1.25	1.20	-.05	171	-9
1.20	1.00	-.2	333	-18
0.95	0.79	-.16	391	-7
0.86	0.75	-.11	565	-8
0.75	0.72	-.03	364	-4
0.52	0.44	-.08	365	-15
0.51	0.48	-.03	337	-6
0.42	0.39	-.03	445	-6
0.41	0.46	+.05	363	+12
0.38	0.36	-.02	363	-5

JWR:ldr/10/19/83

SHORT SERVICE OPERATORS
C-8 BLOOD SAMPLE RESULTS

Fine Powder

Last Sample PPM	Days in Job	PPM Per Year Change
.02	61	+.09
.19	212	+.24
.93	375	+.03
4.00	603	-.18

FEP

.05	95	+.15
.05	124	+.10
.15	135	+.38
.05	165	+.09
.23	492	+.24
.66	266	-.24

JWR:ldr
10/19/83

NEW HIRES - TEFLON®

Date of First Sample	Date Hired	C-8 Blood Level (ppm)	Months on Plant Before First C-8 Blood Test
07/28/81	07/27/81	<0.007	0
10/01/81	08/03/81	0.009	2
10/07/81	04/20/81	0.007	5 1/2
10/13/81	04/20/81	0.015	5 3/4

JWR:ldr
10/19/83

3pp

AR226_3444

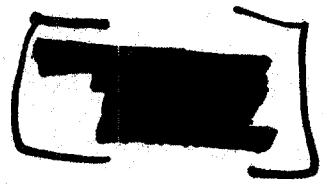
RECYCLED

000415

Z-47 REV 1-67

E. I. DU PONT DE NEMOURS & COMPANY
INCORPORATED
P. O. Box 1217
PARKERSBURG, W. VA. 26101

POLYMER PRODUCTS DEPARTMENT



October 27, 1983

PERSONAL AND CONFIDENTIAL

TO: J. W. RAINES

FROM: J. G. LOSCHIAVO J.G.L.

WASHINGTON WORKS
BLOOD C-8 LEVELS FOR NON-FLUOROPOLYMERS DIVISION EMPLOYEES

As you requested, detailed blood C-8 data on Washington Works employees who have not worked in the Fluoropolymers Division are attached. A summary of this data is as follows:

AVG. LENGTH OF EMPLOYMENT AT WASHINGTON WORKS (MONTHS)	NO. OF PERSONS	AVG. BLOOD C-8 LEVEL (PPM)
8	14	0.027
24	3	0.020
48	1	0.034
92	1	0.022

As you can see, Washington Works employees who have not worked in the Fluoropolymers Division have small amounts of C-8 in their blood. However, it appears that the blood C-8 levels reach an equilibrium level in less than a year.

JGL:sdc
2801B-1

Attachment

There's a world of things we're doing something about

Company Sanitized. Does not contain TSCA CBI

TABLE 1

WASHINGTON WORKS
BLOOD C-8 LEVELS FOR NON-FLUOROPOLYMERS DIVISION EMPLOYEES

EMPLOYEE REFERENCE NO.	DATE HIRED	DATE OF SAMPLING	TIME ON PLANT BEFORE SAMPLING (MONTHS)	BLOOD C-8 LEVEL (PPM)
[redacted]	7/27/81	7/28/81	0	<0.007
	8/3/81	10/1/81	2	0.009
	4/20/81	10/7/81	5-1/2	0.007
	4/20/81	10/13/81	5-3/4	0.015
	2/23/81	10/7/81	7-1/2	0.007
	2/23/81	10/7/81	7-1/2	0.021
	2/23/81	10/7/81	7-1/2	0.061
	2/9/81	10/7/81	8	0.039
	2/23/81	10/21/81	8	0.052
	11/17/80	10/21/81	11	0.008
	11/17/80	10/22/81	11	0.012
	5/12/80	4/27/81	11-1/2	0.020
	5/12/80	4/27/81	12-1/2	0.031
	2/11/80	4/30/81	14-1/2	0.098
	12/3/79	10/13/81	22-1/4	0.013
	10/16/79	10/13/81	24	0.039
	2/26/79	4/29/81	26	0.009
	5/2/77	4/29/81	48	0.034
	1/1/73	8/21/80	92-3/4	0.022

Redacted - Privacy

JGL:sdc
2801B-2

Redacted - Privacy

2pp

AR 226-3445

RECYCLED

AR 226-3445

Update by Loschiavo & Doughty 6/11/84

TABLE 1

TEFLON® FINE POWDER/DISPERSION OPERATORS

C-8 BLOOD SAMPLE RESULTS

DATE OF FIRST SAMPLE	C-8 IN BLOOD (PPM)	DAYS IN JOB AT SAMPLE DATE	DATE OF SECOND SAMPLE	C-8 IN BLOOD (PPM)	DAYS IN JOB AT SAMPLE DATE
1/14/82	26.0	9,358	1/12/83	20.0	9,721 1/10/84 - 19 no further data
2/18/82	24.0	2,332	2/17/83	25.0	2,696 no further data
10/8/81	11.0	9,260	11/3/82	8.2	9,651 11/4/83 - 5.9 10,017
8/7/81	9.4	2,379	8/6/82	7.9	2,743 8/5/83 - 6.0 3,107
10/1/81	8.2	5,813	9/29/82	6.5	6,176 9/29/83 5.4 6541
2/11/82	7.0	1,989	2/10/83	7.7	2,353 2/9/84 - 7.6 no further data
8/12/81	6.8	1,743	7/15/82	5.9	2,080 7/12/83 6.0 2442
4/2/82	5.6	8,311	3/2/83	4.2	8,645 3/28/84 - 4.5 no further data
1/7/82	4.4	5,765	1/7/83	4.9	6,130 1/4/84 4.5 no further data
4/6/81	4.3	857	5/12/82	5.6	1,258 1/18/84 6.5 no further data
3/11/82	3.9	800	3/10/83	3.6	1,164 3/7/84 3.2
12/30/81	3.6	962	12/27/82	2.7	1,324 12/2/83 2.0 1664
8/19/81	3.5	871	8/17/82	2.1	1.234 no further data
3/26/82	2.9	8,242	3/18/83	2.8	8,599 [illegible]
12/2/81	2.8	2,256	12/2/82	2.8	2,621 no further data 2.8 12/9/83
3/11/82	2.6	1,621	4/6/83	2.4	2,012 4/5/84 no further data
7/16/81	2.5	5,652	6/17/82	1.8	5,988 6/15/83 1.6 6351
7/16/81	2.5	1,705	6/30/82	2.5	2,054 no further data
4/6/81	2.1	918	1/19/82	1.6	1,206 no further data
3/3/82	1.6	5,880	3/22/83	1.5	6,264 6/7/83 .95 6,851
2/9/82	1.5	770	2/10/83	1.2	1,136 2/9/84 1.3 no further data
10/9/81	1.3	1,803	10/6/82	1.1	2,165 no further data

$\bar{X}$ = 6.3 ppm 6.2 $\bar{X}$ = 5.5 ppm 4.9 X = 3.85

16 out of 22 employees experienced decreased blood C-8 levels.
2 out of 22 employees experienced no change in blood C-8 levels.
4 out of 22 employees experienced increased blood C-8 levels.

Decrease in C-8 in blood levels is statistically significant at p = 0.05 level.

83B-2604B-3

6pp

AR226-3446

AR226 - 3446

CC: H. V. Bradley
D. G. Wika
W. A. Bower
H. T. Begg
Y. L. Power, M.D.
J. A. Schmid
T. L. Schrenk
J. F. Thomas
R. J. Zipfel

June 14, 1984

PERSONAL & CONFIDENTIAL

TO: T. M. KEMP

FROM: J. G. LOSCHIAVO J.G.L.

UPDATE ON THE C-8 BLOOD SAMPLING PROGRAM

An overall drop continues to be observed in TEFLON® Fine Powder/Dispersion and FEP Operators. In Table 1, it can be noted from the most recent blood sample results (right-hand columns) that 10 out of 14 Fine Powder/Dispersion Operators experienced a drop in blood C-8 levels. The 4 remaining Operators experienced increases. However, 3 of those 4 Operators experienced relatively small increases (< 10%) since their last sample was taken.

In Table 2, it can be noted from the most recent blood sample results (right-hand columns) that 8 out of 10 FEP Operators experienced a drop in blood C-8 levels. An additional Operator experienced no change. The one remaining Operator experienced an increase.

Data on individuals who left TEFLON® (see Table 3) indicate that the average biological half-life of C-8 in the blood (i.e., the time it takes to reduce blood C-8 level by 50%) is approximately 2.4 years and can vary significantly by individual.

Discussion

Tables 1 and 2 contain blood C-8 data for TEFLON® Fine Powder/Dispersion and FEP Operators. Blood C-8 data were obtained from the FLAIR (Fluoropolymers Laboratory Analysis Information Retrieval) program. All blood samples were analyzed by the C-8 specific method. Only data on Operators who have worked in TEFLON® FEP or Fine Powder/Dispersion at least 730 days as of the first of the 3 listed sample dates are included since new Operators will experience increasing blood C-8 levels until an equilibrium level is reached.

Fine Powder/Dispersion Operators experienced an average 24% drop in blood C-8 levels over the past 2 to 3 years. FEP Operators experienced an average 12% drop in blood C-8 levels over the past 2 to 3 years.

Although many of the Fine Powder/Dispersion Operators are experiencing blood C-8 decreases, there are 4 Operators whose blood C-8 levels have increased. However, the increases experienced by 3 of those 4 Operators were relatively small, that is, less than a 10% increase since their last sample result. The increases experienced by the remaining Operator is believed significant, and follow-up with this Operator will be done. This particular Operator works a significant amount of overtime which may be contributing to the higher-than-expected levels. Follow-up with the one FEP Operator experiencing a blood C-8 increase will also be done.

Blood C-8 data were obtained on 11 individuals who left TEFLON® due to transfer, resignation or retirement (see Table 3). Data on these individuals indicate that, on the average, it takes about 2.4 years to reduce blood C-8 levels by 50%.

JGL:mah
Attachments
0681m

TABLE 1

TEFLON® FINE POWDER/DISPERSION OPERATORS

C-8 BLOOD SAMPLE RESULTS

Date of First Sample	C-8 in Blood (ppm)	Days in TEFLON® at Sample Date
1/14/82	26.0	9,358
2/18/82	24.0*	2,332
10/8/81	11.0	9,260
8/7/81	9.4	2,379
10/1/81	8.2	5,813
2/11/82	7.0	1,989
8/12/81	6.9	1,743
4/2/82	5.6	8,311
1/7/82	4.4	5,765
4/6/81	4.3	857
3/11/82	3.9	800
8/19/81	3.5*	871
3/26/82	2.9*	8,242
9/15/81	2.6	9,176
7/16/81	2.5	5,652
7/16/81	2.5*	1,705
3/3/82	1.6	5,880
2/9/82	1.5	770
9/8/82	1.4*	829
10/9/81	1.3*	1,803
$\bar{x}$ = 6.78 ppm		

Date of Second Sample	C-8 in Blood (ppm)	Days in TEFLON® at Sample Date
1/12/83	20.0	9,721
2/17/83	25.0*	2,696
11/3/82	8.2	9,651
8/6/82	7.9	2,743
9/29/82	6.5	6,176
2/10/83	7.7	2,353
7/15/82	5.9	2,080
3/2/83	4.2	8,645
1/7/83	4.9	6,130
5/12/82	5.6	1,258
3/10/83	3.6	1,164
8/17/82	2.1*	1,234
3/18/83	2.8*	8,599
9/14/82	2.3	9,540
6/17/82	1.8	5,988
6/30/82	2.5*	2,054
3/22/83	1.5	6,264
2/10/83	1.2	1,136
10/4/83	1.3*	1,220
10/6/82	1.1*	2,165
$\bar{x}$ = 5.81 ppm		

Date of Third Sample	C-8 in Blood (ppm)	Days in TEFLON® at Sample Date
1/10/84	18.0	10,084
No Further Data		
11/4/83	5.9	10,017
8/5/83	6.0	3,107
9/29/83	5.4	6,541
2/9/84	7.6	2,717
7/12/83	6.0	2,442
2/28/84	4.5	9,008
1/4/84	4.5	6,492
1/18/84	6.5	1,509
3/7/84	3.2	1,526
No Further Data		
No Further Data		
9/1/83	0.96	9,892
6/15/83	1.6	6,351
No Further Data		
6/17/83	0.95	6,351
2/9/84	1.3	1,500
No Further Data		
No Further Data		
$\bar{x}$ = 5.17 ppm		

* These values are not included in the column average in order to directly compare the column averages.

JGL:mah
6/14/84
0679m

0004423

TABLE 2

TEFLON® FEP OPERATORS

C-8 BLOOD SAMPLE RESULTS

Date of First Sample	C-8 in Blood (ppm)	Days in TEFLON® at Sample Date
9/25/81	7.5*	8,131
10/14/81	4.5*	7,257
8/5/81	4.2	9,456
2/2/82	3.1	9,438
4/15/82	2.1*	8,917
11/9/81	1.8	9,139
12/16/81	1.8	1,977
4/1/81	1.3	5,449
4/21/81	1.25	732
8/13/81	1.20	8,109
12/4/81	0.82*	1,145
10/15/81	0.75	1,807
3/17/82	0.52	5,417
8/26/81	0.51	891

$\bar{x}$ = 1.64 ppm

Date of Second Sample	C-8 in Blood (ppm)	Days in TEFLON® at Sample Date
9/23/82	6.3*	8,494
8/18/83	1.3*	7,930
7/29/82	4.2	9,814
2/21/83	2.8	9,822
4/14/83	1.5*	9,281
12/13/82	1.6	9,538
1/12/83	1.6	2,369
3/31/82	0.95	5,813
10/9/81	1.2	903
7/12/82	1.0	8,442
12/1/83	0.75*	1,872
10/14/82	0.72	2,171
3/17/83	0.44	5,782
7/29/82	0.48	1,228

$\bar{x}$ = 1.50 ppm

Date of Third Sample	C-8 in Blood (ppm)	Days in TEFLON® at Sample Date
No Further Data		
No Further Data		
6/30/83	4.2	10,150
3/6/84	2.6	10,200
No Further Data		
11/25/83	1.3	9,881
1/12/84	2.4	2,734
4/26/83	0.79	6,204
12/1/83	1.1	1,686
6/15/83	0.94	8,780
No Further Data		
10/12/83	0.46	2,534
3/15/84	0.35	6,145
8/23/83	0.38	1,618

$\bar{x}$ = 1.45 ppm

* These values are not included in the column average in order to directly compare the column averages.

JGL:mah
6/14/84
0680m

TABLE 3

EMPLOYEES WHO LEFT "TEFLON®" JOBS

C-8 in Blood When Left TEFLON® (ppm)	C-8 in Blood at A Later Date (ppm)	Days Elapsed Between Samples	Reason for Leaving TEFLON®
21.0*	8.4	1,044	Retired from Company
19.0	--16.0	128	Retired from Company
3.8	2.2	780	Retired from Company
2.1	1.7	785	Retired from Company
1.3	0.49	859	Trans. to another WW Div.
0.64	0.47	563	Resigned from Company
0.57	0.14	730	Trans. to another WW Div.
0.22	0.15	315	Retired from Company
0.14	0.08	759	Trans. to another WW Div.
0.11	0.078	780	Trans. to another WW Div.
0.11	0.053	807	Trans. to another WW Div.
x = 4.45 ppm	x = 2.71 ppm	x = 686 days	

$\frac{4.45-2.71}{4.45} \times 100 =$ 39.1% average decrease over 686 days (1.9 yr.)
50.0% average decrease would occur over 877 days (2.4 yr.)

* Sample was collected 4 months before individual left TEFLON®. All other results in this column represent the blood C-8 level at the time individual left TEFLON®.

JGL:mah
6/14/84
0678m

2pp

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AR226-3447

C-8 TREND IN BLOOD

	C-8 IN BLOOD (PPM)					
	1981	1982	1983	1984	1985	1986
FEP PROCESS OPERATOR (17)	1.53	1.48	1.14	1.09	1.09	1.22
FEP SERVICE OPERATOR (18)	0.60	0.59	0.57	0.53	0.53	0.56
RAW DISPERSION PROCESS OPERATOR (18)	7.66	6.67	6.36	6.38	5.96	6.57
GRANULAR PROCESS OPERATOR (7)	3.44	3.12	2.64	2.70	2.38	2.93
FINE POWDER SERVICE OPERATOR (19)	2.25	2.07	1.74	1.59	1.37	1.37
MONOMER OPERATOR (31)	1.01	1.02	0.83	0.82	0.81	--
ALL TEFLON* OPERATORS (490)	0.98	0.92	--	--	--	--

* DuPont's registered trademark for its fluorocarbon resin

003546-5&6 - 06/09/87 - RJZ:kst

2/1

AR226-3448

RECYCLED

AR 226-3448

WW C-8 BLOOD ANALYSES
(NON-FLUOROCARBON EXPOSURE)

NUMBER OF PEOPLE	TIME ON PLANT NOT IN FLUOROCARBON AREAS BEFORE BLOOD ANALYSES	AVERAGE C-8 IN BLOOD (PPM)
14	8 MONTHS	0.027
3	2 YEARS	0.020
1	4 YEARS	0.034
1	7-1/2 YEARS	0.022

003546-16617 - 06/10/87 - RJZ:kst

3pp

AR226-3449

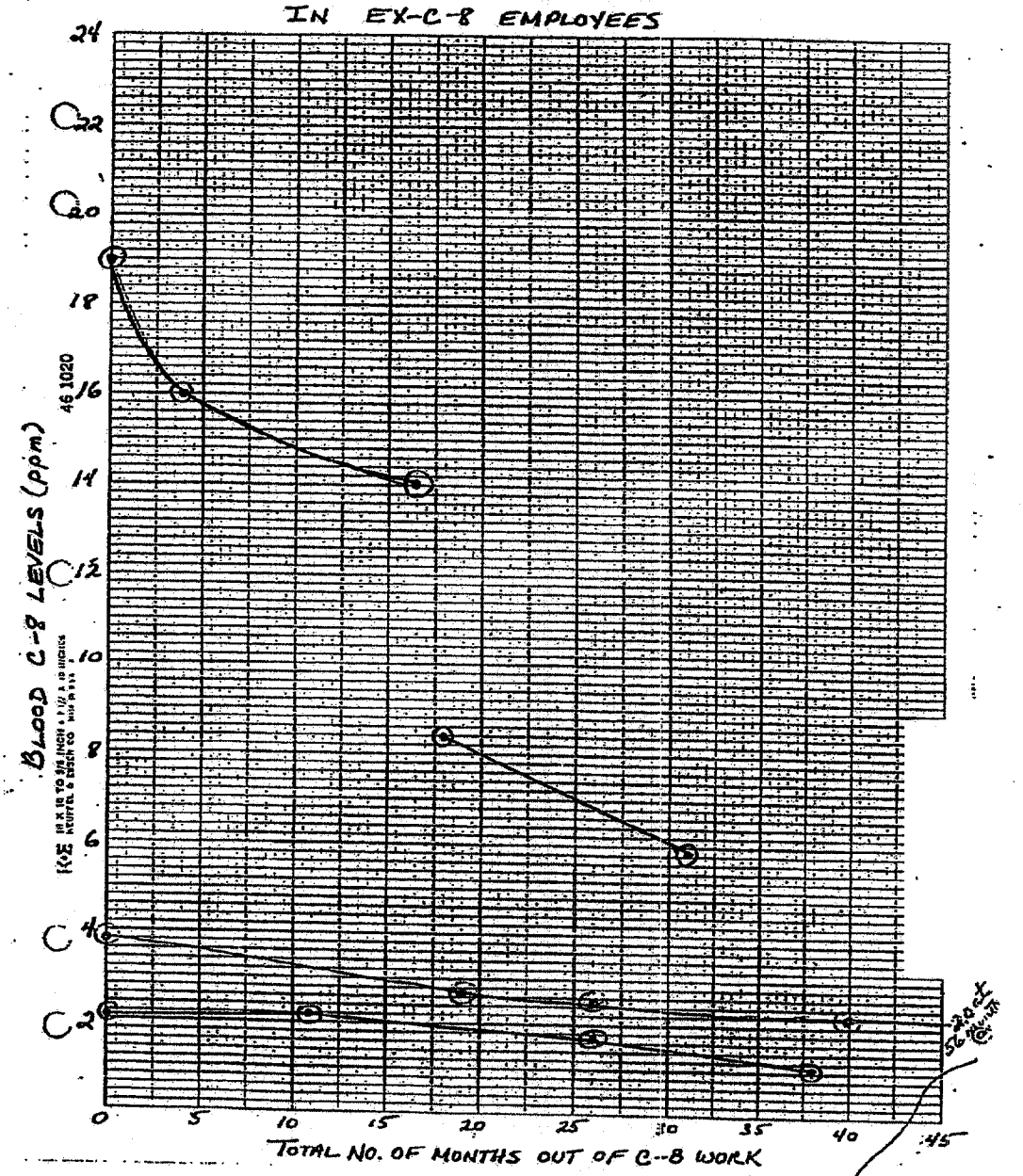
AR 226 - 3449

EX C-8 EMPLOYEES
C-8 DECAY

p.1 of 2

RETIREES

BLOOD C-8 LEVEL CHANGE VS. TIME
IN EX-C-8 EMPLOYEES



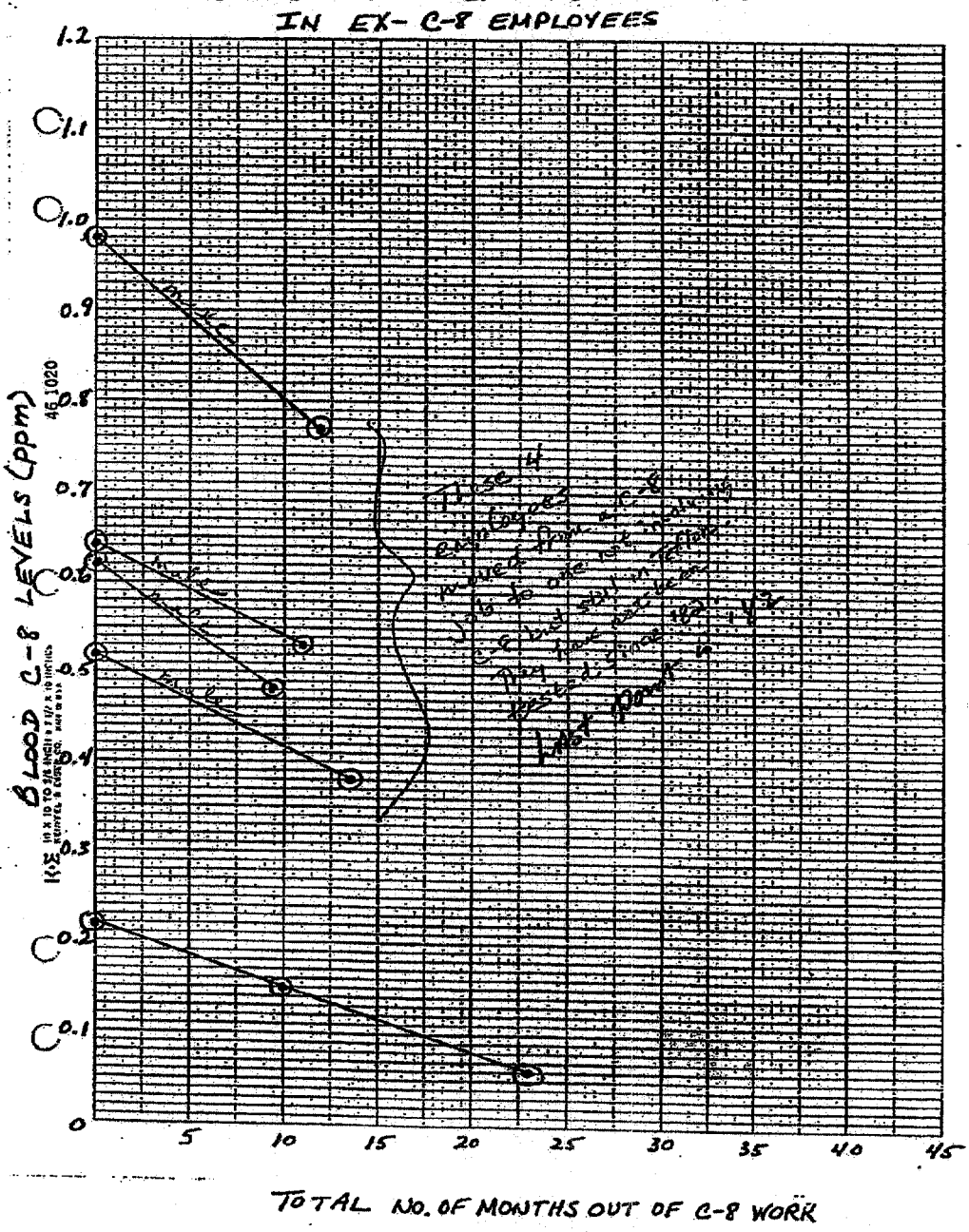
all Males

one more
1.6 ppm
@2481
days
116 mo
9.5 yr

JHL
8/6/87

000431

BLOOD C-8 LEVEL CHANGE VS. TIME
IN EX-C-8 EMPLOYEES



J.M.R.
8/6/87

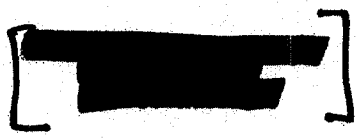
18 ff

AR226_3450

RECYCLED

AR226-3450

Z-47 REV. 6-62



E. I. DU PONT DE NEMOURS & COMPANY
INCORPORATED
P.O. Box 1217
PARKERSBURG, W. VA. 26102

POLYMER PRODUCTS DEPARTMENT

June 14, 1989

CONFIDENTIAL

TO: H. A. SMITH - PPD - D12022 - WILMINGTON
W. E. CRAWLEY - WASHINGTON WORKS

FROM: R. D. LANYON RDL
WASHINGTON WORKS

C-8 BLOOD DATA

Attached is a summary of the data and work histories for those persons tested in 1989. It includes most of the individuals requested by H. A. Smith plus one retiree.

This is a new printout format for the FLAIR report which we feel will be more easily used in looking at individual C-8 blood levels.

At first glance, it appears that several of the individuals tested had increases in C-8 blood levels; however, in general the level is probably somewhat less.

The one retiree is of significant interest inasmuch as he has been retired since 9/30/79. I have attached a plot of his C-8 levels. My estimated rate of decrease is 0.15 ppm per year after an initial high rate of elimination. It would not be expected that this man obtains C-8 from any other situation than his previous work related exposures.

RDL:mah
Attachments
Doc. 2769

1989 Medical Report by Job Status
Exposure Potential

REFERENCE NUMBER	SAMPLE DATE	C-8* PPM	TEFLON STATUS	NUMBER OF DAYS
0840-S TEFLON TFE SERV OPER				
[redacted]				
	11-Apr-1989	00.710	IN	02963
	17-Mar-1988	00.900	IN	02573
	1-Mar-1985	00.330	IN	01461
	4-Nov-1983	00.320	IN	00978
	19-May-1982	00.150	IN	00444
	5-Nov-1981	00.150	OUT	00199
	12-Aug-1981	00.120	OUT	00114
	6-Apr-1981	00.190	IN	00036
0840-S FP/D TEFLON TFE SERV OPER FINE POWDER				
[redacted]				
	20-Mar-1989	01.400	IN	02886
	1-Mar-1986	01.300	IN	01771
	1-Mar-1985	00.880	IN	01406
	16-Aug-1984	00.810	IN	01209
	18-Aug-1982	00.620	IN	00480
	1-Jul-1981	00.200	IN	00067
	27-Apr-1981	00.031	IN	00002
	13-Feb-1980	.000	N/A	00000
[redacted]				
	6-Mar-1989	01.300	IN	10779
	1-Mar-1985	02.600	IN	09313
	24-Apr-1984	02.600	IN	09002
	18-Mar-1983	02.800	IN	08599
	26-Mar-1982	02.900	IN	08242
	28-Aug-1979	02.900	IN	07301
[redacted]				
	6-Mar-1989	00.120	IN	00922
	1-Mar-1987	00.063	IN	00186
[redacted]				
	8-Mar-1989	02.300	IN	08528
	1-Mar-1985	03.400	IN	07060
	29-Sep-1983	05.400	IN	06541
	29-Sep-1982	06.500	IN	06176
	1-Oct-1981	08.200	IN	05813
	28-Aug-1979	05.000	IN	05048
[redacted]				
	17-Mar-1989	00.250	IN	00192
	30-Mar-1984	00.040	OUT	01071
	11-Mar-1982	00.067	OUT	00321
	27-Aug-1981	00.065	OUT	00125
	10-Apr-1981	00.070	IN	00344
	1-Apr-1981	00.078	IN	00335
[redacted]				
	28-Mar-1989	00.980	IN	03374

* - All data beginning in 1981 as PPM C-8.
Previous data was as PPM Organic Fluoride.

Redacted - Privacy

1989 Medical Report by Job Status
Exposure Potential

REFERENCE NUMBER	SAMPLE DATE	C-8* PPM	TEFLON STATUS	NUMBER OF DAYS
	1-Mar-1987	01.300	IN	02616
	1-Mar-1986	00.810	IN	02251
	1-Mar-1985	00.740	IN	01886
	9-Feb-1984	01.300	IN	01500
	10-Feb-1983	01.200	IN	01136
	9-Feb-1982	01.500	IN	00770
	24-Aug-1981	01.500	IN	00601
	6-Apr-1981	01.300	IN	00461
[redacted]				
	6-Mar-1989	00.090	IN	00922
	1-Mar-1987	00.035	IN	00186
[redacted]				
	7-Mar-1989	00.340	IN	00716
[redacted]				
	8-Mar-1989	01.000	IN	02935
	1-Mar-1987	01.000	IN	02197
	1-Mar-1985	00.540	IN	01467
	6-Jul-1984	00.250	IN	01229
	5-Aug-1982	00.400	IN	00528
	6-Aug-1981	00.240	IN	00164
[redacted]				
	23-Mar-1989	00.340	IN	00718
	1-Mar-1986	00.970	IN	01426
	1-Mar-1985	00.540	IN	01061
	11-May-1983	00.210	IN	00401
	28-Sep-1981	00.120	OUT	00161
	3-Apr-1981	00.130	IN	00214
[redacted]				
	21-Mar-1989	00.190	IN	00723
0840-S GRAN	TEFLON TFE SERV OPER GRANULAR			
[redacted]				
	7-Mar-1989	00.130	IN	00716
[redacted]				
	8-Mar-1989	00.080	IN	02874
	1-Mar-1986	00.110	IN	01771
	1-Mar-1985	00.061	IN	01406
	1-Aug-1984	00.065	IN	01194
	2-Sep-1982	00.084	IN	00495
	5-Aug-1981	00.052	IN	00102
[redacted]				
	30-Mar-1989	00.180	IN	06271
	1-Mar-1986	00.080	IN	05146
	1-Mar-1985	00.090	IN	04781
	24-Jan-1984	00.095	IN	04379
	28-Jan-1982	00.110	IN	03653
[redacted]				
	20-Mar-1989	00.270	IN	03196

* - All data beginning in 1981 as PPM C-8.
Previous data was as PPM Organic Fluoride.

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1989 Medical Report by Job Status
Exposure Potential

REFERENCE NUMBER	SAMPLE DATE	C-8* PPM	TEFLON STATUS	NUMBER OF DAYS
	1-Mar-1985	00.270	IN	01716
	12-Sep-1984	00.300	IN	01546
	28-Jul-1982	00.320	IN	00769
	27-Aug-1981	00.340	IN	00434
	27-Apr-1981	00.350	IN	00312
	6-Feb-1980	.000	N/A	00000
0862-S	TEFLON TFE PROC OPER			
[redacted]				
	21-Mar-1989	06.000	IN	05154
	1-Mar-1987	04.100	IN	04403
	1-Mar-1985	02.410	IN	03673
	8-Dec-1983	02.500	IN	03224
	6-Jan-1983	01.400	IN	02888
	6-Jan-1982	00.130	IN	02523
0862-S FP/D	TEFLON TFE PROC OPER FINE POWDER			
[redacted]				
	11-Apr-1989	01.500	IN	08478
	16-Mar-1988	01.700	IN	08087
	1-Mar-1986	01.000	IN	07341
	1-Mar-1985	01.300	IN	06976
	4-Sep-1984	01.500	IN	06798
	15-Jun-1983	01.600	IN	06351
	17-Jun-1982	01.800	IN	05988
	16-Jul-1981	02.500	IN	05652
	22-Aug-1979	01.900	IN	04958
[redacted]				
	23-Mar-1989	01.400	IN	03033
	1-Mar-1987	01.400	IN	02280
	1-Mar-1985	00.760	IN	01550
	29-Feb-1984	01.100	IN	01184
	3-Mar-1983	00.830	IN	00821
	4-Mar-1982	00.670	IN	00457
[redacted]				
	10-Mar-1989	00.910	IN	03204
	1-Mar-1986	02.800	IN	02099
	1-Mar-1985	02.500	IN	01734
	4-Oct-1983	01.300	IN	01220
	8-Sep-1982	01.400	IN	00829
	10-Sep-1981	01.500	IN	00466
	14-Apr-1981	01.100	IN	00317
[redacted]				
	15-Mar-1989	02.800	IN	03019
	1-Mar-1987	02.100	IN	02274
	6-Jun-1984	02.300	IN	01276
	12-May-1982	02.200	IN	00520

* - All data beginning in 1981 as PPM C-8.
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Redacted - Privacy

1989 Medical Report by Job Status
Exposure Potential

REFERENCE NUMBER	SAMPLE DATE	C-8* PPM	TEFLON STATUS	NUMBER OF DAYS
[redacted]				
	7-Mar-1989	04.500	IN	03353
	1-Mar-1987	01.800	IN	02616
	27-Jul-1984	01.500	IN	01669
	22-Aug-1983	01.500	IN	01329
	26-Aug-1981	04.000	IN	00603
	6-Apr-1981	04.300	IN	00461
[redacted]				
	12-Apr-1989	00.670	IN	05184
	22-Mar-1988	00.740	IN	04798
	1-Mar-1986	00.750	IN	04046
	1-Mar-1985	01.200	IN	03681
	31-Jan-1984	01.300	IN	03286
	4-Feb-1982	01.600	IN	02560
	20-Aug-1979	00.220	IN	01661
[redacted]				
	20-Mar-1989	11.100	IN	08394
	1-Mar-1986	10.000	IN	07279
	4-Jan-1984	04.500	IN	06492
	7-Jan-1983	04.900	IN	06130
	7-Jan-1982	04.400	IN	05765
[redacted]				
	9-Mar-1989	05.600	IN	03751
	1-Mar-1987	07.700	IN	03012
	1-Mar-1986	12.000	IN	02647
	1-Mar-1985	08.200	IN	02282
	18-Jan-1984	06.500	IN	01874
	12-May-1982	05.600	IN	01258
	1-Sep-1981	04.400	IN	01005
	6-Apr-1981	04.300	IN	00857
[redacted]				
	11-Apr-1989	05.700	IN	12002
	16-Mar-1988	07.000	IN	11611
	1-Mar-1986	07.000	IN	10865
	1-Mar-1985	11.200	IN	10500
	31-Oct-1984	07.200	IN	10379
	4-Nov-1983	05.900	IN	10017
	3-Nov-1982	08.200	IN	09651
	8-Oct-1981	11.000	IN	09260
	30-Aug-1979	10.600	IN	08490
	15-Jun-1979	10.100	IN	08414
[redacted]				
	6-Mar-1989	06.200	IN	05147
	1-Mar-1985	08.400	IN	03681
	1-Aug-1984	07.400	IN	03469
	5-Aug-1983	06.000	IN	03107
	6-Aug-1982	07.900	IN	02743

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F L A I R
1989 Medical Report by Job Status
Exposure Potential

REFERENCE NUMBER	SAMPLE DATE	C-8* PPM	TEFLON STATUS	NUMBER OF DAYS
	7-Aug-1981	09.400	IN	02379
	27-Aug-1979	08.800	IN	01668
[redacted]				
	31-Mar-1989	00.810	IN	04520
	1-Mar-1987	01.100	IN	03759
	1-Mar-1986	01.000	IN	03394
	1-Mar-1985	01.200	IN	03029
	29-Jun-1984	01.900	IN	02784
	30-Jun-1982	02.500	IN	02054
	16-Jul-1981	02.500	IN	01705
	28-Aug-1979	02.300	IN	01017
[redacted]				
	8-Mar-1989	06.300	IN	04907
	28-Mar-1988	08.000	IN	04562
	1-Mar-1987	11.000	IN	04169
	1-Mar-1986	24.000	IN	03804
	1-Mar-1985	18.000	IN	03439
	15-Feb-1984	24.000	IN	03059
	17-Feb-1983	25.000	IN	02696
	18-Feb-1982	24.000	IN	02332
	6-Jul-1981	32.000	IN	02105
	14-Apr-1981	33.000	IN	02022
	28-Aug-1979	21.600	IN	01427
[redacted]				
	11-Apr-1989	00.720	IN	04544
	17-Mar-1988	00.770	IN	04154
	1-Mar-1986	01.100	IN	03407
	1-Mar-1985	00.500	IN	03042
	2-Oct-1984	00.750	IN	02892
	6-Oct-1982	01.100	IN	02165
	9-Oct-1981	01.300	IN	01803
	22-Aug-1979	00.490	IN	01024
[redacted]				
	22-Mar-1989	02.900	IN	10857
	1-Mar-1987	03.000	IN	10105
	1-[illegible]r-1985	02.500	IN	09375
	28-Feb-1984	04.500	IN	09008
	2-Mar-1983	04.200	IN	08645
	2-Apr-1982	05.600	IN	08311
	21-Aug-1979	07.600	IN	07356
0862-S GRAN	TEFLON TFE PROC OPER GRANULAR			
[redacted]				
	30-Mar-1989	00.360	IN	12204
	18-Oct-1984	00.550	IN	10580
	19-Oct-1983	00.480	IN	10215
	17-Nov-1982	00.650	IN	09879

* - All data beginning in 1981 as PPM C-8.
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1989 Medical Report by Job Status
Exposure Potential

REFERENCE NUMBER	SAMPLE DATE	C-8* PPM	TEFLON STATUS	NUMBER OF DAYS
	19-Nov-1981	00.900	IN	09516
[redacted]				
	30-Mar-1989	00.360	IN	08004
	1-Mar-1986	00.500	IN	06879
	1-Mar-1985	00.750	IN	06514
	3-Nov-1983	01.400	IN	06030
	4-Nov-1982	01.800	IN	05666
	5-Nov-1981	02.200	IN	05302
	22-Aug-1979	02.000	IN	04496
[redacted]				
	12-Apr-1989	02.900	IN	08502
	23-Mar-1988	02.700	IN	08117
	1-Mar-1985	02.600	IN	06999
	9-Oct-1984	02.600	IN	06856
	12-Oct-1983	01.900	IN	06493
	13-Oct-1982	02.800	IN	06129
	15-Oct-1981	03.600	IN	05766
	20-Aug-1979	03.000	IN	04979
[redacted]				
	8-Mar-1989	01.300	IN	05144
	1-Mar-1987	01.800	IN	04406
	1-Mar-1986	02.300	IN	04041
	1-Mar-1985	02.000	IN	03676
	25-Oct-1983	02.300	IN	03183
	26-Oct-1982	02.700	IN	02819
	29-Oct-1981	02.600	IN	02457
	28-Aug-1979	02.800	IN	01664
[redacted]				
	20-Mar-1989	02.700	IN	09806
	1-Mar-1987	03.800	IN	09056
	1-Mar-1986	03.800	IN	08691
	1-Mar-1985	02.700	IN	08326
	1-Mar-1984	04.000	IN	07961
	30-Mar-1983	04.400	IN	07624
	29-Mar-1982	04.600	IN	07258
	21-Aug-1979	05.000	IN	06307
[redacted]				
	30-Mar-1989	05.400	IN	08764
	1-Mar-1987	08.300	IN	08004
	1-Mar-1986	13.000	IN	07639
	1-Mar-1985	09.200	IN	07274
	31-May-1984	08.700	IN	07000
	1-Jul-1982	08.600	IN	06300
	29-Jul-1981	09.100	IN	05963
	28-Aug-1979	08.800	IN	05262

0863-H FP/D TEFLON TFE PROC OPER FINE POWDER (DAYS)

[redacted]				
	8-Mar-1989	00.780	IN	03783

* - All data beginning in 1981 as PPM C-8.
Previous data was as PPM Organic Fluoride.

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1989 Medical Report by Job Status
Exposure Potential

REFERENCE NUMBER	SAMPLE DATE	C-8* PPM	TEFLON STATUS	NUMBER OF DAYS
	1-Mar-1986	00.550	IN	02680
	8-Dec-1981	00.210	IN	01136
1860-S	TEFLON COPOLYMERS POLY FEP OPER			
[redacted]				
	12-Apr-1989	00.720	IN	03677
	1-Mar-1987	00.740	IN	02904
	26-Jul-1984	00.340	IN	01956
	23-Aug-1983	00.380	IN	01618
	29-Jul-1982	00.480	IN	01228
	26-Aug-1981	00.510	IN	00891
1861-H	TEFLON COPOLYMERS POLY FEP OPER (DAYS)			
[redacted]				
	20-Mar-1989	00.420	IN	08065
	1-Mar-1986	00.110	IN	06950
[redacted]				
	20-Mar-1989	00.400	IN	01702
	1-Mar-1986	00.150	IN	00587
	1-Mar-1985	00.062	IN	00222
9990-W	RETIRED WAGEROLL			
[redacted]				
	11-Apr-1989	01.600	OUT	03481
	2-May-1984	02.000	OUT	01676
	18-Jan-1983	02.200	OUT	01206
	18-Nov-1981	02.500	OUT	00780
	27-Apr-1981	02.700	OUT	00575
	27-Aug-1979	03.800	IN	08334

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F L A I R
WORK HISTORY REPORT
OF EMPLOYEES TESTED
FOR YEAR 1989

JOB CODE		DATE IN	TOTAL DAYS
[redacted] FEMALE BORN: [redacted]	HIRED: 12-May-1980		
0840-S FP/D	TEFLON TFE SERV OPER FINE POWDER	15-Nov-1982	2403
0844-S	TEFLON COPOLYMERS FEP SERV OPER	11-Apr-1982	218
0840-S FP/D	TEFLON TFE SERV OPER FINE POWDER	25-Apr-1981	351
0940-S	BUTACITE SERV OPER	1-Nov-1980	175
0600	UTILITY POOL	12-May-1980	173
[redacted] MALE BORN: [redacted]	HIRED: 1-Jun-1959		
0840-S FP/D	TEFLON TFE SERV OPER FINE POWDER	1-Sep-1959	10879
0013	NON-TEFLON WASHINGTON WORKS	1-Jun-1959	92
[redacted] FEMALE BORN: [redacted]	HIRED: 20-Apr-1981		
0840-S FP/D	TEFLON TFE SERV OPER FINE POWDER	27-Aug-1986	1022
0340-S	FILAMENTS SERV OPER	24-Apr-1981	1951
0600	UTILITY POOL	20-Apr-1981	4
[redacted] MALE BORN: [redacted]	HIRED: 4-Nov-1965		
0862-S FP/D	TEFLON TFE PROC OPER FINE POWDER	3-Feb-1974	5610
0840-S FP/D	TEFLON TFE SERV OPER FINE POWDER	26-Mar-1972	679
0840-S GRAN	TEFLON TFE SERV OPER GRANULAR	1-Mar-1972	25
0840-S GRAN	TEFLON TFE SERV OPER GRANULAR	5-Jun-1966	2096
0840-S FP/D	TEFLON TFE SERV OPER FINE POWDER	1-Jun-1966	4
0840-S GRAN	TEFLON TFE SERV OPER GRANULAR	3-Apr-1966	59
0840-S GRAN	TEFLON TFE SERV OPER GRANULAR	24-Jan-1966	69
0600	UTILITY POOL	4-Nov-1965	81
[redacted] MALE BORN: [redacted]	HIRED: 1-Sep-1965		
0840-S FP/D	TEFLON TFE SERV OPER FINE POWDER	20-Apr-1981	2977
0866-S	TEFLON COPOLYMERS TEFZEL - TELOMER A OPER	11-Mar-1981	40
0840-S FP/D	TEFLON TFE SERV OPER FINE POWDER	1-Dec-1972	3022
0840-S GRAN	TEFLON TFE SERV OPER GRANULAR	1-Nov-1965	2587
0013	NON-TEFLON WASHINGTON WORKS	1-Sep-1965	61
[redacted] FEMALE BORN: [redacted]	HIRED: 24-Apr-1978		
0840-S FP/D	TEFLON TFE SERV OPER FINE POWDER	6-Sep-1988	281
0940-S	BUTACITE SERV OPER	24-Apr-1981	2692
0840-S	TEFLON TFE SERV OPER	1-May-1980	358
0360-S	FILAMENTS SPINNER OPER	1-Mar-1980	61
0340-S	FILAMENTS SERV OPER	1-May-1978	670
0600	UTILITY POOL	24-Apr-1978	7
[redacted] MALE BORN: [redacted]	HIRED: 26-Feb-1979		
0862-S FP/D	TEFLON TFE PROC OPER FINE POWDER	27-Jul-1987	688
0840-S GRAN	TEFLON TFE SERV OPER GRANULAR	24-Feb-1983	1614
0844-S	TEFLON COPOLYMERS FEP SERV OPER	2-Dec-1980	814
1042-S	DELRIN FINISHING SERV OPER	26-Apr-1979	586
0600	UTILITY POOL	26-Feb-1979	59
[redacted] MALE BORN: [redacted]	HIRED: 25-Sep-1978		
0862-S FP/D	TEFLON TFE PROC OPER FINE POWDER	19-Jan-1984	1973

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F L A I R
WORK HISTORY REPORT
OF EMPLOYEES TESTED
FOR YEAR 1989

JOB CODE		DATE IN	TOTAL DAYS
0840-S FP/D	TEFLON TFE SERV OPER FINE POWDER	1-Jun-1980	1327
0240-S	ZYTEL POLY SERV OPER	1-Jan-1980	152
0340-S	FILAMENTS SERV OPER	1-Oct-1978	457
0600	UTILITY POOL	25-Sep-1978	6

[redacted] MALE BORN: [redacted] HIRED: 12-Oct-1955

0862-S GRAN	TEFLON TFE PROC OPER GRANULAR	31-Dec-1972	6009
0862-S GRAN	TEFLON TFE PROC OPER GRANULAR	7-Dec-1970	755
0862-S	TEFLON TFE PROC OPER	29-Jun-1959	4179
0840-S	TEFLON TFE SERV OPER	28-Apr-1959	62
0840-S	TEFLON TFE SERV OPER	18-Mar-1957	771
0840-S	TEFLON TFE SERV OPER	4-Mar-1957	14
0002-W	MILITARY SERVICE WAGEROLL	15-Nov-1956	109
0840	(Job does not exist in Job-Code File)	17-Sep-1956	59
0840-S	TEFLON TFE SERV OPER	30-Jul-1956	49
0840-S	TEFLON TFE SERV OPER	25-Jul-1956	5
0840-S	TEFLON TFE SERV OPER	25-Jun-1956	30
0840-S	TEFLON TFE SERV OPER	11-Jun-1956	14
0840-S	TEFLON TFE SERV OPER	9-Jan-1956	154
0840-S FP/D	TEFLON TFE SERV OPER FINE POWDER	31-Oct-1955	70
0600	UTILITY POOL	12-Oct-1955	19

[redacted] MALE BORN: [redacted] HIRED: 3-Dec-1979

0862-S FP/D	TEFLON TFE PROC OPER FINE POWDER	28-Jul-1988	321
0840-S FP/D	TEFLON TFE SERV OPER FINE POWDER	16-Nov-1982	2081
0844-S	TEFLON COPOLYMERS FEP SERV OPER	20-Apr-1982	210
0840-S	TEFLON TFE SERV OPER	8-Dec-1980	498
0240-S	ZYTEL POLY SERV OPER	22-Sep-1980	77
0154-S	(Job does not exist in Job-Code File)	9-Jun-1980	105
0600	UTILITY POOL	3-Dec-1979	189

[redacted] MALE BORN: [redacted] HIRED: 11-Sep-1978

1860-S	TEFLON COPOLYMERS POLY FEP OPER	27-Jan-1986	1234
1860-S	TEFLON COPOLYMERS POLY FEP OPER	30-Oct-1985	89
0844-S	TEFLON COPOLYMERS FEP SERV OPER	19-Mar-1979	2417
0240-S	ZYTEL POLY SERV OPER	1-Oct-1978	169
0600	UTILITY POOL	11-Sep-1978	20

[redacted] MALE BORN: [redacted] HIRED: 23-Aug-1966

1861-H	TEFLON COPOLYMERS POLY FEP OPER (DAYS)	4-Nov-1985	1318
1861-H	TEFLON COPOLYMERS POLY FEP OPER (DAYS)	15-Jul-1984	477
0340-S	FILAMENTS SERV OPER	24-Aug-1975	3248
1540-S	C&P COLOR AND SERV OPER	9-Feb-1975	196
0340-S	FILAMENTS SERV OPER	3-Jan-1971	1498
0340-S	FILAMENTS SERV OPER	19-Jan-1970	349
0340-S	FILAMENTS SERV OPER	16-Aug-1968	521
0343-H	FILAMENTS LEVEL FINISHING SERV OPER	26-May-1968	82
0340-S	FILAMENTS SERV OPER	6-Mar-1968	81
0343-H	FILAMENTS LEVEL FINISHING SERV OPER	17-Dec-1967	80

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F L A I R
WORK HISTORY REPORT
OF EMPLOYEES TESTED
FOR YEAR 1989

JOB CODE		DATE IN	TOTAL DAYS
0600	UTILITY POOL	3-Oct-1967	75
0001-W	NO WORK (LAY OFF) WAGEROLL	2-Apr-1967	184
0600	UTILITY POOL	2-Apr-1967	184
0840-S FP/D	TEFLON TFE SERV OPER FINE POWDER	19-Feb-1967	42
0250-S	ZYTEL CASTER BLENDER	12-Dec-1966	69
0343-H	FILAMENTS LEVEL FINISHING SERV OPER	16-Oct-1966	57
0600	UTILITY POOL	23-Aug-1966	54

[redacted] FEMALE BORN: [redacted] HIRED: 26-Feb-1979

0862-S FP/D	TEFLON TFE PROC OPER FINE POWDER	7-Jul-1987	708
0840-S FP/D	TEFLON TFE SERV OPER FINE POWDER	15-Mar-1983	1575
0844-S	TEFLON COPOLYMERS FEP SERV OPER	27-Nov-1982	108
0866-S	TEFLON COPOLYMERS TEFZEL - TELOMER A OPER	19-Apr-1982	222
0844-S	TEFLON COPOLYMERS FEP SERV OPER	4-Jan-1982	105
0866-S	TEFLON COPOLYMERS TEFZEL - TELOMER A OPER	19-Oct-1981	77
0840-S FP/D	TEFLON TFE SERV OPER FINE POWDER	1-Jan-1980	657
0340-S	FILAMENTS SERV OPER	1-Apr-1979	275
0600	UTILITY POOL	26-Feb-1979	34

[redacted] MALE BORN: [redacted] HIRED: 1-Feb-1966

0862-S GRAN	TEFLON TFE PROC OPER GRANULAR	1-Nov-1975	4974
0866-S	TEFLON COPOLYMERS TEFZEL - TELOMER A OPER	1-Jun-1975	153
0862-S	TEFLON TFE PROC OPER	1-May-1975	31
0866-S	TEFLON COPOLYMERS TEFZEL - TELOMER A OPER	1-Jan-1975	120
0862-S	TEFLON TFE PROC OPER	1-Feb-1974	334
0840-S GRAN	TEFLON TFE SERV OPER GRANULAR	1-Dec-1972	427
0844-S	TEFLON COPOLYMERS FEP SERV OPER	1-Aug-1967	1949
0840-S GRAN	TEFLON TFE SERV OPER GRANULAR	1-May-1967	92
0013	NON-TEFLON WASHINGTON WORKS	1-Feb-1966	454

[redacted] MALE BORN: [redacted] HIRED: 1-Nov-1965

0862-S GRAN	TEFLON TFE PROC OPER GRANULAR	1-Feb-1974	5612
0840-S FP/D	TEFLON TFE SERV OPER FINE POWDER	1-Jul-1966	2772
0840-S GRAN	TEFLON TFE SERV OPER GRANULAR	1-Jan-1966	181
0013	NON-TEFLON WASHINGTON WORKS	1-Nov-1965	61

[redacted] MALE BORN: [redacted] HIRED: 1-Jun-1964

0862-S FP/D	TEFLON TFE PROC OPER FINE POWDER	1-Aug-1976	4700
0844-S	TEFLON COPOLYMERS FEP SERV OPER	1-Feb-1975	547
0013	NON-TEFLON WASHINGTON WORKS	1-Jun-1964	3897

[redacted] MALE BORN: [redacted] HIRED: 10-Sep-1965

0862-S	TEFLON TFE PROC OPER	21-Apr-1982	2611
0840-S GRAN	TEFLON TFE SERV OPER GRANULAR	6-Feb-1977	1900
0870-S	TEFLON MONOMER OPER	5-Dec-1976	63
0840-S	TEFLON TFE SERV OPER	15-Aug-1976	112
0844-S	TEFLON COPOLYMERS FEP SERV OPER	27-Apr-1975	476
0840-S	TEFLON TFE SERV OPER	9-Feb-1975	77
0940-S	BUTACITE SERV OPER	21-Jan-1968	2576

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F L A I R
WORK HISTORY REPORT
OF EMPLOYEES TESTED
FOR YEAR 1989

JOB CODE		DATE IN	TOTAL DAYS
0940-S	BUTACITE SERV OPER	3-Oct-1965	840
0600	UTILITY POOL	10-Sep-1965	23

[redacted] FEMALE BORN: [redacted] HIRED: 26-Feb-1979

0840-S FP/D	TEFLON TFE SERV OPER FINE POWDER	1-Jan-1980	3452
0340-S	FILAMENTS SERV OPER	1-Apr-1979	275
0600	UTILITY POOL	26-Feb-1979	34

[redacted] MALE BORN: [redacted] HIRED: 14-Jan-1964

0862-S GRAN	TEFLON TFE PROC OPER GRANULAR	14-Mar-1976	4840
0840-S	TEFLON TFE SERV OPER	6-Feb-1975	402
0144-S	LUCITE SERV OPER	22-Dec-1974	46
0160-S	LUCITE ACRYLIC OPER	9-Sep-1974	104
0140-S	(Job does not exist in Job-Code File)	10-Feb-1974	211
0142-S	(Job does not exist in Job-Code File)	9-Jul-1972	581
0140	(Job does not exist in Job-Code File)	4-Jun-1972	35
0160	(Job does not exist in Job-Code File)	6-Jan-1972	150
0140	(Job does not exist in Job-Code File)	14-Nov-1971	53
0160	(Job does not exist in Job-Code File)	27-Jun-1971	140
0140	(Job does not exist in Job-Code File)	11-Apr-1971	77
0160	(Job does not exist in Job-Code File)	22-Mar-1970	385
0150	(Job does not exist in Job-Code File)	11-Jan-1970	70
0160	(Job does not exist in Job-Code File)	9-Mar-1969	308
0140	(Job does not exist in Job-Code File)	21-Mar-1968	353
0140	(Job does not exist in Job-Code File)	26-Feb-1967	389
0140	(Job does not exist in Job-Code File)	24-Apr-1966	308
0140	(Job does not exist in Job-Code File)	31-May-1964	693
0230	(Job does not exist in Job-Code File)	19-Apr-1964	42
0330	(Job does not exist in Job-Code File)	5-Apr-1964	14
0600	UTILITY POOL	14-Jan-1964	82

[redacted] MALE BORN: [redacted] HIRED: 1-May-1962

0862-S GRAN	TEFLON TFE PROC OPER GRANULAR	1-Sep-1971	6496
0844-S	TEFLON COPOLYMERS FEP SERV OPER	1-Aug-1970	396
0840-S GRAN	TEFLON TFE SERV OPER GRANULAR	1-Jul-1970	31
0862-S	TEFLON TFE PROC OPER	1-Sep-1969	303
0840-S GRAN	TEFLON TFE SERV OPER GRANULAR	1-Jul-1969	62
0862-S	TEFLON TFE PROC OPER	1-Mar-1969	122
0840-S GRAN	TEFLON TFE SERV OPER GRANULAR	15-May-1962	2482
0013	NON-TEFLON WASHINGTON WORKS	1-May-1962	14

[redacted] FEMALE BORN: [redacted] HIRED: 19-Mar-1979

0840-S FP/D	TEFLON TFE SERV OPER FINE POWDER	27-Aug-1986	1022
0340-S	FILAMENTS SERV OPER	22-Apr-1979	2684
0600	UTILITY POOL	19-Mar-1979	34

[redacted] MALE BORN: [redacted] HIRED: 1-Mar-1965

0862-S GRAN	TEFLON TFE PROC OPER GRANULAR	1-Sep-1973	5765
0840-S GRAN	TEFLON TFE SERV OPER GRANULAR	1-Dec-1972	274

Redacted - Privacy

F L A I R
WORK HISTORY REPORT
OF EMPLOYEES TESTED
FOR YEAR 1989

JOB CODE		DATE IN	TOTAL DAYS
0840-S FP/D	TEFLON TFE SERV OPER FINE POWDER	1-Sep-1965	2648
0840-S GRAN	TEFLON TFE SERV OPER GRANULAR	1-Apr-1965	153
0013	NON-TEFLON WASHINGTON WORKS	1-Mar-1965	31

[redacted] MALE BORN: [redacted] HIRED: 11-Nov-1965

0862-S FP/D	TEFLON TFE PROC OPER FINE POWDER	2-Jan-1980	3451
0866-S	TEFLON COPOLYMERS TEFZEL - TELOMER A OPER	18-May-1975	1690
0870-S	TEFLON MONOMER OPER	12-Feb-1975	95
0866-S	TEFLON COPOLYMERS TEFZEL - TELOMER A OPER	19-Jan-1975	24
1845-H	TEFLON COPOLYMERS FEP SERV OPER (DAYS)	24-Sep-1972	847
0840-S	TEFLON TFE SERV OPER	5-Sep-1971	385
1845-H	TEFLON COPOLYMERS FEP SERV OPER (DAYS)	7-Jun-1970	455
0840-S	TEFLON TFE SERV OPER	4-Dec-1966	1281
0840-S GRAN	TEFLON TFE SERV OPER GRANULAR	24-Jul-1966	133
0840-S GRAN	TEFLON TFE SERV OPER GRANULAR	27-Mar-1966	119
0340-S	FILAMENTS SERV OPER	16-Mar-1966	11
0340-S	FILAMENTS SERV OPER	31-Jan-1966	44
0600	UTILITY POOL	11-Nov-1965	81

[redacted] MALE BORN: [redacted] HIRED: 18-Jun-1984

0840-S FP/D	TEFLON TFE SERV OPER FINE POWDER	22-Mar-1987	815
0013	NON-TEFLON WASHINGTON WORKS	18-Jun-1984	1007

[redacted] FEMALE BORN: [redacted] HIRED: 30-Aug-1976

0862-S FP/D	TEFLON TFE PROC OPER FINE POWDER	1-Feb-1980	3421
0866-S	TEFLON COPOLYMERS TEFZEL - TELOMER A OPER	1-Jan-1980	31
0840-S	TEFLON TFE SERV OPER	1-Dec-1978	396
0340-S	FILAMENTS SERV OPER	1-Nov-1976	760
0600	UTILITY POOL	30-Aug-1976	63

[redacted] MALE BORN: [redacted] HIRED: 4-Jun-1956

9990-W	RETIRED WAGEROLL	30-Sep-1979	3545
0840-S FP/D	TEFLON TFE SERV OPER FINE POWDER	1-Nov-1956	8368
0340-S	FILAMENTS SERV OPER	1-Aug-1956	92
0600	UTILITY POOL	4-Jun-1956	58

[redacted] FEMALE BORN: [redacted] HIRED: 23-Feb-1981

0840-S GRAN	TEFLON TFE SERV OPER GRANULAR	22-Mar-1987	815
0013	NON-TEFLON WASHINGTON WORKS	23-Feb-1981	2218

[redacted] MALE BORN: [redacted] HIRED: 11-Feb-1980

0840-S GRAN	TEFLON TFE SERV OPER GRANULAR	25-Apr-1981	2972
0240-S	ZYTEL POLY SERV OPER	1-Jun-1980	328
0600	UTILITY POOL	11-Feb-1980	111

[redacted] MALE BORN: [redacted] HIRED: 11-Feb-1980

0840-S FP/D	TEFLON TFE SERV OPER FINE POWDER	23-Feb-1981	3033
1042-S	DELRIN FINISHING SERV OPER	8-Dec-1980	77
0940-S	BUTACITE SERV OPER	19-May-1980	203

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F L A I R
WORK HISTORY REPORT
OF EMPLOYEES TESTED
FOR YEAR 1989

JOB CODE		DATE IN	TOTAL DAYS
0600	UTILITY POOL	11-Feb-1980	98

[redacted] MALE BORN: [redacted] HIRED: 27-Jul-1959

0863-H FP/D	TEFLON TFE PROC OPER FINE POWDER (DAYS)	5-Aug-1985	1409
0845-H	TEFLON WAREHOUSE OPER	20-Nov-1978	2450
0840-S	TEFLON TFE SERV OPER	29-Oct-1978	22
0360-S	FILAMENTS SPINNER OPER	17-Aug-1975	1169
0340-S	FILAMENTS SERV OPER	4-May-1975	105
0360-S	FILAMENTS SPINNER OPER	21-Feb-1971	1533
0340-S	FILAMENTS SERV OPER	18-Mar-1964	2531
0003-W	LEAVE OF ABSENCE WAGEROLL	6-Sep-1963	194
0340-S	FILAMENTS SERV OPER	11-Feb-1963	207
0340-S	FILAMENTS SERV OPER	8-Jan-1962	399
0600	UTILITY POOL	15-Dec-1961	24
0001-W	NO WORK (LAY OFF) WAGEROLL	13-Mar-1960	642
0971-H	BUTACITE FLAKE CONTROL OPER (DAYS)	18-Jan-1960	55
0600	UTILITY POOL	27-Jul-1959	175

[redacted] MALE BORN: [redacted] HIRED: 6-Jan-1969

0840-S GRAN	TEFLON TFE SERV OPER GRANULAR	26-Feb-1976	4857
1540-S	C&P COLOR AND SERV OPER	29-Sep-1975	150
0600	UTILITY POOL	11-Aug-1975	49
0001-W	NO WORK (LAY OFF) WAGEROLL	27-Jan-1975	196
0840-S	TEFLON TFE SERV OPER	12-Apr-1973	655
1042-S	DELRIN FINISHING SERV OPER	14-Sep-1972	210
0240-S	ZYTEL POLY SERV OPER	24-Jul-1972	52
0240-S	ZYTEL POLY SERV OPER	16-May-1972	69
0250-S	ZYTEL CASTER BLENDER	23-Mar-1972	54
0340-S	FILAMENTS SERV OPER	29-Jan-1972	54
0840-S	TEFLON TFE SERV OPER	28-Jan-1972	1
1042-S	DELRIN FINISHING SERV OPER	15-Sep-1970	500
1042-S	DELRIN FINISHING SERV OPER	28-Feb-1969	564
0600	UTILITY POOL	6-Jan-1969	53

[redacted] MALE BORN: [redacted] HIRED: 1-Nov-1955

0862-S FP/D	TEFLON TFE PROC OPER FINE POWDER	31-Dec-1972	6009
0862-S FP/D	TEFLON TFE PROC OPER FINE POWDER	1-Apr-1962	3927
0840-S FP/D	TEFLON TFE SERV OPER FINE POWDER	1-Jun-1956	2130
0013	NON-TEFLON WASHINGTON WORKS	1-Nov-1955	213

[redacted] FEMALE BORN: [redacted] HIRED: 3-Dec-1979

0840-S FP/D	TEFLON TFE SERV OPER FINE POWDER	5-Apr-1987	801
0013	NON-TEFLON WASHINGTON WORKS	17-Nov-1986	139
0840-S GRAN	TEFLON TFE SERV OPER GRANULAR	5-Apr-1982	1687
1540-S	C&P COLOR AND SERV OPER	19-Oct-1981	168
1042-S	DELRIN FINISHING SERV OPER	20-Apr-1981	182
0840-S	TEFLON TFE SERV OPER	1-Sep-1980	231
0240-S	ZYTEL POLY SERV OPER	1-Aug-1980	31
1042-S	DELRIN FINISHING SERV OPER	1-Jun-1980	61

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F L A I R
WORK HISTORY REPORT
OF EMPLOYEES TESTED
FOR YEAR 1989

JOB CODE		DATE IN	TOTAL DAYS
0600	UTILITY POOL	3-Dec-1979	181
[redacted] MALE	BORN: [redacted] HIRED: 1-Aug-1965		
0862-S FP/D	TEFLON TFE PROC OPER FINE POWDER	1-Apr-1977	4457
0844-S	TEFLON COPOLYMERS FEP SERV OPER	1-Feb-1975	790
0013	NON-TEFLON WASHINGTON WORKS	1-Aug-1965	3471
[redacted] FEMALE	BORN: [redacted] HIRED: 24-Apr-1978		
0840-S FP/D	TEFLON TFE SERV OPER FINE POWDER	29-Mar-1987	808
0013	NON-TEFLON WASHINGTON WORKS	24-Apr-1978	3261
[redacted] MALE	BORN: [redacted] HIRED: 12-May-1980		
0840-S GRAN	TEFLON TFE SERV OPER GRANULAR	1-Jul-1981	2905
0840-S FP/D	TEFLON TFE SERV OPER FINE POWDER	25-Apr-1981	67
0240-S	ZYTEL POLY SERV OPER	1-Nov-1980	175
0600	UTILITY POOL	2-Sep-1980	60
0840-S FP/D	TEFLON TFE SERV OPER FINE POWDER	19-Jun-1980	75
0600	UTILITY POOL	12-May-1980	38
[redacted] MALE	BORN: [redacted] HIRED: 9-Feb-1966		
1861-H	TEFLON COPOLYMERS POLY FEP OPER (DAYS)	19-Aug-1985	1395
0844-S	TEFLON COPOLYMERS FEP SERV OPER	5-Dec-1984	257
0844-S	TEFLON COPOLYMERS FEP SERV OPER	22-Jul-1984	136
0340-S	FILAMENTS SERV OPER	15-Jan-1984	189
0341-H	FILAMENTS SERV OPER (DAYS)	10-Nov-1982	431
0341-H	FILAMENTS SERV OPER (DAYS)	28-Oct-1982	13
0341-H	FILAMENTS SERV OPER (DAYS)	18-Oct-1979	1106
0341-H	FILAMENTS SERV OPER (DAYS)	7-Sep-1975	1502
0340-S	FILAMENTS SERV OPER	17-Aug-1975	21
1540-S	C&P COLOR AND SERV OPER	27-Jul-1975	21
0940-S	BUTACITE SERV OPER	22-Apr-1975	96
0340-S	FILAMENTS SERV OPER	15-Jul-1973	646
0340-S	FILAMENTS SERV OPER	20-Jan-1970	1272
0340-S	FILAMENTS SERV OPER	10-Nov-1968	436
0340-S	FILAMENTS SERV OPER	27-May-1968	167
0340-S	FILAMENTS SERV OPER	29-Oct-1967	211
0340-S	FILAMENTS SERV OPER	1-Oct-1967	28
0940-S	BUTACITE SERV OPER	20-Mar-1966	560
0600	UTILITY POOL	9-Feb-1966	39
[redacted] MALE	BORN: [redacted] HIRED: 26-Jul-1976		
0862-S FP/D	TEFLON TFE PROC OPER FINE POWDER	29-Jan-1980	3424
0862-S FP/D	TEFLON TFE PROC OPER FINE POWDER	29-Jan-1980	3424
0866-S	TEFLON COPOLYMERS TEFZEL - TELOMER A OPER	2-Jan-1980	27
0840-S	TEFLON TFE SERV OPER	14-Nov-1976	1144
0340-S	FILAMENTS SERV OPER	8-Aug-1976	98
0600	UTILITY POOL	26-Jul-1976	13
[redacted] MALE	BORN: [redacted] HIRED: 1-Sep-1968		
0862-S FP/D	TEFLON TFE PROC OPER FINE POWDER	1-Aug-1978	3970

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F L A I R
WORK HISTORY REPORT
ON EMPLOYEES TESTED
FOR YEAR 1989

JOB CODE		DATE IN	TOTAL DAYS
0866-S	TEFLON COPOLYMERS TEFZEL - TELOMER A OPER	1-Apr-1977	487
0840-S FP/D	TEFLON TFE SERV OPER FINE POWDER	1-Oct-1975	548
0013	NON-TEFLON WASHINGTON WORKS	1-Sep-1968	2586

[redacted] MALE BORN: [redacted] HIRED: 1-Sep-1974

0862-S FP/D	TEFLON TFE PROC OPER FINE POWDER	1-Mar-1979	3758
0840-S GRAN	TEFLON TFE SERV OPER GRANULAR	1-Nov-1976	850
0013	NON-TEFLON WASHINGTON WORKS	1-Sep-1974	792

[redacted] FEMALE BORN: [redacted] HIRED: 3-Dec-1979

0840-S	TEFLON TFE SERV OPER	5-Apr-1982	2627
1540-S	C&P COLOR AND SERV OPER	5-Jan-1982	90
1560-S	C&P COLOR AND PROC OPER	28-Sep-1981	99
1540-S	C&P COLOR AND SERV OPER	20-Apr-1981	161
0840-S	TEFLON TFE SERV OPER	1-Mar-1981	50
1540-S	C&P COLOR AND SERV OPER	1-Jun-1980	273
0600	UTILITY POOL	3-Dec-1979	181

[redacted] MALE BORN: [redacted] HIRED: 1-Nov-1956

0862-S FP/D	TEFLON TFE PROC OPER FINE POWDER	1-May-1965	8810
1860-S	TEFLON COPOLYMERS POLY FEP OPER	1-Apr-1965	30
0840-S FP/D	TEFLON TFE SERV OPER FINE POWDER	1-Jul-1959	2101
0013	NON-TEFLON WASHINGTON WORKS	1-Nov-1956	972

END OF REPORT

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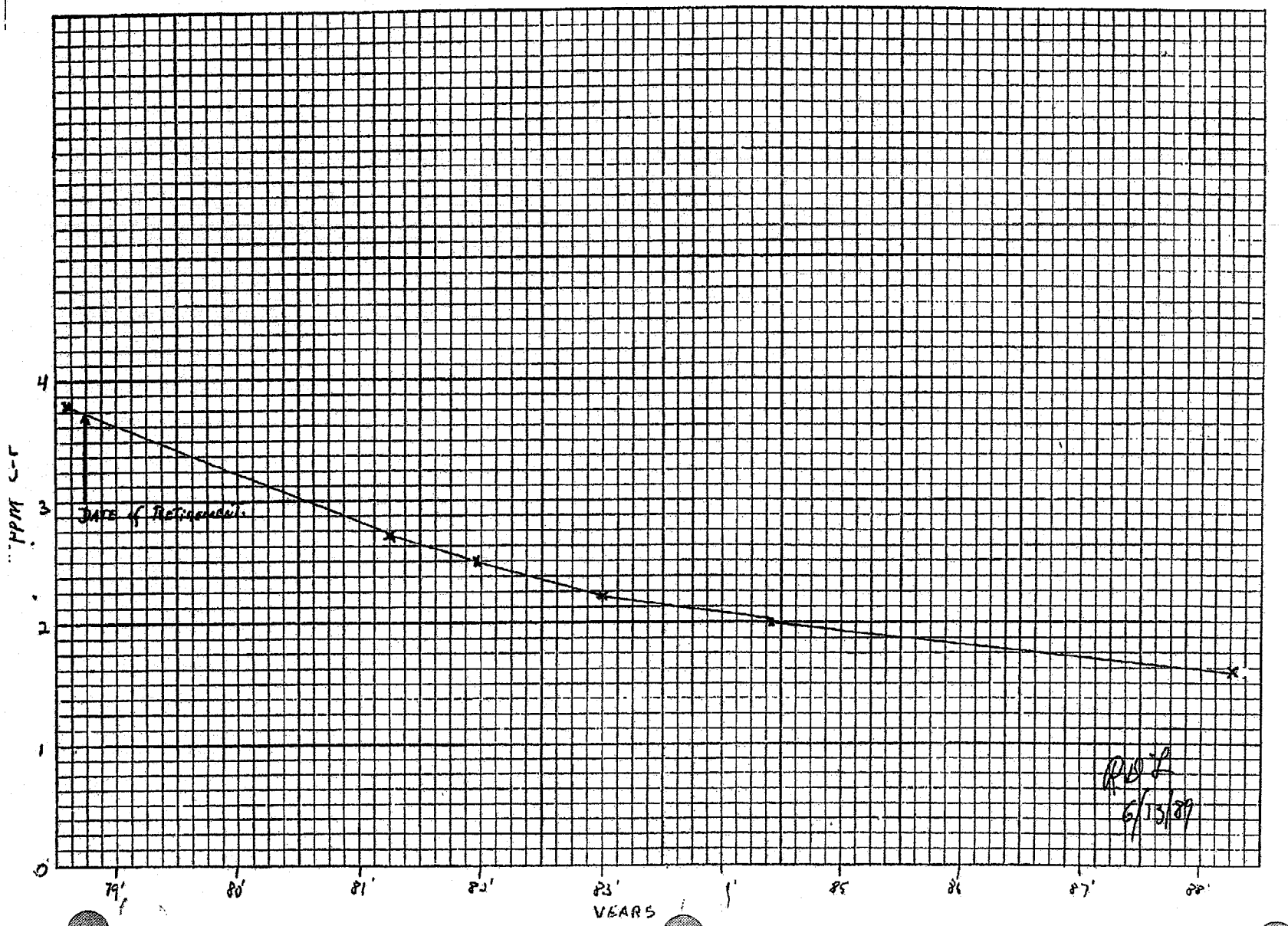
Blood C-8 Depletion in Pensioner



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POLYMER PRODUCTS DEPARTMENT
MANUFACTURING DIVISION

March 19, 1990

TO: J. G. LOSCHIAVO - FIBR - SPRUANCE
R. D. LANYON - PPD - WASHINGTON WORKS
W. E. CRAWLEY - PPD - WASHINGTON WORKS

FROM: H. A. SMITH, Howard Smith

REVIEW OF WASHINGTON WORKS C-8 DATA
PERSONNEL AIR MONITORING AND BLOOD DATA

Following is a summary of our meeting and the conclusions reached. Please get back to me with comments as soon as possible. I've attached the package of backup data used at the meeting.

C-8 personnel air monitoring data taken over the period April 1988 through September 1989 (220+ samples covering 22 jobs) and all personnel C-8 in blood data going back to 1979-80, were summarized and reviewed. When correlating blood data with air monitoring data by PERS jobs, the only people included in the blood data base were those who had been in the indicated job for years; had not moved all over the Fluoropolymers area; and are still in the jobs. The task of interpreting the data is complicated by the fact that the air monitoring data is recent whereas the blood data (because of the very slow drop off rate of C-8 in the blood) essentially reflects exposure dating back to the "early days".

Following are the conclusions from this review:

1) There is a correlation between C-8 personnel air levels and C-8 in blood levels, and between skin contact and C-8 in blood levels. Table 1 summarizes the blood data/air data/skin contact potential by PERS jobs. It is interesting to note that the jobs that have high C-8 in blood populations and that are not in compliance with the AEL, are those jobs that have potential for C-8 skin exposure. Figure 1 is a plot of personnel air levels for a PERS job code vs. blood levels for the same jobe code. Figure 1 also shows the high blood levels that do not fit the curve which we attributed to skin contact on the part of the specific individuals.

2) Figure 1 would indicate that exposure at the AEL of 0.56 ppb would equate to a blood level of ~3 ppm.

3) Background blood levels, for people just working in this area of the plant, are in the 0.1-0.5 ppm range.

4) The effect of skin contact is strong and apparent as demonstrated in Table 1 and Figure 1, especially documented by jobs 08PE, 08PH, 08PF. Skin contact results in blood levels in the 7-8 ppm range or way higher. This position is also supported by 3M and by review of all the other blood plots we have; where some people stand out with very high blood levels.

5) A side observation - people working in a job seem to jump to the blood level for the job and stay there.

6) Drop-off rate for C-8 in the blood is a half life of ~4-5 years or more. This is based on a very small amount of data on pensioners and on the observation that there is a slight perceived decline in workers in the various jobs.

7) Because of the slow drop-off rate, annual blood testing is telling us nothing. We should discontinue blood testing (unless an employee requests it) for now and reconsider taking another "snapshot" in a few years after we have completed our process improvements (e.g. use of C-8 in solution).

   When we elect to do more blood monitoring, we should sample as many workers as possible. We would need the people new to the area as well as the older workers because the older workers would still be on the slow decay C-8 in blood curve. Even at best the data will again be difficult to interpret because of the frequent job-to-job movement of people within the fluoropolymers area and from area to area on the Washington Works site. Other confounding factors that will continue to add to variability are individual work habits and individual biological responses such as excretion rate and retention in body other than in blood (e.g. fat).

8) Eighteen of the 22 PERS jobs were in compliance with the AEL for C-8. Four jobs were out of compliance or marginal. All four jobs involved potential for skin exposure. Use of C-8 in solution should eliminate the problem for three of the four jobs.

HAS/is
Attachment

TABLE 1

ASSESSMENT OF BLOOD VS. AIR DATA

Job	Blood (ppm)	95 %'tile Air (ppb)	Handles C-8 Potential for Skin Exposure	AEL Compliance
08PE Poly Autoclave Operator	(3 (7 (Data showed two populations)	0.66	Yes*	No
08PI Poly Dryer/Environmental Control Operator	2	0.25	No	Yes
18PB FEP Extrusion/Oven Operator	0.5	<0.03 (ND)	No	Yes
08PH Poly Dispersion Operator	(1 (7.5 (one person) (Data showed two populations)	0.08	Yes*	Yes
08PF Poly Polykettle Operator	(2.5 (8.5 (one person) (Data showed two populations)	0.27	Yes*	Marginal
08PG Granular TA Zone 6 Operator	0.4	<0.03 (ND)	No	Yes
08PK Granular TA 3rd Floor Operator	0.1	~.05	No	Yes
18PA FEP Polykettle Operator	No data	5.97	Yes*	No
68ME FEP General Day Mechanic	No data	0.58	Yes	Marginal

* C-8 in solution use should eliminate this problem.

Crawley/Lanyon/Loschiavo/Smith - 11/89

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RECYCLED

REVIEW OF WASHINGTON WORKS C-8 DATA
PERSONNEL AIR MONITORING AND BLOOD

THE REVIEW OF BLOOD DATA VS. CURRENT PERSONNEL AIR MONITORING DATA MUST BE VIEWED AS A TECHNICAL STUDY WHICH DEMONSTRATES THE CORRELATION BETWEEN C-8 IN AIR, C-8 SKIN EXPOSURE, AND BLOOD LEVELS. THE ABSOLUTE LEVELS ARE DIFFICULT TO INTERPRET BECAUSE THE BLOOD LEVELS ARE INFLUENCED BY PEOPLE'S EXPOSURE GOING BACK 10 YEARS (C-8 DROP-OFF RATE IN THE BLOOD IS VERY, VERY SLOW), AND THE PERSONNEL AIR MONITORING RESULTS ARE CURRENT DATA.

C-8 PERSONNEL AIR MONITORING DATA TAKEN OVER THE PERIOD APRIL 1988 THROUGH SEPTEMBER 1989 (220+ SAMPLES COVERING 22 JOBS) AND ALL PERSONNEL C-8 IN BLOOD DATA GOING BACK TO 1979-80, WERE SUMMARIZED AND REVIEWED. WHEN CORRELATING BLOOD DATA WITH AIR MONITORING DATA BY PERS JOBS, THE ONLY PEOPLE INCLUDED IN THE BLOOD DATA BASE WERE THOSE WHO HAD BEEN IN THE INDICATED JOB FOR YEARS; HAD NOT MOVED ALL OVER THE FLUOROPOLYMERS AREA; AND ARE STILL IN THE JOBS. THE TASK OF INTERPRETING THE DATA IS COMPLICATED BY THE FACT THAT THE AIR MONITORING DATA IS RECENT, WHEREAS THE BLOOD DATA (BECAUSE OF THE VERY SLOW DROP-OFF RATE OF C-8 IN THE BLOOD) ESSENTIALLY REFLECTS EXPOSURE DATING BACK TO THE "EARLY DAYS".

CONCLUSIONS

1) THERE IS A CORRELATION BETWEEN C-8 PERSONNEL AIR LEVELS AND C-8 IN BLOOD LEVELS, AND BETWEEN SKIN CONTACT AND C-8 IN BLOOD LEVELS.

   TABLE 1 SUMMARIZES THE BLOOD DATA/AIR DATA/SKIN CONTACT POTENTIAL BY PERS JOBS. THOSE JOBS SHOWING WIDELY DIVERGENT BLOOD LEVEL POPULATIONS ARE THE JOBS THAT HAVE POTENTIAL FOR SKIN EXPOSURE.

2) THE EFFECT OF SKIN CONTACT IS STRONG AND APPARENT AS DEMONSTRATED IN TABLE 1 AND FIGURE 1, ESPECIALLY DOCUMENTED BY JOBS 08PE, 08PH, AND 08PF.

3) SKIN CONTACT RESULTS IN BLOOD LEVELS IN THE 7-8 PPM RANGE OR WAY HIGHER. THIS POSITION IS ALSO SUPPORTED BY 3M AND BY REVIEW OF ALL OTHER BLOOD PLOTS WE HAVE; WHERE SOME PEOPLE STAND OUT WITH VERY HIGH BLOOD LEVELS.

   FIGURE 1 IS A PLOT OF PERSONNEL AIR LEVELS FOR A PERS JOB CODE VS. BLOOD LEVELS FOR THE SAME JOB CODE. FIGURE 1 ALSO SHOWS THE HIGH BLOOD LEVELS THAT DO NOT FIT THE CURVE WHICH ARE ATTRIBUTED TO SKIN CONTACT ON THE PART OF THE SPECIFIC INDIVIDUALS.

HAS/ls
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4) FIGURE 1 WOULD INDICATE THAT EXPOSURE AT THE AEL OF 0.56 PPB WOULD EQUATE TO A BLOOD LEVEL OF ~3 PPM.

5) BACKGROUND BLOOD LEVELS, FOR PEOPLE JUST WORKING IN THIS AREA OF THE PLANT, ARE IN THE 0.1-0.5 PPM RANGE.

6) A SIDE OBSERVATION - PEOPLE WORKING IN A JOB SEEM TO ACHIEVE THE BLOOD LEVEL FOR THE JOB AND STAY THERE UNLESS THERE IS AN INCIDENT (SKIN CONTACT) OR, IN ONE INSTANCE, A PROCESS CHANGE.

7) DROP-OFF RATE FOR C-8 IN THE BLOOD IS A HALF LIFE OF ~4-5 YEARS OR MORE. THIS IS BASED ON A VERY SMALL AMOUNT OF DATA ON PENSIONERS AND ON THE OBSERVATION THAT THERE IS A SLIGHT PERCEIVED DECLINE IN WORKERS IN THE VARIOUS JOBS.

8) BECAUSE OF THE SLOW DROP-OFF RATE, ANNUAL BLOOD TESTING IS TELLING US NOTHING. WE ARE DISCONTINUING BLOOD TESTING (UNLESS AN EMPLOYEE REQUESTS IT) FOR NOW, AND WILL RECONSIDER TAKING ANOTHER "SNAPSHOT" IN A FEW YEARS AFTER WE HAVE COMPLETED OUR PROCESS IMPROVEMENTS (E.G., USE OF C-8 IN SOLUTION).

   WHEN WE ELECT TO DO MORE BLOOD MONITORING, WE SHOULD SAMPLE AS MANY WORKERS AS POSSIBLE. WE WOULD NEED THE PEOPLE NEW TO THE AREA AS WELL AS THE OLDER WORKERS BECAUSE THE OLDER WORKERS WOULD STILL BE ON THE SLOW DECAY C-8 IN BLOOD CURVE. EVEN AT BEST, THE DATA WILL AGAIN BE DIFFICULT TO INTERPRET BECAUSE OF THE FREQUENT JOB-TO-JOB MOVEMENT OF PEOPLE WITHIN THE FLOUORPOLYMERS AREA, AND FROM AREA-TO-AREA ON THE WASHINGTON WORKS SITE. OTHER CONFOUNDING FACTORS THAT WILL CONTINUE TO ADD TO VARIABILITY ARE INDIVIDUAL WORK HABITS AND INDIVIDUAL BIOLOGICAL RESPONSES SUCH AS EXCRETION RATE AND RETENTION IN BODY OTHER THAN IN BLOOD (E.G., FAT).

9) EIGHTEEN OF THE 22 PERS JOBS WERE IN COMPLIANCE WITH THE AEL FOR C-8. FOUR JOBS WERE OUT OF COMPLIANCE OR MARGINAL; ALL FOUR JOBS INVOLVED POTENTIAL FOR SKIN EXPOSURE. USE OF C-8 IN SOLUTION SHOULD ELIMINATE THE PROBLEM FOR THREE OF THE FOUR JOBS.

HAS/IS
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C-8 BLOOD DATA (WASHINGTON WORKS)

STATUS OF EMPLOYEES AS OF:

	≤ 0.5 PPM	≤ 1.0 PPM	≤ 5.0 PPM	≤ 10 PPM	>10 PPM
BASE DATA 1984-1986 (108 PEOPLE)	22% (24)	67% (73)	92% (100)	97% (105)	3% (3)
1987 (31 PEOPLE)	26% (8)	39% (12)	87% (27)	97% (30)	3% (1)
1988 (28 PEOPLE)	43 (12)	61% (17)	93% (26)	100% (28)	0%
1987-1988 COMBINED (58 PEOPLE)	34% (20)	50% (29)	90% (52)	100% (58)	0%
1989 (41 PEOPLE)	34% (14)	59% (23)	83% (34)	98% (40)	2% (1)

- THIS DATA IS ONLY USEFUL TO PROVIDE A GENERAL OVERVIEW (A SNAPSHOT IN TIME).
- NOT USEFUL FOR TRENDS BECAUSE OF PEOPLE MOVEMENT, AND THE COMPOSITION OF PEOPLE TESTED CHANGES EACH YEAR.

H. A. SMITH
MARCH '90
B:44 #4

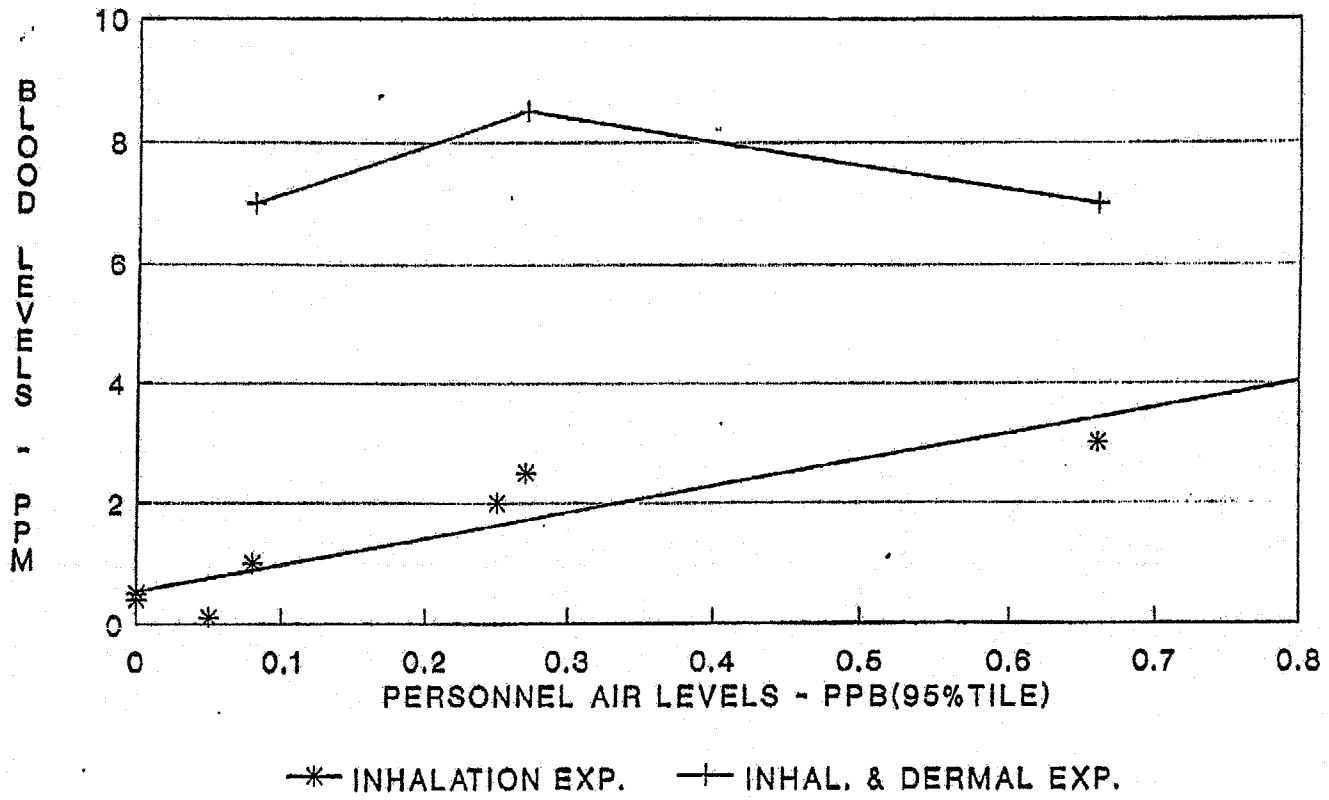
WASHINGTON WORKS

"TEFLON" AREA EMPLOYEE BLOOD LEVELS

PERIOD	POPULATION	<=1PPM (%)	<=5PPM (%)
1984-86	108	67	92
1987-88	58	50	90
1989	41	59	83
1990	21	90	100

WASHINGTON WORKS DATA

BLOOD LEVELS VS. AIR EXPOSURE LEVELS
(BY JOB)



H A Smith
Oct 90

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1990 C-8 INDUSTRIAL HYGIENE DATA REVIEW

(HA Smith, JG Loschiavo, RD Lanyon, WE Crawley)

CONCLUSIONS (Recognizing the data limitations)

There is a correlation between blood and air C-8 levels that is confused by dermal exposure.

Exposure at the AEL of 0.56 mpb would result in a blood level of about 3 ppm.

Background blood level for the Teflon* area is between 0.1 and 0.5 ppm.

Dermal exposure is the cause for higher blood levels.

Half life for C-8 in blood is about 4 to 5 years.

Annual blood testing is not useful and should be replaced by "snapshots" at longer intervals.

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WASHINGTON WORKS

"TEFLON" AREA EMPLOYEE BLOOD LEVELS

PERIOD	POPULATION	<=1PPM (%)	<=5PPM (%)
1984-86	108	67	92
1987-88	58	50	90
1989	41	59	83
1990	21	90	100
1991	3	N/A	N/A

C:SLG
1/2/92

LIVER STUDY OF WASHINGTON WORKS EMPLOYEES

EXPOSED TO C-8, 1/15/81

OBJECTIVE: DETERMINE IF OCCUPATIONAL EXPOSURE TO C-8 ADVERSELY AFFECTS LIVER FUNCTION AS MEASURED BY BLOOD LEVELS OF SGOT, LDH, AP, AND BILIRIBIN.

COHORT: (88) "TEFLON" AREA EMPLOYEES IN ONE OF FIVE JOB ASSIGNMENTS TESTED IN 1979 FOR BLOOD FLUORIDE.

CONTROL: 10% OF ALL WW EMPLOYEES WHO HAD NEVER WORKED "TEFLON".

RESULTS: BLOOD FLUORIDE IN COHORT 16 HIGHEST (TOP 20%) RANGED FROM 5-21 PPM (AVERAGE 10 PPM).

CONCLUSION:

1. NO EVIDENCE OF OCCUPATIONALLY RELATED HEALTH PROBLEMS AMONG WORKERS EXPOSED TO C-8.
2. FEP WORKER AP LEVELS MAY HAVE RISEN FOLLOWING C-8 EXPOSURE.
3. NO SIGNIFICANT CHANGE IN TFE EMPLOYEE SGOT, LDH, AP, OR BILIRIBIN LEVELS FOLLOWING C-8 EXPOSURE.

PROPOSED STUDY UPDATE

[redacted]

REVIEWED WITH KARRH AND LIGO, 10/4, DECIDED NOT TO PURSUE

Company Sanitized. Does not contain TSCA CBI

C:SLG
1/2/92

BIOACCUMULATION IN FISH

BACKGROUND: BIOPERSISTENCE IN MAN, RODENTS

- NO DATA ON TISSUE BUILD-UP, STORAGE SITES IN ANIMALS;
- DISTRIBUTION OF C-8 DIFFERS AMONG SPECIES; WITHIN SPECIES (MALE VS. FEMALE)

WOULD C-8 BE EXPECTED IN BUILD-UP IN FISH?

- OCTANOL-WATER PARTITION COEFFICIENT ESTIMATES PREDICT VERY LITTLE TO ACCUMULATE IN FATTY TISSUES OF ORGANISMS
  - IS THERE A STORAGE SITE IN FISH SIMILAR TO THAT IN MAN (FIND C-8 BOUND TO PLASMA)
  - EXPERIMENT TO ANSWER PROPOSED TO POLYMERS BUSINESS

[redacted]

Company Sanitized. Does not contain TSCA CBI

AR226-3454

AR 226 - 3454

1994 C-8 IN BLOOD RESULTS

NAME	NMS (ppb)	3M (ppb)	CONTROL #
[redacted - Privacy]	460	500	969518
	590	900	245285
	86	400	245272
	230	700	245274
	200	200	969517
	200	400	969524
	500	900	252292
	280	500	245281
	360	500	245277
	89	400	245282
	260	400	245276
	400	900	252291
	280	300	252288
	90	500	969522
	640	1000	245285
	150	400	245271
	140	400	245275
	130		252295
	230	400	245278
	450	800	245295
	170	200	245292
	480	800	252287
	270	200	969525
	800	1000	245264
	410	800	252294
	1200		245297
	470	700	245268
	1400	1500	245280
	330	300	245279
	120	200	245289
	560	500	969526
	330	300	245269
	N.D.	200	245283
	360	800	245287
	310	600	252289
	2700	3400	245291
	290	600	969520
	400	500	245267
	690	1000	245296
	370	800	245293

[Redacted - Privacy]

160	400	969521
160	400	245266
160	100	969519
3200	5500	245270
110	400	969516
340	500	245290
130	400	245273
1100	1700	969523
320	600	245294
490	1000	245286
2600	7100	252293
170	300	245284
410	800	252290

AR226 - 3455

2pp

AR226-3455

INTEROFFICE MEMORANDUM

Date: 17-Jun-1997 02:30pm EDT
From: ANTHONY J. [TONY] PLAYTIS
PLAYTIS
Dept: POLYMERS SHE&EA
Tel No: 304-863-2228

TO: YOUNGER L. POWER, M.D. (POWERYL)

CC: C. June Greenwalt (GREENWCJ)
CC: ROBERT R. MATTSON (MATTSORR)

Subject: 1997 Voluntary C-8 Blood Testing

Twelve people voluntarily had their blood tested for C-8 this year. Eight of them were laboratorians. Results ranged from 0.00 to 0.56 ppm. No trends were noted. The results have been entered into the FLAIR system, and the volunteers have been informed of their individual test results.

I think it's fair to say that this small group of tests does not add significantly to our knowledge nor does it present any cause for alarm or action.

2pp

AR226_3456

60

RECYCLED

000471

RESULTS OF THE 1995 STUDY OF C-8 BLOOD LEVELS

Ammonium perfluorooctanoate, better known as C-8, is a surfactant that is commonly used in the Teflon* BTO. People who have been exposed to C-8 may have low levels of it in their blood, and even after exposure stops, it can take years for the C-8 to be completely eliminated from the body. Although no harmful effects have ever been observed, C-8's persistence in the blood merits careful monitoring. For this reason, we do systematic testing of employees' blood C-8 levels at intervals of about five years. This is not done every year because it has been found that more frequent testing does not yield any additional information.

A round of systematic testing was done last year, when we tested the blood of over 100 people who may have had past or present exposure to C-8. Although we won't be doing such extensive testing again for another few years, we are continuing our practice of offering an annual opportunity for employees to voluntarily have their blood tested for C-8. This year, twenty people had their blood tested.

The testing we did last year revealed several things. Results were grouped by job in order to find any situations where exposures might be high enough to warrant additional control measures. Recognizing that the data did not always allow a clearcut conclusion, here is what was found.

- None of the people tested had a blood level of C-8 higher than 5 ppm, which was not the case in years past.
- Different jobs have different average blood levels for the people in them, with job averages in the range of 0.5 - 3.5 ppm.
- Average job blood levels in 1995 seem somewhat lower than in 1989, but there are a couple of jobs where the average level may have gone up. It is hard to be precise, since often the blood donors were not the same people in both years.
- It is possible for two people to work in the same job for many years and have widely different C-8 blood levels.
- Area mechanics have lower blood levels than do most operators in jobs that involve C-8, with their average around 1 ppm.
- Results from pensioners no longer exposed to C-8 indicate that the time it takes for the C-8 level in blood to go down by half is about four years, although considerable variation is seen from one person to the next.

We are now in the process of reviewing the jobs with higher than average C-8 blood levels to see if we can discover any routes of exposure that can be better controlled. We are also talking to operators with blood levels at the upper or lower end of the range for their job with the hope of learning something that could be helpful to everyone. If you have any ideas on how to reduce C-8 exposure, or if you have any questions or concerns about C-8, please contact Tony Playtis, who will be happy to discuss them with you.

Revised by A. J. Playtis, Plant OH Coordinator, 11/3/97.
Due For Review 11/02.

3pp

AR226-3457

61

RECYCLED

000473

AR226-3457

Anthony J Playtis
08/02/2000 02:43 PM

To: Robbin Banerjee/AE/DuPont@DuPont, Rex M Branstetter/AE/DuPont@DuPont, Becky Szakats Dines/CL/DuPont@DuPont, Dawn D Jackson/CL/DuPont@DuPont, Robin C Leonard/AE/DuPont@DuPont, Jack L Offenberger/AE/DuPont@DuPont, Robert F Pinchot/DEV/AE/DuPont@DuPont, Younger L Power_MD/SE/DuPont@DuPont, H David Ramsey/AE/DuPont@DuPont, Arie J Vermeulen/EUR/DuPont@DuPont, Roger J Zipfel/AE/DuPont@DuPont

cc:

Subject: Preliminary C-8 Blood Results For Washington Works

Attached is a table showing the distribution of this year's results for C-8 blood levels. As expected, the bulk of the 125 people tested had blood levels of less than 3 ppm. However, we had four people with levels in excess of 5 ppm, whereas in 1995 we had none. All four of these people work in the same job, so we have an obvious cluster. The following course of action is being implemented:

1. Jack, Becky and I will be investigating the cluster of high results, which is in job 08PF, the Granular Polykettle Operator.

2. Marty Hamilton is completing the entry of the data and employee work histories into the FLAIR database. We discovered several bugs in FLAIR, so this is taking longer that anticipated.

3. Individual results will be reported to the employees tested.

4. Once the data entry is completed, reports will be generated which will allow a more detailed analysis by job assignment. This will be done here at Washington Works and at Haskell Lab.

5. A communication will be issued to the site employees.

6. Additional industrial hygiene follow-up work will be done as needed.

2000 C-8 Blood Resi

2000 C-8 BLOOD TESTING
DISTRIBUTION OF RESULTS

PPB	NUMBER
0 – 999	87
1000 – 1999	16
2000 – 2999	11
3000 – 3999	3
4000 – 4999	4
5000 – 5999	0
6000 – 6999	2
7000 – 7999	0
8000 – 8999	1
9000 – 9999	1

RECYCLED

AR 226_ 3458

Anthony J Playtis
08/08/2000 12:36 PM

To: Gary W Jepson/AE/DuPont@DuPont
cc: Robin C Leonard/AE/DuPont@DuPont, Robert F Pinchot/DEV/AE/DuPont@DuPont
Subject: Pensioner Blood Data

Gary,

Here are the results for C-8 in blood for all pensioners who were tested in both 1995 and 2000. All of these results are after retirement and any on-job exposure has ceased. It looks like the half-life estimate will still be about four years.

Employee Code #	Sample Date	ppm C-8
[redacted]	3/1/95	1.1
	4/6/00	0.34
[redacted]	3/1/95	4.3
	4/21/00	2.1
[redacted]	3/1/95	2.4
	4/21/00	1.3
[redacted]	3/1/95	0.72
	4/7/00	0.40
[redacted]	6/30/83	8.4
	7/19/84	5.9
	3/1/95	0.94
	4/6/00	0.16
[redacted]	3/1/95	2.2
	4/7/00	0.68

Let me know what else you need.

Tony

Redacted - Privacy

9pp

AR 226 - 3459

63

RECYCLED

000478

AR 226 _ 3459

Washington Works Blood Data Summary

R.F.Pinchot

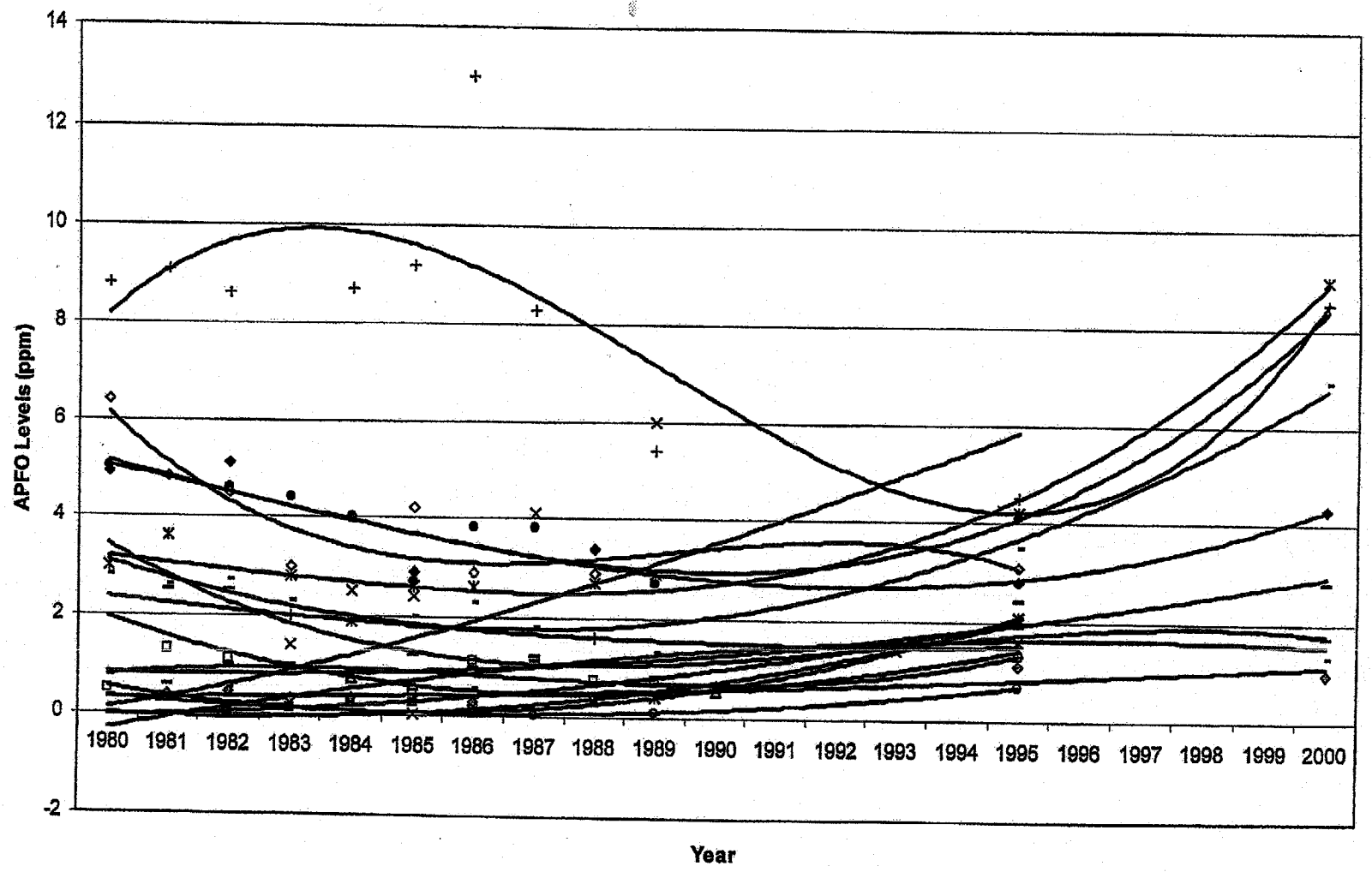
11/17/00

000479

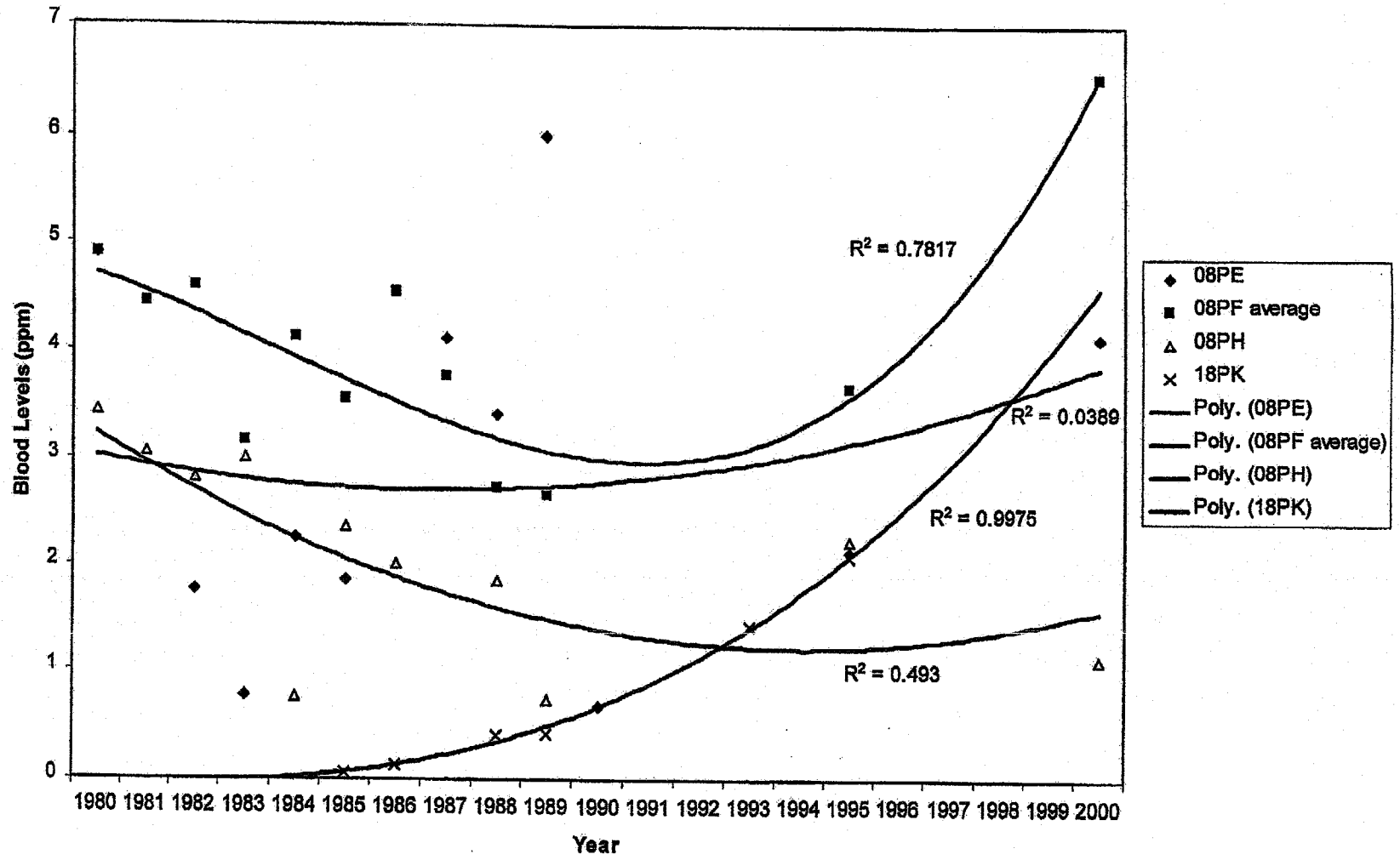
Comparison of 1989 to 2000 by Job Classification (ppm)

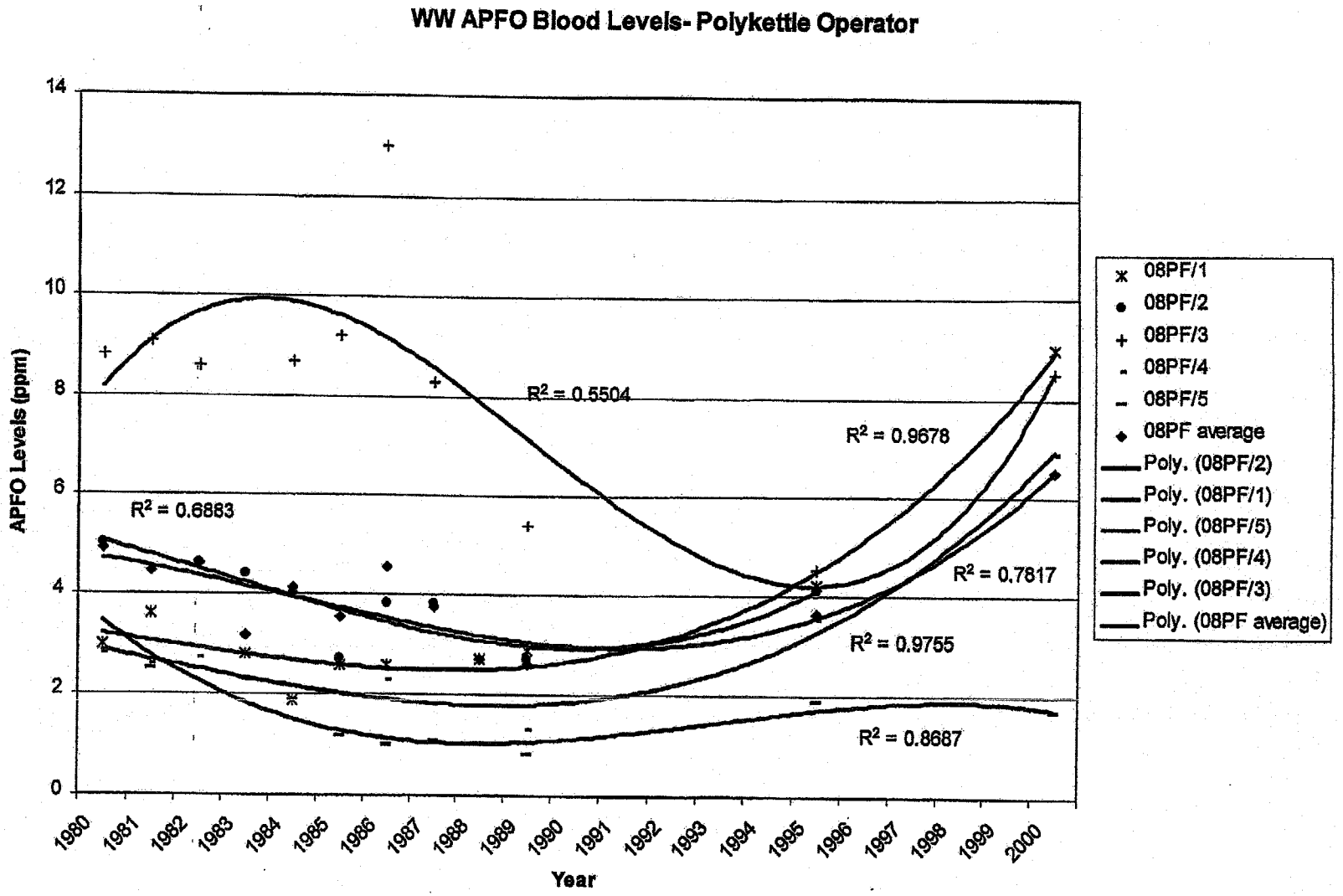
JOB	DESCRIPTION	2000 Average (n)	1995 AVERAGE (n)	1989 AVERAGE (n)
08/18A1	Office/Admin	0.48 (8)		
08AA	FP/D FLS	1.88 (3)		
08PC	Monoomer Operator	0.76 (4)		
08PE	autoclave	**4.1 (4)**	2.5 (6)	4.7 (7)
08PF	polykettle	**6.5 (5)**	2.9 (7)	4.0 (4)
08PH	dispersion	1.1 (2)	2.2 (2)	3.2 (3)
08PI	FP finishing	**3.8 (3)**	2.2 (5)	2.0 (6)
08PJ	FP packout		0.6 (5)	
08PM	C-8 dryer recovery	1.3 (2)	1.7 (2)	
18PA	FEP polykettle	1.6 (4)	2.3 (4)	
18PB	FEP extruder/oven	1.1 (5)	1.6 (5)	0.5 (3)
18PC	FEP wet finishing		3.3 (2)	
18PD	FEP packout		0.1 (3)	
18PF	Tefzel/PFA/3P	0.4 (3)		
18PJ	PFA/FEP bead	1.5 (2)	0.7 (2)	
18PK	FEP safety/disp		2.1 (2)	
RESULTS SUMMARY - MECHANICS				
58MC	FP/disp/gran/TA	1.3 (4)	1.4 (1)	
58MD	general shift		1.1 (8)	
58MG	process ElI		0.8 (7)	
68MA	general shift	0.3 (1)	1.1 (5)	
68MB	FEP E&I		0.9 (7)	

WW APFO Blood Levels- Selected Individuals

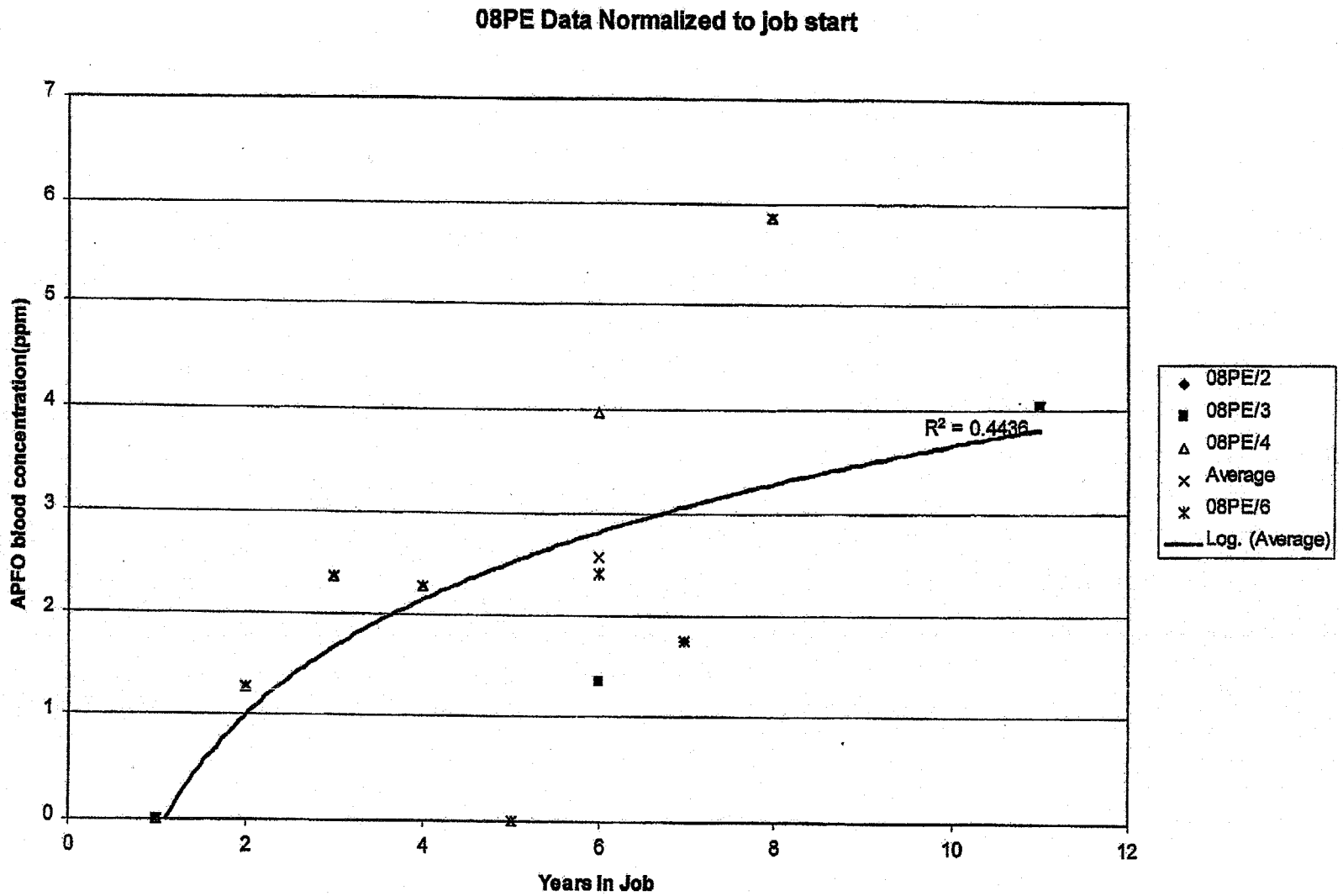


Job Averages




WW APFO Blood Levels- Polykettle Operator
APFO Levels (ppm)
Year
0
2
4
6
8
10
12
14
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
R² = 0.5504
R² = 0.9678
R² = 0.6883
R² = 0.7817
R² = 0.9755
R² = 0.8687
08PF/1
08PF/2
08PF/3
08PF/4
08PF/5
08PF average
Poly. (08PF/2)
Poly. (08PF/1)
Poly. (08PF/5)
Poly. (08PF/4)
Poly. (08PF/3)
Poly. (08PF average)

000483


08PE Data Normalized to job start
APFO blood concentration(ppm)
Years in Job
0
1
2
3
4
5
6
7
0
2
4
6
8
10
12
R² = 0.4436
08PE/2
08PE/3
08PE/4
Average
08PE/6
Log. (Average)

Disclaimer on Observations

"It is very important to recognize the serious limitations on the usefulness of this(sic) data. These include the small size of most of the data sets, the frequent transfer of site employees from one job to another, and the slow rate at which C- 8 blood levels decrease after exposure stops."

In the analysis completed, statistical rigor was not used in all cases due to the small size of the data set.

Observations

- *"Different employees with long tenure in the same job sometimes show marked differences in their blood level... This can be due to either different work habits or differences in individual metabolism."* ***Not so sure that this is the case based on 2000 data.***
- **"Comparison of average job blood levels from the 1995 and 1989 studies is badly confused by the fact that much of the data is not from the same people.** Levels in 1995 seem somewhat lower on the average than in 1989, and this is probably due to reduced skin contact following the use of C- 8 liquid solutions instead of the dry powder."
- The individual data points tend to be trending down from 1980-1990. From 1990-1995, no conclusions can be drawn from the data to determine if the concentrations are going up or staying flat. **In 2000, the general average has dropped (1.16ppm from 1.57ppm) but three job classifications have shown a significant increase.**
- For most individuals and jobs, blood concentrations seem to be stabilizing at 2-4 ppm.
- **Job 08PE, autoclave operator data allows an analysis to be completed normalized for low levels when they started in the job. Though confounded by the different time frames (spanning the time when dry and solution APFO were used), the data seem to point to suggest a steady increase in concentrations up to about 4 ppm.**

Note: items in quotes are taken from AJ Playtis summary, May 7, 1996.

Bold items are observations that are from the 2000 sampling round.

Italics item is an observation from 1995 that may not be valid based on 2000 data.

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AR226-3460

RECYCLED

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 1979

Matrix: PFOA in Whole Blood

Operation: Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	72	0.1	4.99	2.8	28.4	6.24
Males	72	0.1	4.99	2.8	28.4	6.24
Females	0	-	-	-	-	-
Operators	61	0.1	5.74	3.9	28.4	6.48
Males	61	0.1	5.74	3.9	28.4	6.48
Females	0	-	-	-	-	-
Mechanics	5	0.6	0.71	0.65	0.9	0.13
Males	5	0.6	0.71	0.65	0.9	0.13
Females	0	-	-	-	-	-
Laboratorians	2	0.31	0.52	0.52	0.72	0.29
Males	2	0.31	0.52	0.52	0.72	0.29
Females	0	-	-	-	-	-
Supervision	4	0.53	1.14	0.72	2.6	0.99
Males	4	0.53	1.14	0.72	2.6	0.99
Females	0	-	-	-	-	-

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: November 20, 2004

DuPont Company
PFOA in Blood
Washington Works - Teflon - 1979

Operators	Mechanics	Laboratorians	Supervision
Male	Male	Male	Male
0.1	0.6	0.31	0.53
0.22	0.63	0.72	0.55
0.22	0.65		0.88
0.45	0.78		2.6
0.47	0.9		
0.49			
0.5			
0.64			
0.67			
0.67			
0.69			
0.76			
0.9			
0.92			
1.25			
1.3			
1.5			
1.9			
1.9			
2			
2.2			
2.3			
2.5			
2.5			
2.7			
2.8			
2.9			
2.9			
3			
3.8			
3.9			
4.1			
4.5			
4.5			
4.7			
4.9			
5			
5			
5.3			
5.6			
5.9			
6.2			
6.3			
6.4			
6.8			

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon - 1979

Entire Teflon Cohort
0.1
0.22
0.22
0.31
0.45
0.47
0.49
0.5
0.53
0.55
0.6
0.63
0.64
0.65
0.67
0.67
0.69
0.72
0.76
0.78
0.88
0.9
0.9
0.92
1.25
1.3
1.5
1.9
1.9
2
2.2
2.3
2.5
2.5
2.6
2.7
2.8
2.9
2.9
3
3.8
3.9
4.1
4.5
4.5
4.7
4.9
5
5
5.3
5.6
5.9

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon - 1979

	Entire Teflon Cohort
	6.2
	6.3
	6.4
	6.8
	7.18
	7.2
	7.6
	8.5
	8.8
	8.8
	10.1
	10.6
	11.1
	11.5
	16.4
	17.6
	21.6
	24.2
	26.6
	28.4
Count	72
Average	4.99
Standard Deviation	6.24
Median	2.8

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon - 1979

Operators	Mechanics	Laboratorians	Supervision	
Male	Male	Male	Male	
7.18				
7.2				
7.6				
8.5				
8.8				
8.8				
10.1				
10.6				
11.1				
11.5				
16.4				
17.6				
21.6				
24.2				
26.6				
28.4				
61	5	2	4	Count
5.74	0.71	0.52	1.14	Average
6.48	0.13	0.29	0.99	Standard Deviation
3.9	0.65	0.52	0.72	Median

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 1979

Matrix: PFOA in Whole Blood

Operation: Non-Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	8	0.28	0.57	0.58	0.92	0.25
Males	8	0.28	0.57	0.58	0.92	0.25
Females	0	-	-	-	-	-
Operators	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Mechanics	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Laboratorians	8	0.28	0.57	0.58	0.92	0.25
Males	8	0.28	0.57	0.58	0.92	0.25
Females	0	-	-	-	-	-
Supervision	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: November 20, 2004

DuPont Company
PFOA in Blood
Washington Works - Non-Teflon - 1979

	Non-Teflon
	Laboratorian
	Male
	0.28
	0.31
	0.38
	0.56
	0.59
	0.64
	0.9
	0.92
Count	8
Average	0.57
Standard Deviation	0.25
Median	0.58

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 1980

Matrix: PFOA in Whole Blood

Operation: Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	26	0	5.75	3.85	29	7.80
Males	20	0.04	6.93	4.45	29	8.48
Females	6	0	1.82	0.22	5.6	2.58
Operators	20	0	7.43	5.2	29	8.20
Males	16	0.04	8.60	5.95	29	8.73
Females	4	0	2.73	2.66	5.6	2.78
Mechanics	1	0	0	0	0	-
Males	0	-	-	-	-	-
Females	1	0	0	0	0	-
Laboratorians	1	0.24	0.24	0.24	0.24	-
Males	1	0.24	0.24	0.24	0.24	-
Females	0	-	-	-	-	-
Supervision	4	0	0.20	0.21	0.4	0.16
Males	3	0.19	0.27	0.22	0.4	0.11
Females	1	0	0	0	0	-

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: November 20, 2004

DuPont Company
Washington Works
PFOA in Blood - Teflon - 1980

Operators		Mechanics	Laboratorians	Supervision		
Male	Female	Female	Male	Male	Female	
0.04	0	0	0.24	0.19	0	
0.78	0.72			0.22		
1.2	4.6			0.4		
1.5	5.6					
3.7						
4						
4.9						
5.5						
6.4						
6.6						
7.8						
8.2						
13						
21						
24						
29						
16	4	1	1	3	1	Count
8.60	2.73	0	0.24	0.27	0	Average
8.73	2.78			0.11		Standard Deviation
5.95	2.66	0	0.24	0.22	0	Median

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
1980 Summary

	All	All Male	All Female	OperAll	SuperAll
	0	0.04	0	0	0
	0	0.19	0	0.04	0.19
	0	0.22	0	0.72	0.22
	0.04	0.24	0.72	0.78	0.4
	0.19	0.4	4.6	1.2	
	0.22	0.78	5.6	1.5	
	0.24	1.2		3.7	
	0.4	1.5		4	
	0.72	3.7		4.6	
	0.78	4		4.9	
	1.2	4.9		5.5	
	1.5	5.5		5.6	
	3.7	6.4		6.4	
	4	6.6		6.6	
	4.6	7.8		7.8	
	4.9	8.2		8.2	
	5.5	13		13	
	5.6	21		21	
	6.4	24		24	
	6.6	29		29	
	7.8				
	8.2				
	13				
	21				
	24				
	29				
Count	26	20	6	20	4
Average	5.75	6.93	1.82	7.43	0.20
St Dev	7.80	8.48	2.58	8.20	0.16
Median	3.85	4.45	0.205	5.2	0.21

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 1980

Matrix: PFOA in Whole Blood

Operation: Non-Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	2	0.02	0.27	0.27	0.52	0.35
Males	1	0.52	0.52	0.52	0.52	-
Females	1	0.02	0.02	0.02	0.02	-
Operators	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	1	0.02	0.02	0.02	0.02	-
Mechanics	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Laboratorians	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Supervision	0	-	-	-	-	-
Males	1	0.52	0.52	0.52	0.52	-
Females	0	-	-	-	-	-

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: November 20, 2004

DuPont Company
PFOA in Blood
Washington Works - Non-Teflon - 1980

Non-Teflon			
Supervision	**Operator**		**All**
Male	**Female**		0.52
0.52	0.02		0.02
1	1	**Count**	2
0.52	0.02	**Average**	0.27
		Standard Deviation	0.35
0.52	0.02	**Median**	0.27

Prepared from Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 1981

Matrix: PFOA in Whole Blood

Operation: Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	345	0.01	1.16	0.33	33	2.90
Males	297	0.01	1.11	0.32	33	3.05
Females	48	0.03	1.52	0.63	5.1	1.64
Operators	170	0.01	1.95	0.65	33	3.95
Males	136	0.01	1.95	0.62	33	4.34
Females	34	0.03	1.98	1.65	5.1	1.70
Mechanics	60	0.04	0.35	0.21	1.5	0.32
Males	58	0.05	0.36	0.22	1.5	0.32
Females	2	0.04	0.05	0.05	0.05	0.01
Laboratorians	11	0.05	0.19	0.15	0.5	0.13
Males	11	0.05	0.19	0.15	0.5	0.13
Females	0	-	-	-	-	-
Supervision	104	0.01	0.44	0.21	3.4	0.63
Males	92	0.01	0.44	0.21	3.4	0.63
Females	12	0.06	0.44	0.25	2.6	0.70

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: December 2, 2004

DuPont Company
PFOA in Blood
'Washington Works - Teflon - 1981

Operators		Mechanics		Laboratorians	Supervision	
Male	Female	Male	Female	Male	Male	Female
0.01	0.03	0.05	0.04	0.05	0.01	0.06
0.01	0.05	0.06	0.05	0.08	0.03	0.11
0.01	0.11	0.07		0.1	0.03	0.11
0.01	0.13	0.07		0.11	0.03	0.12
0.01	0.19	0.09		0.13	0.03	0.19
0.01	0.19	0.1		0.15	0.03	0.23
0.02	0.2	0.14		0.17	0.04	0.27
0.02	0.27	0.15		0.25	0.05	0.29
0.02	0.59	0.15		0.26	0.05	0.31
0.04	0.59	0.15		0.29	0.05	0.41
0.05	0.62	0.16		0.5	0.06	0.53
0.05	0.64	0.16			0.06	2.6
0.05	0.74	0.17			0.06	
0.05	0.81	0.17			0.07	
0.05	1	0.17			0.07	
0.06	1.3	0.17			0.07	
0.08	1.6	0.17			0.08	
0.08	1.7	0.18			0.08	
0.09	1.7	0.18			0.08	
0.09	2.1	0.19			0.08	
0.1	2.1	0.19			0.08	
0.1	2.4	0.19			0.09	
0.12	2.5	0.19			0.09	
0.12	3.5	0.2			0.1	
0.15	3.5	0.2			0.1	
0.15	3.6	0.21			0.11	
0.15	3.9	0.21			0.11	
0.17	4	0.21			0.12	
0.21	4.3	0.21			0.12	
0.22	4.3	0.22			0.12	
0.24	4.4	0.22			0.12	
0.24	4.5	0.23			0.13	
0.25	4.8	0.24			0.13	
0.26	5.1	0.25			0.14	
0.26		0.26			0.14	
0.27		0.26			0.14	
0.27		0.26			0.14	
0.27		0.32			0.15	
0.3		0.33			0.15	
0.31		0.35			0.16	
0.31		0.43			0.16	
0.32		0.45			0.16	
0.32		0.46			0.18	
0.33		0.52			0.18	
0.33		0.52			0.2	
0.34		0.52			0.2	
0.34		0.58			0.21	
0.34		0.63			0.21	
0.36		0.63			0.21	
0.36		0.75			0.22	

From Washington Works FLAIR Database

Prepared November 21, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
'Washington Works - Teflon - 1981

Operators		Mechanics		Laboratorians	Supervision	
Male	Female	Male	Female	Male	Male	Female
0.38		0.78			0.23	
0.41		0.78			0.25	
0.41		0.79			0.26	
0.42		0.8			0.27	
0.43		0.87			0.27	
0.43		1.2			0.28	
0.43		1.3			0.3	
0.43		1.5			0.3	
0.49					0.33	
0.51					0.33	
0.52					0.33	
0.54					0.34	
0.54					0.36	
0.59					0.39	
0.6					0.4	
0.61					0.4	
0.61					0.42	
0.61					0.44	
0.62					0.45	
0.62					0.46	
0.64					0.48	
0.64					0.49	
0.64					0.5	
0.65					0.51	
0.65					0.55	
0.71					0.65	
0.71					0.81	
0.75					0.91	
0.76					0.95	
0.8					0.98	
0.82					1	
0.86					1.1	
0.88					1.1	
0.9					1.2	
0.92					1.4	
0.93					1.5	
0.98					1.7	
1					2	
1					2.1	
1.1					2.4	
1.1					2.8	
1.2					3.4	
1.2						
1.2						
1.3						
1.3						
1.3						
1.31						
1.4						
1.5						

From Washington Works FLAIR Database

Prepared November 21, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
'Washington Works - Teflon - 1981

Operators		Mechanics		Laboratorians	Supervision		
Male	Female	Male	Female	Male	Male	Female	
1.5							
1.6							
1.7							
1.8							
1.8							
2.1							
2.2							
2.5							
2.5							
2.5							
2.6							
2.6							
2.8							
3							
3.3							
3.6							
3.6							
4.1							
4.2							
4.2							
4.3							
4.5							
4.8							
4.9							
5.3							
5.8							
6.5							
6.9							
7.5							
8.2							
9.1							
9.4							
9.6							
11							
32							
33							
136	34	58	2	11	92	12	**Count**
1.95	1.98	0.36	0.05	0.19	0.44	0.44	**Average**
4.34	1.70	0.32	0.01	0.13	0.63	0.70	**Std Dev**
0.62	1.65	0.22	0.05	0.15	0.21	0.25	**Median**

From Washington Works FLAIR Database

Prepared November 21, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
1981 Summary

All	All Male	All Female	All Operator	All Mechanics	All Supervision
0.01	0.01	0.03	0.01	0.04	0.01
0.01	0.01	0.04	0.01	0.05	0.03
0.01	0.01	0.05	0.01	0.05	0.03
0.01	0.01	0.05	0.01	0.06	0.03
0.01	0.01	0.06	0.01	0.07	0.03
0.01	0.01	0.11	0.01	0.07	0.03
0.01	0.01	0.11	0.02	0.09	0.04
0.02	0.02	0.11	0.02	0.1	0.05
0.02	0.02	0.12	0.02	0.14	0.05
0.02	0.02	0.13	0.03	0.15	0.05
0.03	0.03	0.19	0.04	0.15	0.06
0.03	0.03	0.19	0.05	0.15	0.06
0.03	0.03	0.19	0.05	0.16	0.06
0.03	0.03	0.2	0.05	0.16	0.06
0.03	0.03	0.23	0.05	0.17	0.07
0.03	0.04	0.27	0.05	0.17	0.07
0.04	0.04	0.27	0.05	0.17	0.07
0.04	0.05	0.29	0.06	0.17	0.08
0.04	0.05	0.31	0.08	0.17	0.08
0.05	0.05	0.41	0.08	0.18	0.08
0.05	0.05	0.53	0.09	0.18	0.08
0.05	0.05	0.59	0.09	0.19	0.08
0.05	0.05	0.59	0.1	0.19	0.09
0.05	0.05	0.62	0.1	0.19	0.09
0.05	0.05	0.64	0.11	0.19	0.1
0.05	0.05	0.74	0.12	0.2	0.1
0.05	0.05	0.81	0.12	0.2	0.11
0.05	0.06	1	0.13	0.21	0.11
0.05	0.06	1.3	0.15	0.21	0.11
0.05	0.06	1.6	0.15	0.21	0.11
0.05	0.06	1.7	0.15	0.21	0.12
0.06	0.06	1.7	0.17	0.22	0.12
0.06	0.07	2.1	0.19	0.22	0.12
0.06	0.07	2.1	0.19	0.23	0.12
0.06	0.07	2.4	0.2	0.24	0.12
0.06	0.07	2.5	0.21	0.25	0.13
0.06	0.07	2.6	0.22	0.26	0.13
0.07	0.08	3.5	0.24	0.26	0.14
0.07	0.08	3.5	0.24	0.26	0.14
0.07	0.08	3.6	0.25	0.32	0.14
0.07	0.08	3.9	0.26	0.33	0.14
0.07	0.08	4	0.26	0.35	0.15
0.08	0.08	4.3	0.27	0.43	0.15
0.08	0.08	4.3	0.27	0.45	0.16
0.08	0.08	4.4	0.27	0.46	0.16
0.08	0.09	4.5	0.27	0.52	0.16
0.08	0.09	4.8	0.3	0.52	0.18

From Washington Works FLAIR Database

Prepared November 21, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
1981 Summary

All	All Male	All Female	All Operator	All Mechanics	All Supervision
0.08	0.09	5.1	0.31	0.52	0.18
0.08	0.09		0.31	0.58	0.19
0.08	0.09		0.32	0.63	0.2
0.09	0.1		0.32	0.63	0.2
0.09	0.1		0.33	0.75	0.21
0.09	0.1		0.33	0.78	0.21
0.09	0.1		0.34	0.78	0.21
0.09	0.1		0.34	0.79	0.22
0.1	0.1		0.34	0.8	0.23
0.1	0.11		0.36	0.87	0.23
0.1	0.11		0.36	1.2	0.25
0.1	0.11		0.38	1.3	0.26
0.1	0.12		0.41	1.5	0.27
0.1	0.12		0.41		0.27
0.11	0.12		0.42		0.27
0.11	0.12		0.43		0.28
0.11	0.12		0.43		0.29
0.11	0.12		0.43		0.3
0.11	0.13		0.43		0.3
0.11	0.13		0.49		0.31
0.12	0.13		0.51		0.33
0.12	0.14		0.52		0.33
0.12	0.14		0.54		0.33
0.12	0.14		0.54		0.34
0.12	0.14		0.59		0.36
0.12	0.14		0.59		0.39
0.12	0.15		0.59		0.4
0.13	0.15		0.6		0.4
0.13	0.15		0.61		0.41
0.13	0.15		0.61		0.42
0.13	0.15		0.61		0.44
0.14	0.15		0.62		0.45
0.14	0.15		0.62		0.46
0.14	0.15		0.62		0.48
0.14	0.15		0.64		0.49
0.14	0.16		0.64		0.5
0.15	0.16		0.64		0.51
0.15	0.16		0.64		0.53
0.15	0.16		0.65		0.55
0.15	0.16		0.65		0.65
0.15	0.17		0.71		0.81
0.15	0.17		0.71		0.91
0.15	0.17		0.74		0.95
0.15	0.17		0.75		0.98
0.15	0.17		0.76		1
0.16	0.17		0.8		1.1
0.16	0.17		0.81		1.1

From Washington Works FLAIR Database

Prepared November 21, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
1981 Summary

All	All Male	All Female	All Operator	All Mechanics	All Supervision
0.16	0.18		0.82		1.2
0.16	0.18		0.86		1.4
0.16	0.18		0.88		1.5
0.17	0.18		0.9		1.7
0.17	0.19		0.92		2
0.17	0.19		0.93		2.1
0.17	0.19		0.98		2.4
0.17	0.19		1		2.6
0.17	0.2		1		2.8
0.17	0.2		1		3.4
0.18	0.2		1.1		
0.18	0.2		1.1		
0.18	0.21		1.2		
0.18	0.21		1.2		
0.19	0.21		1.2		
0.19	0.21		1.3		
0.19	0.21		1.3		
0.19	0.21		1.3		
0.19	0.21		1.3		
0.19	0.21		1.31		
0.19	0.22		1.4		
0.2	0.22		1.5		
0.2	0.22		1.5		
0.2	0.22		1.6		
0.2	0.23		1.6		
0.2	0.23		1.7		
0.21	0.24		1.7		
0.21	0.24		1.7		
0.21	0.24		1.8		
0.21	0.25		1.8		
0.21	0.25		2.1		
0.21	0.25		2.1		
0.21	0.25		2.1		
0.21	0.26		2.2		
0.22	0.26		2.4		
0.22	0.26		2.5		
0.22	0.26		2.5		
0.22	0.26		2.5		
0.23	0.26		2.5		
0.23	0.26		2.6		
0.23	0.27		2.6		
0.24	0.27		2.8		
0.24	0.27		3		
0.24	0.27		3.3		
0.25	0.27		3.5		
0.25	0.28		3.5		
0.25	0.29		3.6		

From Washington Works FLAIR Database

Prepared November 21, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
1981 Summary

All	All Male	All Female	All Operator	All Mechanics	All Supervision
0.25	0.3		3.6		
0.26	0.3		3.6		
0.26	0.3		3.9		
0.26	0.31		4		
0.26	0.31		4.1		
0.26	0.32		4.2		
0.26	0.32		4.2		
0.26	0.32		4.3		
0.27	0.33		4.3		
0.27	0.33		4.3		
0.27	0.33		4.4		
0.27	0.33		4.5		
0.27	0.33		4.5		
0.27	0.33		4.8		
0.27	0.34		4.8		
0.28	0.34		4.9		
0.29	0.34		5.1		
0.29	0.34		5.3		
0.3	0.35		5.8		
0.3	0.36		6.5		
0.3	0.36		6.9		
0.31	0.36		7.5		
0.31	0.38		8.2		
0.31	0.39		9.1		
0.32	0.4		9.4		
0.32	0.4		9.6		
0.32	0.41		11		
0.33	0.41		32		
0.33	0.42		33		
0.33	0.42				
0.33	0.43				
0.33	0.43				
0.33	0.43				
0.34	0.43				
0.34	0.43				
0.34	0.44				
0.34	0.45				
0.35	0.45				
0.36	0.46				
0.36	0.46				
0.36	0.48				
0.38	0.49				
0.39	0.49				
0.4	0.5				
0.4	0.5				
0.41	0.51				

From Washington Works FLAIR Database

Prepared November 21, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
1981 Summary

All	All Male	All Female	All Operator	All Mechanics	All Supervision
0.41	0.51				
0.41	0.52				
0.42	0.52				
0.42	0.52				
0.43	0.52				
0.43	0.54				
0.43	0.54				
0.43	0.55				
0.43	0.58				
0.44	0.59				
0.45	0.6				
0.45	0.61				
0.46	0.61				
0.46	0.61				
0.48	0.62				
0.49	0.62				
0.49	0.63				
0.5	0.63				
0.5	0.64				
0.51	0.64				
0.51	0.64				
0.52	0.65				
0.52	0.65				
0.52	0.65				
0.52	0.71				
0.53	0.71				
0.54	0.75				
0.54	0.75				
0.55	0.76				
0.58	0.78				
0.59	0.78				
0.59	0.79				
0.59	0.8				
0.6	0.8				
0.61	0.81				
0.61	0.82				
0.61	0.86				
0.62	0.87				
0.62	0.88				
0.62	0.9				
0.63	0.91				
0.63	0.92				
0.64	0.93				
0.64	0.95				
0.64	0.98				
0.64	0.98				
0.65	1				

From Washington Works FLAIR Database

Prepared November 21, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
1981 Summary

All	All Male	All Female	All Operator	All Mechanics	All Supervision
0.65	1				
0.65	1				
0.71	1.1				
0.71	1.1				
0.74	1.1				
0.75	1.1				
0.75	1.2				
0.76	1.2				
0.78	1.2				
0.78	1.2				
0.79	1.2				
0.8	1.3				
0.8	1.3				
0.81	1.3				
0.81	1.3				
0.82	1.31				
0.86	1.4				
0.87	1.4				
0.88	1.5				
0.9	1.5				
0.91	1.5				
0.92	1.5				
0.93	1.6				
0.95	1.7				
0.98	1.7				
0.98	1.8				
1	1.8				
1	2				
1	2.1				
1	2.1				
1.1	2.2				
1.1	2.4				
1.1	2.5				
1.1	2.5				
1.2	2.5				
1.2	2.6				
1.2	2.6				
1.2	2.8				
1.2	2.8				
1.3	3				
1.3	3.3				
1.3	3.4				
1.3	3.6				
1.3	3.6				
1.31	4.1				
1.4	4.2				
1.4	4.2				

From Washington Works FLAIR Database

Prepared November 21, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
1981 Summary

All	All Male	All Female	All Operator	All Mechanics	All Supervision
1.5	4.3				
1.5	4.5				
1.5	4.8				
1.5	4.9				
1.6	5.3				
1.6	5.8				
1.7	6.5				
1.7	6.9				
1.7	7.5				
1.7	8.2				
1.8	9.1				
1.8	9.4				
2	9.6				
2.1	11				
2.1	32				
2.1	33				
2.1					
2.2					
2.4					
2.4					
2.5					
2.5					
2.5					
2.5					
2.6					
2.6					
2.6					
2.8					
2.8					
3					
3.3					
3.4					
3.5					
3.5					
3.6					
3.6					
3.6					
3.9					
4					
4.1					
4.2					
4.2					
4.3					
4.3					
4.3					
4.4					

From Washington Works FLAIR Database

Prepared November 21, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
1981 Summary

	All	All Male	All Female	All Operator	All Mechanics	All Supervision
	4.5					
	4.5					
	4.8					
	4.8					
	4.9					
	5.1					
	5.3					
	5.8					
	6.5					
	6.9					
	7.5					
	8.2					
	9.1					
	9.4					
	9.6					
	11					
	32					
	33					
Count	345	297	48	170	60	104
Average	1.16	1.11	1.52	1.95	0.35	0.44
Std Dev	2.90	3.05	1.64	3.95	0.32	0.63
Median	0.33	0.32	0.63	0.65	0.21	0.21

From Washington Works FLAIR Database

Prepared November 21, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 1981

Matrix: PFOA in Whole Blood

Operation: Non-Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	113	0.01	0.52	0.19	4.5	0.85
Males	34	0.02	0.51	0.23	2.8	0.74
Females	79	0.01	0.59	0.18	4.5	1.01
Operators	42	0.01	0.47	0.12	4.5	0.88
Males	7	0.02	0.82	0.14	2.7	1.22
Females	35	0.01	0.41	0.12	4.5	0.80
Mechanics	11	0.09	0.30	0.26	0.67	0.17
Males	9	0.09	0.27	0.19	0.67	0.18
Females	2	0.41	0.43	0.43	0.44	0.02
Laboratorians	38	0.01	0.83	0.29	4.4	1.24
Males	14	0.06	0.54	0.32	2.8	0.72
Females	24	0.01	0.99	0.17	4.4	1.45
Supervision	22	0.02	0.31	0.21	0.97	0.30
Males	4	0.12	0.15	0.15	0.17	0.02
Females	18	0.02	0.35	0.26	0.97	0.32

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: December 2, 2004

DuPont Company
PFOA in Blood
Washington Works - Non-Teflon - 1981

Non-Teflon								
Operators		Mechanics		Laboratorians		Supervision		
Male	Female	Male	Female	Male	Female	Male	Female	
0.21	0.04	0.18	0.44	0.24	0.06	0.17	0.09	
0.02	0.02	0.12	0.41	0.26	0.15	0.15	0.26	
0.14	0.21	0.36		0.54	0.31	0.12	0.18	
0.09	0.23	0.17		0.34	4.4	0.15	0.97	
2.5	0.98	0.4		0.1	3.8		0.35	
2.7	0.07	0.26		0.07	3.2		0.04	
0.05	0.01	0.19		0.33	4.2		0.05	
	0.01	0.67		0.06	0.17		0.94	
	0.09	0.09		0.43	0.17		0.57	
	0.39			0.14	0.08		0.23	
	0.57			0.31	0.08		0.05	
	0.13			2.8	1.9		0.02	
	0.78			1.1	1.4		0.39	
	0.12			0.87	0.61		0.83	
	0.64				0.01		0.7	
	0.52				0.08		0.28	
	1				0.06		0.26	
	0.04				0.09		0.09	
	0.05				0.08			
	1.2				0.45			
	1.25				0.41			
	0.02				2			
	0.02				0.07			
	0.12				0.05			
	0.1							
	0.04							
	0.65							
	4.5							
	0.03							
	0.09							
	0.08							
	0.24							
	0.27							
	0.15							
	0.12							
7	35	9	2	14	24	4	18	**Count**
0.82	0.41	0.27	0.43	0.54	0.99	0.15	0.35	**Average**
1.22	0.80	0.18	0.02	0.72	1.45	0.02	0.32	**Std Dev**
0.14	0.12	0.19	0.43	0.32	0.17	0.15	0.26	**Median**

From Washington Works FLAIR Database

Prepared November 21, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Non-Teflon
1981 Summary

All	All Male	All Female	All Oper	All Mech	All Lab	All Super
0.01	0.02	0.01	0.01	0.09	0.01	0.02
0.01	0.05	0.01	0.01	0.12	0.05	0.04
0.01	0.06	0.01	0.02	0.17	0.06	0.05
0.02	0.07	0.02	0.02	0.18	0.06	0.05
0.02	0.09	0.02	0.02	0.19	0.06	0.09
0.02	0.09	0.02	0.02	0.26	0.07	0.09
0.02	0.1	0.02	0.03	0.36	0.07	0.12
0.02	0.12	0.03	0.04	0.4	0.08	0.15
0.03	0.12	0.04	0.04	0.41	0.08	0.15
0.04	0.14	0.04	0.04	0.44	0.08	0.17
0.04	0.14	0.04	0.05	0.67	0.08	0.18
0.04	0.15	0.04	0.05		0.09	0.23
0.04	0.15	0.05	0.05		0.1	0.26
0.05	0.17	0.05	0.07		0.14	0.26
0.05	0.17	0.05	0.08		0.15	0.28
0.05	0.18	0.05	0.09		0.17	0.35
0.05	0.19	0.05	0.09		0.17	0.39
0.05	0.21	0.06	0.09		0.24	0.57
0.05	0.24	0.06	0.1		0.26	0.7
0.06	0.26	0.07	0.12		0.31	0.83
0.06	0.26	0.07	0.12		0.31	0.94
0.06	0.31	0.08	0.12		0.33	0.97
0.07	0.33	0.08	0.13		0.34	
0.07	0.34	0.08	0.14		0.41	
0.07	0.36	0.08	0.15		0.43	
0.08	0.4	0.08	0.21		0.45	
0.08	0.43	0.09	0.21		0.54	
0.08	0.54	0.09	0.23		0.61	
0.08	0.67	0.09	0.24		0.87	
0.08	0.87	0.09	0.27		1.1	
0.09	1.1	0.09	0.39		1.4	
0.09	2.5	0.1	0.52		1.9	
0.09	2.7	0.12	0.57		2	
0.09	2.8	0.12	0.64		2.8	
0.09		0.12	0.78		3.2	
0.09		0.13	0.98		3.8	
0.09		0.15	1		4.2	
0.1		0.15	1.2		4.4	
0.1		0.17	1.25			
0.12		0.17	2.5			
0.12		0.18	2.7			
0.12		0.21	4.5			
0.12		0.23				
0.12		0.23				

From Washington Works FLAIR Database

Prepared November 21, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Non-Teflon
1981 Summary

All	All Male	All Female	All Oper	All Mech	All Lab	All Super
0.13		0.24				
0.14		0.26				
0.14		0.26				
0.15		0.27				
0.15		0.28				
0.15		0.31				
0.15		0.35				
0.17		0.39				
0.17		0.39				
0.17		0.41				
0.17		0.41				
0.18		0.44				
0.18		0.45				
0.19		0.52				
0.21		0.57				
0.21		0.57				
0.23		0.61				
0.23		0.64				
0.24		0.7				
0.24		0.78				
0.26		0.83				
0.26		0.94				
0.26		0.97				
0.26		0.98				
0.27		1				
0.28		1.2				
0.31		1.25				
0.31		1.4				
0.33		1.9				
0.34		2				
0.35		3.2				
0.36		3.8				
0.39		4.2				
0.39		4.4				
0.4		4.5				
0.41						
0.41						
0.43						
0.44						
0.45						
0.52						
0.54						
0.57						
0.57						
0.61						
0.64						

From Washington Works FLAIR Database

Prepared November 21, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Non-Teflon
1981 Summary

	All	All Male	All Female	All Oper	All Mech	All Lab	All Super
	0.67						
	0.7						
	0.78						
	0.83						
	0.87						
	0.94						
	0.97						
	0.98						
	1						
	1.1						
	1.2						
	1.25						
	1.4						
	1.9						
	2						
	2.5						
	2.7						
	2.8						
	3.2						
	3.8						
	4.2						
	4.4						
	4.5						
Count	113	34	79	42	11	38	22
Average	0.52	0.51	0.59	0.47	0.30	0.83	0.31
Std Dev	0.85	0.74	1.01	0.88	0.17	1.24	0.30
Median	0.19	0.23	0.18	0.12	0.26	0.29	0.21

From Washington Works FLAIR Database

Prepared November 21, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 1982

Matrix: PFOA in Whole Blood

Operation: Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	299	0.01	1.29	0.41	26	2.96
Males	274	0.01	1.30	0.40	26	3.07
Females	25	0.03	1.20	0.64	5.6	1.36
Operators	157	0.02	2.07	0.76	26	3.91
Males	142	0.02	2.11	0.73	26	4.08
Females	15	0.15	1.68	1.40	5.6	1.51
Mechanics	48	0.07	0.46	0.31	1.6	0.37
Males	48	0.07	0.46	0.31	1.6	0.37
Females	0	-	-	-	-	-
Laboratorians	9	0.03	0.47	0.26	1.2	0.43
Males	8	0.11	1.10	0.34	1.2	0.43
Females	1	0.03	0.03	0.03	0.03	-
Supervision	85	0.01	0.41	0.19	3	0.58
Males	76	0.02	0.40	0.17	3	0.57
Females	9	0.19	0.53	0.31	2.3	0.68

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: December 3, 2004

DuPont Company
PFOA in Blood
Washington Works - Teflon - 1982

Teflon						
Operators		Mechanics	Laboratorians		Supervision	
Male	Female	Male	Male	Female	Male	Female
0.77	1.6	0.83	1.1	0.03	0.15	0.19
0.22	1.4	0.19	0.17		0.15	0.32
1	0.19	0.61	0.23		0.28	0.31
13	0.76	0.35	0.69		3	0.67
0.94	0.7	0.71	0.26		0.17	0.19
26	2.1	0.08	0.42		0.09	2.3
0.53	3.7	0.6	0.11		0.29	0.21
1.8	0.15	0.13	1.2		0.53	0.23
4.5	0.62	0.44			0.07	0.35
0.65	2.6	0.13			2.4	
1.8	5.6	0.19			0.88	
0.14	2.7	0.32			0.13	
0.02	0.64	0.07			0.44	
0.99	2	0.47			0.1	
0.97	0.45	0.18			0.26	
0.82		0.23			0.02	
0.4		0.98			0.07	
0.4		0.3			1	
0.11		0.68			0.31	
0.07		0.96			0.25	
0.06		0.46			0.09	
2.8		0.1			0.07	
0.94		0.16			0.13	
0.32		1.1			0.25	
0.14		0.17			0.09	
0.07		0.2			0.17	
5.9		0.81			0.38	
7		0.61			0.12	
0.13		0.58			0.57	
1.6		0.12			0.19	
0.72		0.25			0.42	
1.8		0.81			0.75	
0.11		1.1			0.11	
2.9		0.22			0.06	
1.2		0.22			0.25	
0.25		0.28			0.07	
0.08		0.21			0.15	
0.28		0.92			0.11	
1		0.16			1.5	
0.73		0.2			0.09	
2.6		0.12			0.18	
8.2		1.4			0.24	
0.19		1.6			0.07	
1.8		0.19			1.9	
0.78		0.4			0.51	
0.95		0.48			1.5	
0.52		0.1			0.25	
0.46		0.6			0.13	
0.03					0.12	

From Washington Works FLAIR Database

Prepared November 27, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon - 1982

Teflon						
Operators		Mechanics	Laboratorians		Supervision	
Male	Female	Male	Male	Female	Male	Female
2.3					0.57	
0.02					0.1	
0.56					0.03	
0.48					0.16	
0.83					0.14	
1.6					1.6	
6.3					0.22	
0.38					0.06	
0.42					0.34	
0.06					0.05	
2.1					0.13	
0.13					0.17	
0.15					0.51	
0.65					0.27	
4.1					0.06	
2.8					1.9	
1.4					0.1	
0.09					0.49	
0.05					0.1	
0.39					0.08	
0.35					0.19	
1.2					1	
0.08					0.03	
0.36					0.09	
0.41					0.73	
0.48					0.01	
1.1					0.14	
1.6						
1.5						
0.43						
0.03						
0.28						
0.65						
1						
0.12						
0.07						
4.6						
1						
2.1						
0.33						
0.92						
0.93						
0.62						
0.05						
20						
19						
0.15						
2.2						
0.38						

From Washington Works FLAIR Database

Prepared November 27, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon - 1982

Teflon							
Operators		Mechanics	Laboratorians		Supervision		
Male	Female	Male	Male	Female	Male	Female	
7.8							
0.09							
4.6							
1.6							
0.92							
0.13							
0.15							
3.1							
6.5							
1.8							
4.4							
0.07							
0.05							
1.5							
1.1							
0.11							
5.6							
0.52							
7.9							
0.67							
24							
0.61							
3.9							
0.08							
2.5							
8.6							
0.21							
0.22							
0.27							
5.1							
0.67							
5.8							
0.16							
0.24							
0.18							
0.29							
0.89							
2.8							
1.4							
4.2							
0.12							
0.45							
0.83							
2.7							
142	15	48	8	1	76	9	Count
2.11	1.68	0.46	1.10	0.03	0.40	0.53	Average
4.08	1.51	0.37	0.43		0.57	0.68	Std Dev
0.73	1.40	0.31	0.34	0.03	0.17	0.31	Median

From Washington Works FLAIR Database

Prepared November 27, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
1982 Summary

All	All Male	All Female	All Op	All Lab	All Sup
0.01	0.01	0.03	0.02	0.03	0.01
0.02	0.02	0.15	0.02	0.11	0.02
0.02	0.02	0.19	0.03	0.17	0.03
0.02	0.02	0.19	0.03	0.23	0.03
0.03	0.03	0.19	0.05	0.26	0.05
0.03	0.03	0.21	0.05	0.42	0.06
0.03	0.03	0.23	0.05	0.69	0.06
0.03	0.03	0.31	0.06	1.1	0.06
0.03	0.05	0.32	0.06	1.2	0.07
0.05	0.05	0.35	0.07		0.07
0.05	0.05	0.45	0.07		0.07
0.05	0.05	0.62	0.07		0.07
0.05	0.06	0.64	0.07		0.07
0.06	0.06	0.67	0.08		0.08
0.06	0.06	0.7	0.08		0.09
0.06	0.06	0.76	0.08		0.09
0.06	0.06	1.4	0.09		0.09
0.06	0.07	1.6	0.09		0.09
0.07	0.07	2	0.11		0.09
0.07	0.07	2.1	0.11		0.1
0.07	0.07	2.3	0.11		0.1
0.07	0.07	2.6	0.12		0.1
0.07	0.07	2.7	0.12		0.1
0.07	0.07	3.7	0.13		0.11
0.07	0.07	5.6	0.13		0.11
0.07	0.07		0.13		0.12
0.07	0.07		0.14		0.12
0.07	0.08		0.14		0.13
0.08	0.08		0.15		0.13
0.08	0.08		0.15		0.13
0.08	0.08		0.15		0.13
0.08	0.08		0.15		0.14
0.08	0.09		0.16		0.14
0.09	0.09		0.18		0.15
0.09	0.09		0.19		0.15
0.09	0.09		0.19		0.15
0.09	0.09		0.21		0.16
0.09	0.09		0.22		0.17
0.09	0.09		0.22		0.17
0.09	0.1		0.24		0.17
0.1	0.1		0.25		0.18
0.1	0.1		0.27		0.19
0.1	0.1		0.28		0.19
0.1	0.1		0.28		0.19
0.1	0.1		0.29		0.19
0.1	0.11		0.32		0.21
0.11	0.11		0.33		0.22
0.11	0.11		0.35		0.23
0.11	0.11		0.36		0.24
0.11	0.11		0.38		0.25

From Washington Works FLAIR Database

Prepared November 27, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
1982 Summary

0.11	0.11		0.38		0.25
0.11	0.12		0.39		0.25
0.12	0.12		0.4		0.25
0.12	0.12		0.4		0.26
0.12	0.12		0.41		0.27
0.12	0.12		0.42		0.28
0.12	0.12		0.43		0.29
0.12	0.13		0.45		0.31
0.13	0.13		0.45		0.31
0.13	0.13		0.46		0.32
0.13	0.13		0.48		0.34
0.13	0.13		0.48		0.35
0.13	0.13		0.52		0.38
0.13	0.13		0.52		0.42
0.13	0.13		0.53		0.44
0.13	0.13		0.56		0.49
0.13	0.14		0.61		0.51
0.14	0.14		0.62		0.51
0.14	0.14		0.62		0.53
0.14	0.14		0.64		0.57
0.14	0.15		0.65		0.57
0.15	0.15		0.65		0.67
0.15	0.15		0.65		0.73
0.15	0.15		0.67		0.75
0.15	0.15		0.67		0.88
0.15	0.15		0.7		1
0.15	0.16		0.72		1
0.15	0.16		0.73		1.5
0.16	0.16		0.76		1.5
0.16	0.16		0.77		1.6
0.16	0.17		0.78		1.9
0.16	0.17		0.82		1.9
0.17	0.17		0.83		2.3
0.17	0.17		0.83		2.4
0.17	0.17		0.89		3
0.17	0.18		0.92		
0.17	0.18		0.92		
0.18	0.18		0.93		
0.18	0.19		0.94		
0.18	0.19		0.94		
0.19	0.19		0.95		
0.19	0.19		0.97		
0.19	0.19		0.99		
0.19	0.19		1		
0.19	0.2		1		
0.19	0.2		1		
0.19	0.21		1		
0.19	0.21		1.1		
0.19	0.22		1.1		
0.2	0.22		1.2		
0.2	0.22		1.2		

From Washington Works FLAIR Database

Prepared November 27, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
1982 Summary

0.21	0.22		1.4		
0.21	0.22		1.4		
0.21	0.23		1.4		
0.22	0.23		1.5		
0.22	0.24		1.5		
0.22	0.24		1.6		
0.22	0.25		1.6		
0.22	0.25		1.6		
0.23	0.25		1.6		
0.23	0.25		1.6		
0.23	0.25		1.8		
0.24	0.25		1.8		
0.24	0.26		1.8		
0.25	0.26		1.8		
0.25	0.27		1.8		
0.25	0.27		2		
0.25	0.28		2.1		
0.25	0.28		2.1		
0.25	0.28		2.1		
0.26	0.28		2.2		
0.26	0.29		2.3		
0.27	0.29		2.5		
0.27	0.3		2.6		
0.28	0.31		2.6		
0.28	0.32		2.7		
0.28	0.32		2.7		
0.28	0.33		2.8		
0.29	0.34		2.8		
0.29	0.35		2.8		
0.3	0.35		2.9		
0.31	0.36		3.1		
0.31	0.38		3.7		
0.32	0.38		3.9		
0.32	0.38		4.1		
0.32	0.39		4.2		
0.33	0.4		4.4		
0.34	0.4		4.5		
0.35	0.4		4.6		
0.35	0.41		4.6		
0.35	0.42		5.1		
0.36	0.42		5.6		
0.38	0.42		5.6		
0.38	0.43		5.8		
0.38	0.44		5.9		
0.39	0.44		6.3		
0.4	0.45		6.5		
0.4	0.46		7		
0.4	0.46		7.8		
0.41	0.47		7.9		
0.42	0.48		8.2		
0.42	0.48		8.6		

From Washington Works FLAIR Database

Prepared November 27, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
1982 Summary

0.42	0.48		13		
0.43	0.49		19		
0.44	0.51		20		
0.44	0.51		24		
0.45	0.52		26		
0.45	0.52				
0.46	0.53				
0.46	0.53				
0.47	0.56				
0.48	0.57				
0.48	0.57				
0.48	0.58				
0.49	0.6				
0.51	0.6				
0.51	0.61				
0.52	0.61				
0.52	0.61				
0.53	0.62				
0.53	0.65				
0.56	0.65				
0.57	0.65				
0.57	0.67				
0.58	0.67				
0.6	0.68				
0.6	0.69				
0.61	0.71				
0.61	0.72				
0.61	0.73				
0.62	0.73				
0.62	0.75				
0.64	0.77				
0.65	0.78				
0.65	0.81				
0.65	0.81				
0.67	0.82				
0.67	0.83				
0.67	0.83				
0.68	0.83				
0.69	0.88				
0.7	0.89				
0.71	0.92				
0.72	0.92				
0.73	0.92				
0.73	0.93				
0.75	0.94				
0.76	0.94				
0.77	0.95				
0.78	0.96				
0.81	0.97				
0.81	0.98				
0.82	0.99				

From Washington Works FLAIR Database

Prepared November 27, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
1982 Summary

0.83	1				
0.83	1				
0.83	1				
0.88	1				
0.89	1				
0.92	1				
0.92	1.1				
0.92	1.1				
0.93	1.1				
0.94	1.1				
0.94	1.1				
0.95	1.2				
0.96	1.2				
0.97	1.2				
0.98	1.4				
0.99	1.4				
1	1.4				
1	1.5				
1	1.5				
1	1.5				
1	1.5				
1	1.6				
1.1	1.6				
1.1	1.6				
1.1	1.6				
1.1	1.6				
1.1	1.6				
1.2	1.8				
1.2	1.8				
1.2	1.8				
1.4	1.8				
1.4	1.8				
1.4	1.9				
1.4	1.9				
1.5	2.1				
1.5	2.1				
1.5	2.2				
1.5	2.3				
1.6	2.4				
1.6	2.5				
1.6	2.6				
1.6	2.7				
1.6	2.8				
1.6	2.8				
1.6	2.8				
1.8	2.9				
1.8	3				
1.8	3.1				
1.8	3.9				
1.8	4.1				
1.9	4.2				

From Washington Works FLAIR Database

Prepared November 27, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
1982 Summary

	1.9	4.4				
	2	4.5				
	2.1	4.6				
	2.1	4.6				
	2.1	5.1				
	2.2	5.6				
	2.3	5.8				
	2.3	5.9				
	2.4	6.3				
	2.5	6.5				
	2.6	7				
	2.6	7.8				
	2.7	7.9				
	2.7	8.2				
	2.8	8.6				
	2.8	13				
	2.8	19				
	2.9	20				
	3	24				
	3.1	26				
	3.7					
	3.9					
	4.1					
	4.2					
	4.4					
	4.5					
	4.6					
	4.6					
	5.1					
	5.6					
	5.6					
	5.8					
	5.9					
	6.3					
	6.5					
	7					
	7.8					
	7.9					
	8.2					
	8.6					
	13					
	19					
	20					
	24					
	26					
Count	299	274	25	157	9	85
Average	1.29	1.30	1.20	2.07	0.47	0.41
Std Dev	2.96	3.07	1.36	3.91	0.43	0.58
Median	0.41	0.40	0.64	0.76	0.26	0.19

From Washington Works FLAIR Database

Prepared November 27, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 1982

Matrix: PFOA in Whole Blood

Operation: Non-Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	70	0.02	0.29	0.14	2.6	0.44
Males	51	0.03	0.25	0.15	2.2	0.34
Females	19	0.02	0.38	0.10	2.6	0.64
Operators	18	0.02	0.33	0.13	2.2	0.54
Males	8	0.03	0.37	0.12	2.2	0.74
Females	10	0.02	0.29	0.16	1.1	0.35
Mechanics	18	0.05	0.18	0.17	0.41	0.11
Males	18	0.05	0.18	0.17	0.41	0.11
Females	0	-	-	-	-	-
Laboratorians	20	0.03	0.48	0.24	2.6	0.60
Males	15	0.03	0.37	0.25	0.94	0.28
Females	5	0.06	0.81	0.09	2.6	1.11
Supervision	14	0.04	0.11	0.09	0.42	0.10
Males	10	0.04	0.13	0.09	0.1	0.12
Females	4	0.04	0.08	0.07	0.1	0.04

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: December 3, 2004

000527

DuPont Company
PFOA in Blood
Washington Works - Non-Teflon - 1982

Operators		Mechanics	Laboratorians		Supervision		
Male	Female	Male	Male	Female	Male	Female	
0.2	1.1	0.09	0.03	1.2	0.14	0.04	
0.1	0.04	0.23	0.13	0.08	0.07	0.12	
2.2	0.12	0.18	0.34	0.09	0.05	0.04	
0.14	0.02	0.06	0.63	0.06	0.05	0.1	
0.08	0.19	0.11	0.07	2.6	0.23		
0.14	0.04	0.1	0.21		0.1		
0.03	0.19	0.13	0.8		0.09		
0.07	0.07	0.21	0.56		0.04		
	0.65	0.05	0.25		0.09		
	0.47	0.37	0.21		0.42		
		0.05	0.69				
		0.17	0.15				
		0.32	0.3				
		0.17	0.23				
		0.13	0.94				
		0.41					
		0.27					
		0.17					
8	10	18	15	5	10	4	**Count**
0.37	0.29	0.18	0.37	0.81	0.13	0.08	**Average**
0.74	0.35	0.11	0.28	1.11	0.12	0.04	**Std Dev**
0.12	0.16	0.17	0.25	0.09	0.09	0.07	**Median**

Prepared from Washington Works FLAIR Database

Prepared November 27, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Non-Teflon
1982 Summary

All	All Male	All Female	All Op	All Lab	All Sup
0.2	0.2	1.1	0.2	0.03	0.14
0.1	0.1	0.04	0.1	0.13	0.07
2.2	2.2	0.12	2.2	0.34	0.05
0.14	0.14	0.02	0.14	0.63	0.05
0.08	0.08	0.19	0.08	0.07	0.23
0.14	0.14	0.04	0.14	0.21	0.1
0.03	0.03	0.19	0.03	0.8	0.09
0.07	0.07	0.07	0.07	0.56	0.04
1.1	0.09	0.65	1.1	0.25	0.09
0.04	0.23	0.47	0.04	0.21	0.42
0.12	0.18	1.2	0.12	0.69	0.04
0.02	0.06	0.08	0.02	0.15	0.12
0.19	0.11	0.09	0.19	0.3	0.04
0.04	0.1	0.06	0.04	0.23	0.1
0.19	0.13	2.6	0.19	0.94	
0.07	0.21	0.04	0.07	1.2	
0.65	0.05	0.12	0.65	0.08	
0.47	0.37	0.04	0.47	0.09	
0.09	0.05	0.1		0.06	
0.23	0.17			2.6	
0.18	0.32				
0.06	0.17				
0.11	0.13				
0.1	0.41				
0.13	0.27				
0.21	0.17				
0.05	0.03				
0.37	0.13				
0.05	0.34				
0.17	0.63				
0.32	0.07				
0.17	0.21				
0.13	0.8				
0.41	0.56				
0.27	0.25				
0.17	0.21				
0.03	0.69				
0.13	0.15				
0.34	0.3				
0.63	0.23				
0.07	0.94				
0.21	0.14				
0.8	0.07				
0.56	0.05				
0.25	0.05				
0.21	0.23				
0.69	0.1				
0.15	0.09				
0.3	0.04				
0.23	0.09				
0.94	0.42				

Prepared from Washington Works FLAIR Database

Prepared November 27, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Non-Teflon
1982 Summary

	All	All Male	All Female	All Op	All Lab	All Sup
	1.2					
	0.08					
	0.09					
	0.06					
	2.6					
	0.14					
	0.07					
	0.05					
	0.05					
	0.23					
	0.1					
	0.09					
	0.04					
	0.09					
	0.42					
	0.04					
	0.12					
	0.04					
	0.1					
Count	70	51	19	18	20	14
Average	0.29	0.25	0.38	0.33	0.48	0.11
Std Dev	0.44	0.34	0.64	0.54	0.60	0.10
Median	0.14	0.15	0.10	0.13	0.24	0.09

Prepared from Washington Works FLAIR Database

Prepared November 27, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 1983

Matrix: PFOA in Whole Blood

Operation: Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	69	0.15	2.59	1.4	25	3.90
Males	59	0.15	2.79	1.4	25	4.17
Females	10	0.21	1.41	1.10	3.6	1.17
Operators	67	0.21	2.63	1.4	25	3.95
Males	57	0.25	2.84	1.4	25	4.22
Females	10	0.21	1.41	1.10	3.6	1.17
Mechanics	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Laboratorians	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Supervision	2	0.15	1.13	1.13	2.1	1.38
Males	2	0.15	1.13	1.13	2.1	1.38
Females	0	-	-	-	-	-

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: November 20, 2004

DuPont Company
PFOA in Blood
Washington Works - Teflon - 1983

Operators		Supervision		
Male	Female	Male	Female	
0.25	0.21	0.15		
0.34	0.28	2.1		
0.34	0.32			
0.36	0.62			
0.38	0.69			
0.44	1.5			
0.45	2			
0.46	2.4			
0.47	2.5			
0.48	3.6			
0.54				
0.75				
0.75				
0.76				
0.79				
0.83				
0.83				
0.94				
0.95				
0.96				
0.98				
1.1				
1.2				
1.3				
1.3				
1.3				
1.3				
1.4				
1.4				
1.5				
1.5				
1.6				
1.6				
1.9				
2.3				
2.3				
2.4				
2.5				
2.6				
2.8				
2.8				
2.8				
3				
3.6				
4				
4.2				
4.2				
4.4				
4.9				
5.4				

From Washington Works FLAIR Database

Prepared November 27, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon - 1983

Operators		Supervision		
Male	Female	Male	Female	
5.9				
5.9				
6				
6				
7.7				
20				
25				
57	10	2		Count
2.84	1.41	1.13		Average
4.22	1.17	1.38		Std Dev
1.4	1.10	1.13		Median

From Washington Works FLAIR Database

Prepared November 27, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
1983 Summary

All Teflon	Teflon Male	Teflon Fem	OperAll
0.15	0.15	0.21	0.21
0.21	0.25	0.28	0.25
0.25	0.34	0.32	0.28
0.28	0.34	0.62	0.32
0.32	0.36	0.69	0.34
0.34	0.38	1.5	0.34
0.34	0.44	2	0.36
0.36	0.45	2.4	0.38
0.38	0.46	2.5	0.44
0.44	0.47	3.6	0.45
0.45	0.48		0.46
0.46	0.54		0.47
0.47	0.75		0.48
0.48	0.75		0.54
0.54	0.76		0.62
0.62	0.79		0.69
0.69	0.83		0.75
0.75	0.83		0.75
0.75	0.94		0.76
0.76	0.95		0.79
0.79	0.96		0.83
0.83	0.98		0.83
0.83	1.1		0.94
0.94	1.2		0.95
0.95	1.3		0.96
0.96	1.3		0.98
0.98	1.3		1.1
1.1	1.3		1.2
1.2	1.4		1.3
1.3	1.4		1.3
1.3	1.5		1.3
1.3	1.5		1.3
1.3	1.6		1.4
1.4	1.6		1.4
1.4	1.9		1.5
1.5	2.1		1.5
1.5	2.3		1.5
1.5	2.3		1.6
1.6	2.4		1.6
1.6	2.5		1.9
1.9	2.6		2
2	2.8		2.3
2.1	2.8		2.3
2.3	2.8		2.4
2.3	3		2.4
2.4	3.6		2.5
2.4	4		2.5
2.5	4.2		2.6
2.5	4.2		2.8

From Washington Works FLAIR Database

Prepared November 27, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
1983 Summary

All Teflon	Teflon Male	Teflon Fem	OperAll	
2.6	4.4		2.8	
2.8	4.9		2.8	
2.8	5.4		3	
2.8	5.9		3.6	
3	5.9		3.6	
3.6	6		4	
3.6	6		4.2	
4	7.7		4.2	
4.2	20		4.4	
4.2	25		4.9	
4.4			5.4	
4.9			5.9	
5.4			5.9	
5.9			6	
5.9			6	
6			7.7	
6			20	
7.7			25	
20				
25				
69	59	10	67	**Count**
2.59	2.79	1.41	2.63	**Average**
3.90	4.17	1.17	3.95	**Std Dev**
1.4	1.4	1.10	1.4	**Median**

From Washington Works FLAIR Database

Prepared November 27, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 1983

Matrix: PFOA in Whole Blood

Operation: Non-Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	11	0.05	2.76	0.49	16	5.02
Males	6	0.08	4.76	2.2	16	6.30
Females	5	0.05	0.37	0.14	1.1	0.44
Operators	10	0.05	3.03	0.8	16	5.21
Males	6	0.08	4.76	1.95	16	6.30
Females	4	0.05	0.45	0.32	1.1	0.48
Mechanics	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Laboratorians	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Supervision	1	0.08	0.08	0.08	0.08	-
Males	0	-	-	-	-	-
Females	1	0.08	0.08	0.08	0.08	-

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: November 20, 2004

DuPont Company
PFOA in Blood
Washington Works - Non-Teflon - 1983

	Operator		Supervision
	Male	Female	Female
	0.08	0.05	0.08
	0.15	0.14	
	1.7	0.49	
	2.2	1.1	
	8.4		
	16		
Count	6	4	1
Average	4.76	0.45	0.08
Std Dev	6.30	0.48	
Median	1.95	0.32	0.08

From Washington Works FLAIR Database

Prepared November 27, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 1984

Matrix: PFOA in Whole Blood

Operation: Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	88	0	2.25	0.93	24	3.86
Males	71	0	2.54	1	24	4.19
Females	17	0	1.07	0.81	6.5	1.54
Operators	86	0	2.30	0.97	24	3.90
Males	70	0	2.57	1.05	24	4.21
Females	16	0	1.13	0.84	6.5	1.57
Mechanics	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Laboratorians	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Supervision	2	0.17	0.2	0.2	0.22	0.04
Males	1	0.22	0.22	0.22	0.22	-
Females	1	0.17	0.17	0.17	0.17	-

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: December 6, 2004

DuPont Company
PFOA in Blood
Washington Works - Teflon -1984

Operators		Supervision	
Male	Female	Male	Female
0	0	0.22	0.17
0.03	0.02		
0.04	0.05		
0.07	0.06		
0.1	0.17		
0.14	0.2		
0.2	0.5		
0.24	0.81		
0.25	0.86		
0.29	1.1		
0.3	1.4		
0.3	1.4		
0.31	1.5		
0.33	1.5		
0.34	2		
0.35	6.5		
0.36			
0.39			
0.53			
0.55			
0.56			
0.57			
0.57			
0.62			
0.67			
0.71			
0.72			
0.75			
0.75			
0.76			
0.8			
0.86			
0.93			
0.93			
1			
1.1			
1.1			
1.1			
1.1			
1.2			
1.3			
1.3			
1.5			
1.5			
1.6			
1.8			
1.9			
2.3			
2.4			
2.4			

From Washingotn Works FLAIR Database

Prepared November 27, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon -1984

Operators		Supervision		
Male	Female	Male	Female	
2.4				
2.6				
2.6				
2.6				
2.9				
3.2				
3.4				
4				
4				
4.5				
4.5				
5.8				
7.2				
7.4				
7.6				
8.1				
8.7				
16.4				
18				
24				
70	16			Count
2.57	1.13			Average
4.21	1.57			Std Dev
1.05	0.84			Median

From Washingotn Works FLAIR Database

Prepared November 27, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
1984 Summary

All	Op-All	Male-All	F-All
0	0	0	0
0.03	0.03	0.03	0.02
0.04	0.04	0.04	0.05
0.07	0.07	0.07	0.06
0.1	0.1	0.1	0.17
0.14	0.14	0.14	0.2
0.2	0.2	0.2	0.5
0.24	0.24	0.24	0.81
0.25	0.25	0.25	0.86
0.29	0.29	0.29	1.1
0.3	0.3	0.3	1.4
0.3	0.3	0.3	1.4
0.31	0.31	0.31	1.5
0.33	0.33	0.33	1.5
0.34	0.34	0.34	2
0.35	0.35	0.35	6.5
0.36	0.36	0.36	0.17
0.39	0.39	0.39	
0.53	0.53	0.53	
0.55	0.55	0.55	
0.56	0.56	0.56	
0.57	0.57	0.57	
0.57	0.57	0.57	
0.62	0.62	0.62	
0.67	0.67	0.67	
0.71	0.71	0.71	
0.72	0.72	0.72	
0.75	0.75	0.75	
0.75	0.75	0.75	
0.76	0.76	0.76	
0.8	0.8	0.8	
0.86	0.86	0.86	
0.93	0.93	0.93	
0.93	0.93	0.93	
1	1	1	
1.1	1.1	1.1	
1.1	1.1	1.1	
1.1	1.1	1.1	
1.1	1.1	1.1	
1.2	1.2	1.2	
1.3	1.3	1.3	
1.3	1.3	1.3	
1.5	1.5	1.5	
1.5	1.5	1.5	
1.6	1.6	1.6	

From Washington Works FLAIR Database

Prepared November 28, 2004
Barbara J. DAwson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
1984 Summary

	All	Op-All	Male-All	F-All
	1.8	1.8	1.8	
	1.9	1.9	1.9	
	2.3	2.3	2.3	
	2.4	2.4	2.4	
	2.4	2.4	2.4	
	2.4	2.4	2.4	
	2.6	2.6	2.6	
	2.6	2.6	2.6	
	2.6	2.6	2.6	
	2.9	2.9	2.9	
	3.2	3.2	3.2	
	3.4	3.4	3.4	
	4	4	4	
	4	4	4	
	4.5	4.5	4.5	
	4.5	4.5	4.5	
	5.8	5.8	5.8	
	7.2	7.2	7.2	
	7.4	7.4	7.4	
	7.6	7.6	7.6	
	8.1	8.1	8.1	
	8.7	8.7	8.7	
	16.4	16.4	16.4	
	18	18	18	
	24	24	24	
	0	0	0.22	
	0.02	0.02		
	0.05	0.05		
	0.06	0.06		
	0.17	0.17		
	0.2	0.2		
	0.5	0.5		
	0.81	0.81		
	0.86	0.86		
	1.1	1.1		
	1.4	1.4		
	1.4	1.4		
	1.5	1.5		
	1.5	1.5		
	2	2		
	6.5	6.5		
	0.22			
	0.17			
Count	88	86	71	17
Average	2.25	2.30	2.54	1.07
Std Dev	3.86	3.90	4.19	1.54
Median	0.93	0.97	1	0.81

From Washington Works FLAIR Database

Prepared November 28, 2004
Barbara J. DAwson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 1984

Matrix: PFOA in Whole Blood

Operation: Non-Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	13	0.01	1.87	0.12	14	3.99
Males	5	0.06	4.61	2.0	14	5.69
Females	8	0.01	0.15	0.08	0.46	0.18
Operators	10	0.01	2.41	0.43	14	4.45
Males	5	0.06	4.61	2	14	5.69
Females	5	0.01	0.2	0.12	0.46	0.21
Mechanics	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Laboratorians	1	0.11	0.11	0.11	0.11	-
Males	0	-	-	-	-	-
Females	1	0.11	0.11	0.11	0.11	-
Supervision	2	0.03	0.04	0.04	0.04	0.01
Males	0	-	-	-	-	-
Females	2	0.03	0.04	0.04	0.04	0.01

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: November 20, 2004

DuPont Company
PFOA in Blood
Washington Works - Non-Teflon - 1984

	Operator		Laboratorian	Supervision
	Male	Female	Female	Female
	0.06	0.01	0.11	0.03
	1.1	0.04		0.04
	2	0.12		
	5.9	0.39		
	14	0.46		
Count	5	5	1	2
Average	4.61	0.20	0.11	0.04
Std Dev	5.69	0.21		0.01
Median	2.00	0.12	0.11	0.04

From Washington Works FLAIR Database

Prepared November 28, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Non-Teflon
1984 Summary

	All	All Male	All Female	All Ops
	0.06	0.06	0.01	0.01
	1.1	1.1	0.04	0.04
	2	2	0.11	0.06
	5.9	5.9	0.12	0.12
	14	14	0.39	0.39
	0.01		0.46	0.46
	0.04		0.03	1.1
	0.12		0.04	2
	0.39			5.9
	0.46			14
	0.11			
	0.03			
	0.04			
Count	13	5	8	10
Average	1.87	4.61	0.15	2.41
Std Dev	3.99	5.69	0.18	4.45
Median	0.12	2.00	0.08	0.43

From Washington Works FLAIR Database

Prepared November 27, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 1985

Matrix: PFOA in Whole Blood

Operation: Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	88	0.03	2.02	0.76	18	3.58
Males	71	0.03	2.27	0.79	18	3.84
Females	17	0.03	0.97	0.51	8.2	1.92
Operators	85	0.03	2.08	0.77	18	3.63
Males	68	0.03	2.36	0.84	18	3.90
Females	17	0.03	0.97	0.51	8.2	1.92
Mechanics	3	0.2	0.30	0.23	0.46	0.14
Males	3	0.2	0.30	0.23	0.46	0.14
Females	0	-	-	-	-	-
Laboratorians	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Supervision	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates works assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: November 20, 2004

DuPont Company
PFOA in Blood
Washington Works
1985 Teflon Summary

All	AllMale	All Oper
0.03	0.03	0.03
0.03	0.04	0.03
0.04	0.05	0.04
0.05	0.06	0.05
0.05	0.06	0.05
0.06	0.06	0.06
0.06	0.06	0.06
0.06	0.06	0.06
0.06	0.09	0.06
0.06	0.09	0.06
0.06	0.1	0.06
0.07	0.16	0.07
0.08	0.19	0.08
0.09	0.2	0.09
0.09	0.23	0.09
0.1	0.26	0.1
0.1	0.27	0.1
0.16	0.31	0.16
0.19	0.33	0.19
0.2	0.39	0.26
0.23	0.4	0.27
0.26	0.45	0.31
0.27	0.45	0.33
0.31	0.46	0.33
0.33	0.5	0.39
0.33	0.54	0.4
0.39	0.55	0.4
0.4	0.59	0.45
0.4	0.63	0.45
0.45	0.7	0.5
0.45	0.74	0.51
0.46	0.75	0.54
0.5	0.76	0.54
0.51	0.76	0.55
0.54	0.77	0.59
0.54	0.79	0.63
0.55	0.84	0.7
0.59	0.84	0.72
0.63	0.96	0.74
0.7	1	0.75
0.72	1.1	0.76
0.74	1.1	0.76
0.75	1.2	0.77
0.76	1.2	0.77
0.76	1.2	0.79
0.77	1.3	0.84
0.77	2	0.84
0.79	2	0.88
0.84	2.22	0.96
0.84	2.3	0.97

From Washington Works FLAIR Database

Prepared November 27, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works
1985 Teflon Summary

	All	AllMale	All Oper
	0.88	2.4	1
	0.96	2.41	1.1
	0.97	2.45	1.1
	1	2.5	1.19
	1.1	2.5	1.2
	1.1	2.6	1.2
	1.19	2.6	1.2
	1.2	2.6	1.3
	1.2	2.7	1.56
	1.2	2.9	2
	1.3	3	2
	1.56	3.4	2.22
	2	3.4	2.3
	2	4.2	2.4
	2.22	8.4	2.41
	2.3	9.2	2.45
	2.4	10.4	2.5
	2.41	11.2	2.5
	2.45	14.5	2.6
	2.5	18	2.6
	2.5	18	2.6
	2.6		2.7
	2.6		2.9
	2.6		3
	2.7		3.4
	2.9		3.4
	3		4.2
	3.4		8.2
	3.4		8.4
	4.2		9.2
	8.2		10.4
	8.4		11.2
	9.2		14.5
	10.4		18
	11.2		18
	14.5		
	18		
	18		
Count	88	71	85
Average	2.02	2.27	2.08
Std Dev	3.58	3.84	3.63
Median	0.76	0.79	0.77

From Washington Works FLAIR Database

Prepared November 27, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon - 1985

Operators		Mechanics
Male	Female	Male
0.03	0.03	0.2
0.04	0.05	0.23
0.05	0.06	0.46
0.06	0.07	
0.06	0.08	
0.06	0.1	
0.06	0.33	
0.06	0.4	
0.09	0.51	
0.09	0.54	
0.1	0.72	
0.16	0.77	
0.19	0.88	
0.26	0.97	
0.27	1.19	
0.31	1.56	
0.33	8.2	
0.39		
0.4		
0.45		
0.45		
0.5		
0.54		
0.55		
0.59		
0.63		
0.7		
0.74		
0.75		
0.76		
0.76		
0.77		
0.79		
0.84		
0.84		
0.96		
1		
1.1		
1.1		
1.2		
1.2		
1.2		
1.3		
2		
2		
2.22		
2.3		
2.4		
2.41		
2.45		

From Washington Works FLAIR Database

Prepared November 27, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon - 1985

Operators		Mechanics	
Male	Female	Male	
2.5			
2.5			
2.6			
2.6			
2.6			
2.7			
2.9			
3			
3.4			
3.4			
4.2			
8.4			
9.2			
10.4			
11.2			
14.5			
18			
18			
68	17	3	Count
2.36	0.97	0.30	Average
3.90	1.92	0.14	Std Dev
0.84	0.51	0.23	Median

From Washington Works FLAIR Database

Prepared November 27, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 1986

Matrix: PFOA in Whole Blood

Operation: Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	65	0.04	2.09	0.81	24	3.83
Males	55	0.04	2.11	0.80	24	3.91
Females	10	0.16	1.97	0.99	12	3.55
Operators	60	0.04	2.22	0.87	24	3.96
Males	51	0.04	2.24	0.81	24	4.03
Females	9	0.16	2.10	1.00	12	3.73
Mechanics	4	0.31	0.51	0.42	0.9	0.27
Males	4	0.31	0.51	0.42	0.9	0.27
Females	0	-	-	-	-	-
Laboratorians	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Supervision	1	0.78	0.78	0.78	0.78	-
Males	0	-	-	-	-	-
Females	1	0.78	0.78	0.78	0.78	-

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: November 21, 2004

DuPont Company
PFOA in Blood
Washington Works - Teflon - 1986

Teflon				
Operator		Mechanic	Supervison	
Male	Female	Male	Female	
0.04	0.16	0.31	0.78	
0.08	0.38	0.33		
0.08	0.67	0.5		
0.09	0.97	0.9		
0.11	1			
0.11	1.1			
0.15	1.3			
0.2	1.3			
0.2	12			
0.21				
0.22				
0.25				
0.32				
0.32				
0.45				
0.49				
0.5				
0.5				
0.51				
0.55				
0.58				
0.6				
0.69				
0.75				
0.8				
0.81				
0.83				
0.91				
1				
1				
1				
1.1				
1.2				
1.3				
1.5				
1.6				
1.8				
2.3				
2.8				
2.8				
2.9				
3.1				
3.8				
3.9				
4.3				
4.8				
6.5				
7				
10				

From Washington Works FLAIR Database

Prepared November 27, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon - 1986

Teflon				
Operator		Mechanic	Supervison	
Male	Female	Male	Female	
13				
24				
51	9	4		Count
2.24	2.10	0.51		Average
4.03	3.73	0.27		Std Dev
0.81	1.00	0.42		Median

From Washington Works FLAIR Database

Prepared November 27, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
1986 Summary

All	All Male	All Female	All Oper
0.04	0.04	0.16	0.04
0.08	0.08	0.38	0.08
0.08	0.08	0.67	0.08
0.09	0.09	0.78	0.09
0.11	0.11	0.97	0.11
0.11	0.11	1	0.11
0.15	0.15	1.1	0.15
0.16	0.2	1.3	0.2
0.2	0.2	1.3	0.2
0.2	0.21	12	0.21
0.21	0.22		0.22
0.22	0.25		0.25
0.25	0.31		0.32
0.31	0.32		0.32
0.32	0.32		0.45
0.32	0.33		0.49
0.33	0.45		0.5
0.38	0.49		0.5
0.45	0.5		0.51
0.49	0.5		0.55
0.5	0.5		0.58
0.5	0.51		0.6
0.5	0.55		0.69
0.51	0.58		0.75
0.55	0.6		0.8
0.58	0.69		0.81
0.6	0.75		0.83
0.67	0.8		0.91
0.69	0.81		1
0.75	0.83		1
0.78	0.9		1
0.8	0.91		1.1
0.81	1		1.2
0.83	1		1.3
0.9	1		1.5
0.91	1.1		1.6
0.97	1.2		1.8
1	1.3		2.3
1	1.5		2.8
1	1.6		2.8
1	1.8		2.9
1.1	2.3		3.1
1.1	2.8		3.8
1.2	2.8		3.9
1.3	2.9		4.3
1.3	3.1		4.8
1.3	3.8		6.5
1.5	3.9		7

From Washington Works FLAIR Database

Prepared November 27, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
1986 Summary

	All	All Male	All Female	All Oper
	1.6	4.3		10
	1.8	4.8		13
	2.3	6.5		24
	2.8	7		0.16
	2.8	10		0.38
	2.9	13		0.67
	3.1	24		0.97
	3.8			1
	3.9			1.1
	4.3			1.3
	4.8			1.3
	6.5			12
	7			
	10			
	12			
	13			
	24			
Count	65	55	10	60
Average	2.09	2.11	1.97	2.22
Std Dev	3.83	3.91	3.55	3.96
Median	0.81	0.80	0.99	0.87

From Washington Works FLAIR Database

Prepared November 27, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 1987

Matrix: PFOA in Whole Blood

Operation: Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	33	0.03	2.10	1.2	11	2.61
Males	23	0.03	2.38	1.30	11	2.73
Females	10	0.04	1.47	0.66	7.7	2.32
Operators	33	0.03	2.10	1.2	11	2.61
Males	23	0.03	2.38	1.30	11	2.73
Females	10	0.04	1.47	0.66	7.7	2.32
Mechanics	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Laboratorians	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Supervision	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: November 21, 2004

000556

DuPont Company
PFOA in Blood
Washington Works - Teflon - 1987

Operator		
Male	Female	
0.03	0.04	
0.04	0.05	
0.05	0.06	
0.41	0.15	
0.74	0.64	
0.87	0.68	
1	1.6	
1.1	1.8	
1.1	2	
1.2	7.7	
1.2		
1.3		
1.4		
1.8		
1.8		
2.1		
2.3		
3		
3.8		
4.1		
6		
8.3		
11		
23	10	Count
2.38	1.47	Average
2.73	2.32	St Dev
1.30	0.66	Median

All Op	
0.03	
0.04	
0.04	
0.05	
0.05	
0.06	
0.15	
0.41	
0.64	
0.68	
0.74	
0.87	
1	
1.1	
1.1	
1.2	
1.2	
1.3	
1.4	
1.6	
1.8	
1.8	
1.8	
2	
2.1	
2.3	
3	
3.8	
4.1	
6	
7.7	
8.3	
11	
Count	33
Average	2.10
St Dev	2.61
Median	1.20

From Washington Works FLAIR Database

Prepared November 28, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 1988

Matrix: PFOA in Whole Blood

Operation: Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	36	0.05	1.46	0.76	8	1.88
Males	25	0.09	1.84	0.77	8	2.13
Females	10	0.05	0.66	0.61	1.6	0.55
Operators	34	0.05	1.54	0.79	8	1.90
Males	24	0.09	1.91	0.79	8	2.14
Females	10	0.05	0.66	0.61	1.6	0.55
Mechanics	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Laboratorians	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Supervision	1	0.09	0.09	0.09	0.09	-
Males	1	0.09	0.09	0.09	0.09	-
Females	0	-	-	-	-	-

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: December 6, 2004

DuPont Company
PFOA in Blood
Washington Works - 1988

Teflon			Non-Teflon	
Operator		Supervision	Laboratorian	
Male	Female	Male	Female	
3.4	0.2	0.09	0.1	
2.9	0.9			
0.26	0.86			
2.7	0.26			
0.74	0.09			
7	0.9			
1.7	1.4			
0.81	1.6			
0.4	0.36			
0.26	0.05			
1.7				
0.72				
0.24				
0.16				
0.23				
0.15				
0.77				
8				
2.6				
0.57				
3.4				
4.2				
2.8				
0.09				
24	10	1	1	**Count**
1.91	0.66	0.09	0.10	**Average**
2.14	0.55			**Std Dev**
0.79	0.61	0.09	0.10	**Median**

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
1988 Summary

	All	All Male	All Op
	0.05	0.09	0.05
	0.09	0.09	0.09
	0.09	0.15	0.09
	0.15	0.16	0.15
	0.16	0.23	0.16
	0.2	0.24	0.2
	0.23	0.26	0.23
	0.24	0.26	0.24
	0.26	0.4	0.26
	0.26	0.57	0.26
	0.26	0.72	0.26
	0.36	0.74	0.36
	0.4	0.77	0.4
	0.57	0.81	0.57
	0.72	1.7	0.72
	0.74	1.7	0.74
	0.77	2.6	0.77
	0.81	2.7	0.81
	0.86	2.8	0.86
	0.9	2.9	0.9
	0.9	3.4	0.9
	1.4	3.4	1.4
	1.6	4.2	1.6
	1.7	7	1.7
	1.7	8	1.7
	2.6		2.6
	2.7		2.7
	2.8		2.8
	2.9		2.9
	3.4		3.4
	3.4		3.4
	4.2		4.2
	7		7
	8		8
	0.09		
	0.1		
Count	36	25	34
Average	1.46	1.84	1.54
Std Dev	1.88	2.13	1.90
Median	0.76	0.77	0.79

From Washington Works FLAIR Database

November 20, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
1988 Summary

	All	All Male	All Op
	0.05	3.4	0.2
	0.09	2.9	0.9
	0.09	0.26	0.86
	0.15	2.7	0.26
	0.16	0.74	0.09
	0.2	7	0.9
	0.23	1.7	1.4
	0.24	0.81	1.6
	0.26	0.4	0.36
	0.26	0.26	0.05
	0.26	1.7	3.4
	0.36	0.72	2.9
	0.4	0.24	0.26
	0.57	0.16	2.7
	0.72	0.23	0.74
	0.74	0.15	7
	0.77	0.77	1.7
	0.81	8	0.81
	0.86	2.6	0.4
	0.9	0.57	0.26
	0.9	3.4	1.7
	1.4	4.2	0.72
	1.6	2.8	0.24
	1.7	0.09	0.16
	1.7	0.09	0.23
	2.6		0.15
	2.7		0.77
	2.8		8
	2.9		2.6
	3.4		0.57
	3.4		3.4
	4.2		4.2
	7		2.8
	8		0.09
	0.09		
	0.1		
Count	36 35	25	34
Average	1.50	1.84	1.54
Std Dev	1.89	2.13	1.90
Median	0.77	0.77	0.79

From Washington Works FLAIR Database

November 20, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 1988

Matrix: PFOA in Whole Blood

Operation: Non-Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	1	0.1	0.1	0.1	0.1	-
Males	0	-	-	-	-	-
Females	1	0.1	0.1	0.1	0.1	-
Operators	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Mechanics	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Laboratorians	1	0.1	0.1	0.1	0.1	-
Males	0	-	-	-	-	-
Females	1	0.1	0.1	0.1	0.1	-
Supervision	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: November 20, 2004

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 1989

Matrix: PFOA in Whole Blood

Operation: Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	41	0.08	2.00	0.91	11.1	2.45
Males	31	0.08	2.22	1.00	11.1	2.57
Females	10	0.09	1.33	0.30	5.6	2.02
Operators	41	0.08	2.00	0.91	11.1	2.45
Males	31	0.08	2.22	1.00	11.1	2.57
Females	10	0.09	1.33	0.30	5.6	2.02
Mechanics	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Laboratorians	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Supervision	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: November 21, 2004

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 1989

Matrix: PFOA in Whole Blood

Operation: Non-Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	1	1.6	1.6	1.6	1.6	-
Males	1	1.6	1.6	1.6	1.6	-
Females	0	-	-	-	-	-
Operators	1	1.6	1.6	1.6	1.6	-
Males	1	1.6	1.6	1.6	1.6	-
Females	0	-	-	-	-	-
Mechanics	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Laboratorians	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Supervision	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: November 20, 2004

DuPont Company
PFOA in Blood
Washington Works - 1989

Teflon		Non-Teflon	
Operator		Operator	
Male	Female	Male	
0.78	0.19	1.6	
1	0.34		
2.9	0.13		
0.27	0.12		
0.67	0.71		
0.18	0.09		
1.3	1.4		
0.08	5.6		
5.7	4.5		
1.5	0.25		
0.72			
6			
0.4			
0.36			
2.8			
0.34			
2.7			
2.3			
0.36			
11.1			
0.98			
0.72			
2.9			
0.42			
6.2			
1.4			
6.3			
0.81			
5.4			
0.91			
1.3			
31	10	1	Count
2.22	1.33	1.60	Average
2.57	2.02		Std Dev
1.00	0.30	1.60	Median

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
1989 Summary

	All
	0.78
	1
	2.9
	0.27
	0.67
	0.18
	1.3
	0.08
	5.7
	1.5
	0.72
	6
	0.4
	0.36
	2.8
	0.34
	2.7
	2.3
	0.36
	11.1
	0.98
	0.72
	2.9
	0.42
	6.2
	1.4
	6.3
	0.81
	5.4
	0.91
	1.3
	0.19
	0.34
	0.13
	0.12
	0.71
	0.09
	1.4
	5.6
	4.5
	0.25
Count	41
Average	2.00
Std Dev	2.45
Median	0.91

From Washington Works FLAIR Database

November 20, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 1990

Matrix: PFOA in Whole Blood

Operation: Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	22	0.04	0.57	0.26	4.29	0.93
Males	15	0.04	0.75	0.28	4.29	1.08
Females	7	0.04	0.17	0.09	0.43	0.16
Operators	22	0.04	0.57	0.26	4.29	0.93
Males	15	0.04	0.75	0.28	4.29	1.08
Females	7	0.04	0.17	0.09	0.43	0.16
Mechanics	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Laboratorians	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Supervision	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: November 21, 2004

DuPont Company
Washington Works
PFOA in Blood - 1990

Teflon		
Operator		
Male	Female	
0.65	0.43	
0.45	0.06	
0.04	0.37	
0.25	0.09	
0.23	0.13	
0.95	0.06	
0.13	0.04	
0.58		
0.28		
0.27		
1.13		
0.22		
4.29		
0.14		
1.69		
15	7	Count
0.75	0.17	Average
1.08	0.16	Std Dev
0.28	0.09	Median

All	
0.04	
0.04	
0.06	
0.06	
0.09	
0.13	
0.13	
0.14	
0.22	
0.23	
0.25	
0.27	
0.28	
0.37	
0.43	
0.45	
0.58	
0.65	
0.95	
1.13	
1.69	
4.29	
22	Count
0.567273	Average
0.926597	Std Dev
0.26	Median

Prepared from Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 1993

Matrix: PFOA in Whole Blood

Operation: Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	3	0.27	1.39	1.40	2.5	1.12
Males	1	1.4	1.4	1.4	1.4	-
Females	2	0.27	1.39	1.39	2.5	1.58
Operators	1	1.4	1.4	1.4	1.4	-
Males	1	1.4	1.4	1.4	1.4	-
Females	1	2.5	2.5	2.5	2.5	-
Mechanics	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Laboratorians	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Supervision	1	0.27	0.27	0.27	0.27	-
Males	0	-	-	-	-	-
Females	1	0.27	0.27	0.27	0.27	-

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: November 22, 2004

000569

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 1993

Matrix: PFOA in Whole Blood

Operation: Non-Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	8	0.27	0.51	0.52	0.62	0.11
Males	2	0.47	0.53	0.53	0.58	0.08
Females	6	0.27	0.50	0.52	0.62	0.13
Operators	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Mechanics	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Laboratorians	8	0.27	0.51	0.52	0.62	0.11
Males	2	0.47	0.53	0.53	0.58	0.08
Females	6	0.27	0.50	0.52	0.62	0.13
Supervision	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: November 20, 2004

DuPont Company
PFOA in Blood
Washington Works 1993

Teflon			Non-Teflon			All T	All T F	All NT Lab
Operator		Supervision	Laboratorian			0.27	0.27	0.27
Male	Female	Female	Male	Female		1.4	2.5	0.47
1.4	2.5	0.27	0.47	0.27		2.5		0.48
			0.58	0.48				0.5
				0.5				0.54
				0.54				0.58
				0.6				0.6
				0.62				0.62
1	1	1	2	6	Count	3	2	8
			0.53	0.50	Average	1.39	1.39	0.51
			0.08	0.13	Std Dev	1.12	1.58	0.11
			0.53	0.52	Median	1.40	1.39	0.52

Prepared from Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 1994

Matrix: PFOA in Whole Blood

Operation: Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	21	0.13	0.83	0.41	3.2	0.91
Males	18	0.13	0.73	0.41	3.2	0.85
Females	3	0.29	1.40	1.20	2.7	1.22
Operators	8	0.13	1.17	1.18	3.2	1.18
Males	7	0.13	1.16	0.41	3.2	1.28
Females	1	1.2	1.2	1.2	1.2	-
Mechanics	8	0.23	0.40	0.37	0.69	0.18
Males	8	0.23	0.40	0.37	0.69	0.18
Females	0	-	-	-	-	-
Laboratorians	4	0.41	1.14	0.72	2.7	1.05
Males	3	0.41	0.62	0.64	0.8	0.2
Females	1	2.7	2.7	2.7	2.7	-
Supervision	1	0.29	0.29	0.29	0.29	-
Males	0	-	-	-	-	-
Females	1	0.29	0.29	0.29	0.29	-

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: November 22, 2004

DuPont Company
PFOA in Blood
Washington Works - Teflon - 1994

Teflon						
Operator		Mechanic	Laboratorian		Supervision	
Male	Female	Male	Male	Female	Female	
0.26	1.2	0.59	0.64	2.7	0.29	
0.14		0.5	0.8			
0.13		0.28	0.41			
0.41		0.4				
1.4		0.23				
3.2		0.33				
2.6		0.69				
		0.17				
7	1	8	3	1	1	Count
1.16		0.40	0.62			Average
1.28		0.18	0.20			Std Dev
0.41		0.37	0.64			Median

From Washington Works FLAIR Datavase

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
1994 Summary

	All Tef	All Male	All Female	All Op	All Lab
	0.13	0.13	0.29	0.13	0.41
	0.14	0.14	1.2	0.14	0.64
	0.17	0.17	2.7	0.26	0.8
	0.23	0.23		0.41	2.7
	0.26	0.26		1.2	
	0.28	0.28		1.4	
	0.29	0.33		2.6	
	0.33	0.4		3.2	
	0.4	0.41			
	0.41	0.5			
	0.41	0.59			
	0.5	0.69			
	0.59	1.4			
	0.64	2.6			
	0.69	3.2			
	0.8	0.64			
	1.2	0.8			
	1.4	0.41			
	2.6				
	2.7				
	3.2				
Count	21	18	3	8	4
Average	0.83	0.73	1.40	1.17	1.14
Std Dev	0.91	0.85	1.22	1.18	1.05
Median	0.41	0.41	1.20	0.81	0.72

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 1994

Matrix: PFOA in Whole Blood

Operation: Non-Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	31	0.08	0.31	0.31	0.11	0.17
Males	17	0.08	0.35	0.33	0.8	0.19
Females	14	0.09	0.28	0.28	0.56	0.14
Operators	7	0.08	0.24	0.23	0.48	0.14
Males	5	0.08	0.25	0.23	0.48	0.15
Females	2	0.09	0.21	0.21	0.32	0.16
Mechanics	5	0.2	0.38	0.45	0.47	0.12
Males	5	0.2	0.38	0.45	0.47	0.12
Females	0	-	-	-	-	-
Laboratorians	12	0.09	0.37	0.35	1.1	0.27
Males	3	0.16	0.58	0.49	1.1	0.48
Females	9	0.09	0.29	0.34	0.56	0.15
Supervision	7	0.11	0.20	0.16	0.4	0.10
Males	4	0.13	0.22	0.18	0.4	0.12
Females	3	0.11	0.18	0.16	0.28	0.09

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: November 20, 2004

DuPont Company
PFOA in Blood
Washington Works - Non-Teflon - 1994

	Non-Teflon						
	Operator		Mechanic	Laboratorian		Supervision	
	Male	Female	Male	Male	Female	Male	Female
	0.23	0.09	0.46	0.16	0.36	0.2	0.28
	0.08	0.32	0.2	1.1	0.09	0.15	0.16
	0.48		0.45	0.49	0.17	0.4	0.11
	0.31		0.47		0.27	0.13	
	0.16		0.33		0.12		
					0.56		
					0.36		
					0.37		
					0.34		
Count	5	2	5	3	9	4	3
Average	0.25	0.21	0.38	0.58	0.29	0.22	0.18
Std Dev	0.15	0.16	0.12	0.48	0.15	0.12	0.09
Median	0.23	0.21	0.45	0.49	0.34	0.18	0.16

Prepared from Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Non-Teflon
1994 Summary

	All	All Male	All Female	All Op	All Lab	All Sup
	0.08	0.08	0.09	0.08	0.09	0.11
	0.09	0.13	0.09	0.09	0.12	0.13
	0.09	0.15	0.11	0.16	0.16	0.15
	0.12	0.16	0.12	0.23	0.17	0.16
	0.13	0.2	0.16	0.31	0.27	0.2
	0.15	0.2	0.17	0.32	0.34	0.28
	0.16	0.23	0.27	0.48	0.36	0.4
	0.16	0.31	0.28		0.36	
	0.17	0.33	0.32		0.37	
	0.2	0.4	0.34		0.49	
	0.2	0.41	0.36		0.56	
	0.23	0.45	0.36		1.1	
	0.27	0.46	0.37			
	0.28	0.47	0.56			
	0.31	0.48				
	0.32	0.64				
	0.33	0.8				
	0.34					
	0.36					
	0.36					
	0.37					
	0.4					
	0.41					
	0.45					
	0.46					
	0.47					
	0.48					
	0.56					
	0.64					
	0.8					
	0.11					
Count	31	17	14	7	12	7
Average	0.31	0.35	0.26	0.24	0.37	0.20
Std Dev	0.17	0.19	0.14	0.14	0.27	0.10
Median	0.31	0.33	0.28	0.23	0.35	0.16

Prepared from Washingotn Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 1995

Matrix: PFOA in Whole Blood

Operation: Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	82	0.02	1.55	1.3	4.5	1.13
Males	68	0.02	1.66	1.4	4.5	1.24
Females	14	0.13	0.99	0.74	4	1.02
Operators	57	0.02	1.77	1.70	4.5	0.33
Males	44	0.02	2.01	1.95	4.5	1.25
Females	13	0.15	0.96	0.73	4	1.06
Mechanics	25	0.35	1.03	0.96	1.7	0.33
Males	24	0.35	1.02	0.96	1.7	0.33
Females	1	1.4	1.4	1.4	1.4	-
Laboratorians	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Supervision	2	0.22	0.76	0.76	1.3	0.76
Males	2	0.22	0.76	0.76	1.3	0.76
Females	0	-	-	-	-	-

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: November 22, 2004

000578

DuPont Company
PFOA in Blood
Washington Works - Teflon - 1995

Teflon					
Operator		Mechanic		Supervision	
Male	Female	Male	Female	Male	
2	0.15	0.93	1.4	0.22	
3.1	0.74	0.88		1.3	
3	0.69	1.4			
0.14	1.7	0.58			
2.4	0.26	1.1			
4.2	0.32	1.5			
1.7	0.14	1.2			
1.7	0.13	0.69			
0.73	4	1.7			
0.47	0.74	0.93			
0.58	0.73	1.3			
1.1	1.5	1.4			
0.02	1.4	0.94			
2		0.96			
1.4		0.6			
2.7		1.2			
1.2		0.91			
1.7		1.2			
2		0.46			
0.69		0.93			
2.2		0.35			
2.6		1.1			
0.24		1.2			
2.5		0.95			
4.1					
0.55					
0.56					
3.6					
1.3					
2.1					
2.1					
2.1					
4.4					
1.9					
1.4					
4.5					
1.4					
4.2					
1.9					
2.8					
3.6					
1.9					
0.12					
3.5					

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon - 1995

Teflon					
Operator		Mechanic		Supervision	
Male	Female	Male	Female	Male	
44	13	24	1	2	Count
2.01	0.96	1.02		0.76	Average
1.25	1.06	0.33		0.76	Std Dev
1.95	0.73	0.96		0.76	Median

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
1995 Summary

	All	All Male	All Fem	All Op	All Mech
	0.02	0.02	0.13	0.02	0.35
	0.12	0.12	0.14	0.12	0.46
	0.13	0.14	0.15	0.13	0.58
	0.14	0.24	0.26	0.14	0.6
	0.14	0.35	0.32	0.14	0.69
	0.15	0.46	0.69	0.15	0.88
	0.24	0.47	0.73	0.24	0.91
	0.26	0.55	0.74	0.26	0.93
	0.32	0.56	0.74	0.32	0.93
	0.35	0.58	1.4	0.47	0.93
	0.46	0.58	1.4	0.55	0.94
	0.47	0.6	1.5	0.56	0.95
	0.55	0.69	1.7	0.58	0.96
	0.56	0.69	4	0.69	1.1
	0.58	0.73		0.69	1.1
	0.58	0.88		0.73	1.2
	0.6	0.91		0.73	1.2
	0.69	0.93		0.74	1.2
	0.69	0.93		0.74	1.2
	0.69	0.93		1.1	1.3
	0.73	0.94		1.2	1.4
	0.73	0.95		1.3	1.4
	0.74	0.96		1.4	1.4
	0.74	1.1		1.4	1.5
	0.88	1.1		1.4	1.7
	0.91	1.1		1.4	
	0.93	1.2		1.5	
	0.93	1.2		1.7	
	0.93	1.2		1.7	
	0.94	1.2		1.7	
	0.95	1.2		1.7	
	0.96	1.3		1.9	
	1.1	1.3		1.9	
	1.1	1.4		1.9	
	1.1	1.4		2	
	1.2	1.4		2	
	1.2	1.4		2	
	1.2	1.4		2.1	
	1.2	1.5		2.1	
	1.2	1.7		2.1	
	1.3	1.7		2.2	
	1.3	1.7		2.4	
	1.4	1.7		2.5	
	1.4	1.9		2.6	
	1.4	1.9		2.7	
	1.4	1.9		2.8	
	1.4	2		3	
	1.4	2		3.1	
	1.4	2		3.5	

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
1995 Summary

	All	All Male	All Fem	All Op	All Mech
	1.5	2.1		3.6	
	1.5	2.1		3.6	
	1.7	2.1		4	
	1.7	2.2		4.1	
	1.7	2.4		4.2	
	1.7	2.5		4.2	
	1.7	2.6		4.4	
	1.9	2.7		4.5	
	1.9	2.8			
	1.9	3			
	2	3.1			
	2	3.5			
	2	3.6			
	2.1	3.6			
	2.1	4.1			
	2.1	4.2			
	2.2	4.2			
	2.4	4.4			
	2.5	4.5			
	2.6				
	2.7				
	2.8				
	3				
	3.1				
	3.5				
	3.6				
	3.6				
	4				
	4.1				
	4.2				
	4.2				
	4.4				
	4.5				
Count	82	68	14	57	25
Average	1.55	1.66	0.99	1.77	1.03
Std Dev	1.13	1.12	1.02	1.28	0.33
Median	1.30	1.40	0.74	1.70	0.96

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 1995

Matrix: PFOA in Whole Blood

Operation: Non-Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	31	0.08	0.92	0.45	4.3	1.08
Males	19	0.08	1.07	0.57	4.3	1.26
Females	12	0.14	0.70	0.72	2.1	0.69
Operators	13	0.08	1.08	0.72	4.3	1.23
Males	11	0.08	1.24	0.94	4.3	1.28
Females	2	0.14	0.22	0.22	0.3	0.11
Mechanics	3	0.31	0.56	0.37	1	0.38
Males	2	0.31	0.34	0.34	0.37	0.04
Females	1	1.0	1.0	1.0	1.0	-
Laboratorians	13	0.14	0.52	0.40	2.1	0.50
Males	5	0.14	0.40	0.40	0.65	0.18
Females	8	0.14	0.60	0.40	2.1	0.62
Supervision	2	2.1	3.05	3.05	4	1.34
Males	1	1.0	1.0	1.0	1.0	-
Females	1	2.1	2.1	2.1	2.1	-

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: November 20, 2004

DuPont Company
PFOA in Blood
Washington Works - Non-Teflon - 1995

	Non-Teflon							
	Operator		Mechanic		Laboratorian		Supervision	
	Male	Female	Male	Female	Male	Female	Male	Female
	0.09	0.14	0.37	1	0.14	0.33	4	2.1
	1.1	0.3	0.31		0.45	0.14		
	4.3				0.4	0.56		
	0.57				0.65	2.1		
	2.4				0.38	0.32		
	0.08					0.43		
	0.72					0.56		
	1.1					0.36		
	0.94							
	0.11							
	2.2							
Count	11	2	2	1	5	8	1	2.1
Average	1.24	0.22	0.34	1.00	0.40	0.60	1.00	2.10
Std Dev	1.28	0.11	0.04		0.18	0.62		
Median	0.94	0.22	0.34	1.00	0.40	0.40	1.00	2.10

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Non-Teflon
1995 Summary

	All	All Male	All Fem	All Op	All Mech	All Lab	All Sup
	0.08	0.08	0.14	0.08	0.31	0.14	2.1
	0.09	0.09	0.14	0.09	0.37	0.14	4
	0.11	0.11	0.3	0.11	1	0.32	
	0.14	0.14	0.32	0.14		0.33	
	0.14	0.31	0.33	0.3		0.36	
	0.14	0.37	0.36	0.57		0.38	
	0.3	0.38	0.43	0.72		0.4	
	0.31	0.4	0.56	0.94		0.43	
	0.32	0.45	0.56	1.1		0.45	
	0.33	0.57	1	1.1		0.56	
	0.36	0.65	2.1	2.2		0.56	
	0.37	0.72	2.1	2.4		0.65	
	0.38	0.94		4.3		2.1	
	0.4	1.1					
	0.43	1.1					
	0.45	2.2					
	0.56	2.4					
	0.56	4					
	0.57	4.3					
	0.65						
	0.72						
	0.94						
	1						
	1.1						
	1.1						
	2.1						
	2.1						
	2.2						
	2.4						
	4						
	4.3						
Count	31	19	12	13	3	13	2
Average	0.92	1.07	0.70	1.08	0.56	0.52	3.05
Std Dev	1.08	1.26	0.69	1.23	0.38	0.50	1.34
Median	0.45	0.57	0.40	0.72	0.37	0.40	3.05

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 1996

Matrix: PFOA in Whole Blood

Operation: Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	14	0.09	1.10	0.62	3	0.97
Males	11	0.09	1.05	0.38	3	1.06
Females	3	0.61	1.27	1.40	1.8	0.61
Operators	6	0.25	1.45	1.31	3	1.20
Males	5	0.25	1.62	2.0	3	1.26
Females	1	0.61	0.61	0.61	0.61	-
Mechanics	1	1.8	1.8	1.8	1.8	-
Males	1	1.8	1.8	1.8	1.8	-
Females	0	-	-	-	-	-
Laboratorians	1	0.26	0.26	0.26	0.26	-
Males	1	0.26	0.26	0.26	0.26	-
Females	0	-	-	-	-	-
Supervision	6	0.09	0.76	0.51	1.8	0.68
Males	4	0.09	0.35	0.33	0.63	0.22
Females	2	1.4	1.6	1.6	1.8	0.28

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: November 22, 2004

000586

DuPont Company
PFOA in Blood
Washington Works - Teflon - 1996

Teflon						
Operator		Mechanic	Laboratorian	Supervision		
Male	Female	Male	Male	Male	Female	
0.35	0.61	1.8	0.26	0.28	1.8	
2				0.09	1.4	
2.5				0.63		
0.25				0.38		
3						
5	1	1	1	4	2	**Count**
1.62	0.61	1.80	0.26	0.35	1.60	**Average**
1.26				0.22	0.28	**Std Dev**
2.00	0.61	1.80	0.26	0.33	1.60	**Median**

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
1996 Summary

	All	All Male	All Female	All Op	All Sup
	0.09	0.09	0.61	0.25	0.09
	0.25	0.25	1.4	0.35	0.28
	0.26	0.26	1.8	0.61	0.38
	0.28	0.28		2	0.63
	0.35	0.35		2.5	1.4
	0.38	0.38		3	1.8
	0.61	0.63			
	0.63	1.8			
	1.4	2			
	1.8	2.5			
	1.8	3			
	2				
	2.5				
	3				
Count	14	11	3	6	6
Average	1.10	1.05	1.27	1.45	0.76
Std Dev	0.97	1.06	0.61	1.20	0.68
Median	0.62	0.38	1.40	1.31	0.51

From Washington Works FLAIR Database

December 6, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 1996

Matrix: PFOA in Whole Blood

Operation: Non-Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	7	0.15	0.63	0.56	1.8	0.54
Males	6	0.25	0.44	0.51	1.8	0.20
Females	1	0.15	0.15	0.15	0.15	-
Operators	2	0.25	0.43	0.43	0.6	0.25
Males	2	0.25	0.43	0.43	0.6	0.25
Females	0	-	-	-	-	-
Mechanics	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Laboratorians	4	0.45	0.86	0.59	1.8	0.63
Males	4	0.45	0.86	0.59	1.8	0.63
Females	0	-	-	-	-	-
Supervision	1	0.15	0.15	0.15	0.15	-
Males	0	-	-	-	-	-
Females	1	0.15	0.15	0.15	0.15	-

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: November 20, 2004

000589

DuPont Company
PFOA in Blood
Washington Works - Non-Teflon - 1996

	Non-Teflon			All	All Male
	Operator	Laboratorian	Supervision	0.15	0.25
	Male	Male	Female	0.25	0.45
	0.6	1.8	0.15	0.45	0.56
	0.25	0.45		0.56	0.6
		0.62		0.6	0.62
		0.56		0.62	1.8
				1.8	
Count	2	4	1	7	6
Average	0.43	0.86		0.63	0.44
Std Dev	0.25	0.63		0.54	0.20
Median	0.43	0.59		0.56	0.51

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 1997

Matrix: PFOA in Whole Blood

Operation: Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	2	0.14	0.18	0.18	0.22	0.06
Males	0	-	-	-	-	-
Females	2	0.14	0.18	0.18	0.22	0.06
Operators	1	0.22	0.22	0.22	0.22	-
Males	0	-	-	-	-	-
Females	1	0.22	0.22	0.22	0.22	-
Mechanics	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Laboratorians	1	0.14	0.14	0.14	0.14	-
Males	0	-	-	-	-	-
Females	1	0.14	0.14	0.14	0.14	-
Supervision	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: November 22, 2004

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 1997

Matrix: PFOA in Whole Blood

Operation: Non-Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	10	0	0.29	0.27	0.56	0.17
Males	3	0.18	0.36	0.35	0.54	0.18
Females	7	0	0.26	0.22	0.56	0.16
Operators	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Mechanics	1	0.18	0.18	0.18	0.18	-
Males	1	0.18	0.18	0.18	0.18	-
Females	0	-	-	-	-	-
Laboratorians	8	0	0.27	0.27	0.56	0.16
Males	1	0.35	0.35	0.35	0.35	-
Females	7	0	0.26	0.22	0.56	0.17
Supervision	1	0.54	0.54	0.54	0.54	0.54
Males	1	0.54	0.54	0.54	0.54	0.54
Females	0	-	-	-	-	-

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: November 20, 2004

000592

DuPont Company
PFOA in Blood
Washington Works 1997

Teflon		Non-Teflon				
Operator	Laboratorian	Mechanic	Laboratorian		Supervision	
Female	Female	Male	Male	Female	Male	
0.22	0.14	0.18	0.35	0	0.54	
				0.22		
				0.22		
				0.15		
				0.56		
				0.32		
				0.33		
1	1	1	1	7	1	Count
				0.26		Average
				0.17		Std Dev
				0.22		Median

From Washington Works FLAIR Database

November 27, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Non-Teflon
1997 Summary

	All NT	All NT Male	All NT Female	All NT Lab
	0.18	0.18	0	0.35
	0.35	0.35	0.22	0
	0	0.54	0.22	0.22
	0.22		0.15	0.22
	0.22		0.56	0.15
	0.15		0.32	0.56
	0.56		0.33	0.32
	0.32			0.33
	0.33			
	0.54			
Count	10	3	7	8
Average	0.29	0.36	0.26	0.27
Std Dev	0.17	0.18	0.17	0.16
Median	0.27	0.35	0.22	0.27

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 2000

Matrix: PFOA in Whole Blood

Operation: Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	77	0.02	1.46	0.73	9	1.90
Males	63	0.02	1.50	0.78	9	1.99
Females	14	0.03	1.27	0.61	4.5	1.50
Operators	47	0.07	1.88	0.91	9	2.26
Males	37	0.07	2.07	1.00	9	2.38
Females	10	0.07	1.18	0.47	4.5	1.62
Mechanics	10	0.02	1.30	0.94	2.5	0.94
Males	9	0.02	1.16	0.87	2.5	0.89
Females	1	2.5	2.5	2.5	2.5	-
Laboratorians	5	0.31	0.50	0.36	1.1	0.34
Males	5	0.31	0.50	0.36	1.1	0.34
Females	0	-	-	-	-	-
Supervision	15	0.03	0.58	0.33	2.8	0.73
Males	12	0.04	0.43	0.29	1.3	0.41
Females	3	0.03	1.19	0.73	2.8	1.44

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: November 22, 2004

DuPont Company
PFOA in Blood
Washington Works - Teflon - 2000

Teflon							
Operator		Mechanic		Laboratori	Supervision		
Male	Female	Male	Female	Male	Male	Female	
0.96	0.8	2	2.5	0.36	0.7	2.8	
1.4	0.45	0.6		1.1	0.33	0.03	
0.14	0.17	0.34		0.35	0.1	0.73	
2.8	0.17	0.84		0.38	0.04		
9	3.9	2.3		0.31	1.1		
0.27	0.49	0.87			0.25		
6.2	4.5	2.5			0.11		
1	0.78	1			0.45		
0.33	0.43	0.02			0.51		
0.52	0.07				0.16		
4.7					0.11		
1.5					1.3		
0.91							
0.25							
0.29							
2.6							
0.35							
0.19							
0.68							
0.18							
0.07							
0.16							
1.3							
4.9							
1.7							
8.5							
2							
3							
0.99							
2.8							
4.3							
1.6							
2.4							
0.78							
0.23							
6.9							
0.65							
37	10	9	1	5	12	3	**Count**
2.07	1.18	1.16		0.50	0.43	1.19	**Average**
2.38	1.62	0.89		0.34	0.41	1.44	**Std Dev**
1.00	0.47	0.87		0.36	0.29	0.73	**Median**

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
2000 Summary

Tef All	All Male	All Fem	Oper All	Mech All	Sup All	
0.02	0.02	0.03	0.07	0.02	0.03	
0.03	0.04	0.07	0.07	0.34	0.04	
0.04	0.07	0.17	0.14	0.6	0.1	
0.07	0.1	0.17	0.16	0.84	0.11	
0.07	0.11	0.43	0.17	0.87	0.11	
0.1	0.11	0.45	0.17	1	0.16	
0.11	0.14	0.49	0.18	2	0.25	
0.11	0.16	0.73	0.19	2.3	0.33	
0.14	0.16	0.78	0.23	2.5	0.45	
0.16	0.18	0.8	0.25	2.5	0.51	
0.16	0.19	2.5	0.27		0.7	
0.17	0.23	2.8	0.29		0.73	
0.17	0.25	3.9	0.33		1.1	
0.18	0.25	4.5	0.35		1.3	
0.19	0.27		0.43		2.8	
0.23	0.29		0.45			
0.25	0.31		0.49			
0.25	0.33		0.52			
0.27	0.33		0.65			
0.29	0.34		0.68			
0.31	0.35		0.78			
0.33	0.35		0.78			
0.33	0.36		0.8			
0.34	0.38		0.91			
0.35	0.45		0.96			
0.35	0.51		0.99			
0.36	0.52		1			
0.38	0.6		1.3			
0.43	0.65		1.4			
0.45	0.68		1.5			
0.45	0.7		1.6			
0.49	0.78		1.7			
0.51	0.84		2			
0.52	0.87		2.4			
0.6	0.91		2.6			
0.65	0.96		2.8			
0.68	0.99		2.8			
0.7	1		3			
0.73	1		3.9			
0.78	1.1		4.3			
0.78	1.1		4.5			
0.8	1.3		4.7			
0.84	1.3		4.9			
0.87	1.4		6.2			

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
2000 Summary

Tef All	All Male	All Fem	Oper All	Mech All	Sup All	
0.91	1.5		6.9			
0.96	1.6		8.5			
0.99	1.7		9			
1	2					
1	2					
1.1	2.3					
1.1	2.4					
1.3	2.5					
1.3	2.6					
1.4	2.8					
1.5	2.8					
1.6	3					
1.7	4.3					
2	4.7					
2	4.9					
2.3	6.2					
2.4	6.9					
2.5	8.5					
2.5	9					
2.6						
2.8						
2.8						
2.8						
3						
3.9						
4.3						
4.5						
4.7						
4.9						
6.2						
6.9						
8.5						
9						
77	63	14	47	10	15	**Count**
1.46	1.50	1.27	1.88	1.30	0.58	**Average**
1.90	1.99	1.50	2.26	0.94	0.73	**Std Dev**
0.73	0.78	0.61	0.91	0.94	0.33	**Median**

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 2000

Matrix: PFOA in Whole Blood

Operation: Non-Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	48	0	0.48	0.29	3.1	0.59
Males	32	0.07	0.60	0.31	3.1	0.67
Females	16	0	0.24	0.17	1.1	0.28
Operators	14	0.07	0.59	0.32	2.1	0.58
Males	12	0.07	0.65	0.37	2.1	0.62
Females	2	0.29	0.29	0.29	0.29	0
Mechanics	7	0.1	0.28	0.31	0.6	0.17
Males	7	0.1	0.28	0.31	0.6	0.17
Females	0	-	-	-	-	-
Laboratorians	14	0.18	0.79	0.44	3.1	0.79
Males	8	0.18	1.04	0.95	3.1	0.97
Females	6	0.2	0.47	0.39	1.1	0.32
Supervision	13	0	0.12	0.09	0.37	0.11
Males	5	0.1	0.22	0.20	0.37	0.11
Females	8	0	0.05	0.05	0.14	0.05

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: November 20, 2004

DuPont Company
PFOA in Blood
Washington Works - Non-Teflon - 2000

Non-Teflon							
Operator		Mechanic	Laboratorian		Supervision		
Male	Female	Male	Male	Female	Male	Female	
0.07	0.29	0.1	1.6	0.2	0.37	0.05	
0.34	0.29	0.18	3.1	0.48	0.2	0.14	
2.1		0.31	1	0.38	0.29	0.02	
0.22		0.6	0.3	0.27	0.16	0.09	
0.12		0.31	0.21	0.39	0.1	0.08	
0.27		0.16	0.18	1.1		0.01	
1.3		0.33	1			0.04	
0.4			0.9			0	
0.16							
1.2							
0.88							
0.68							
12	2	7	8	6	5	8	**Count**
0.65	0.29	0.28	1.04	0.47	0.22	0.05	**Average**
0.62	0.00	0.17	0.97	0.32	0.11	0.05	**Std Dev**
0.37	0.29	0.31	0.95	0.39	0.20	0.05	**Median**

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Non-Teflon
2000 Summary

	All	All Male	All Female	All Oper	All Lab	All Sup
	0	0.07	0	0.07	0.18	0
	0.01	0.1	0.01	0.12	0.2	0.01
	0.02	0.1	0.02	0.16	0.21	0.02
	0.04	0.12	0.04	0.22	0.27	0.04
	0.05	0.16	0.05	0.27	0.3	0.05
	0.07	0.16	0.08	0.29	0.38	0.08
	0.08	0.16	0.09	0.29	0.39	0.09
	0.09	0.18	0.14	0.34	0.48	0.1
	0.1	0.18	0.2	0.4	0.9	0.14
	0.1	0.2	0.27	0.68	1	0.16
	0.12	0.21	0.29	0.88	1	0.2
	0.14	0.22	0.29	1.2	1.1	0.29
	0.16	0.27	0.38	1.3	1.6	0.37
	0.16	0.29	0.39	2.1	3.1	
	0.16	0.3	0.48			
	0.18	0.31	1.1			
	0.18	0.31				
	0.2	0.33				
	0.2	0.34				
	0.21	0.37				
	0.22	0.4				
	0.27	0.6				
	0.27	0.68				
	0.29	0.88				
	0.29	0.9				
	0.29	1				
	0.3	1				
	0.31	1.2				
	0.31	1.3				
	0.33	1.6				
	0.34	2.1				
	0.37	3.1				
	0.38					
	0.39					
	0.4					
	0.48					
	0.6					
	0.68					
	0.88					
	0.9					
	1					
	1					
	1.1					

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Non-Teflon
2000 Summary

	All	All Male	All Female	All Oper	All Lab	All Sup
	1.2					
	1.3					
	1.6					
	2.1					
	3.1					
Count	48	32	16	14	14	13
Average	0.48	0.60	0.24	0.59	0.79	0.12
Std Dev	0.59	0.67	0.28	0.58	0.79	0.11
Median	0.29	0.31	0.17	0.32	0.44	0.09

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 2001

Matrix: PFOA in Whole Blood

Operation: Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	23	0.23	1.45	1.1	3.7	1.06
Males	20	0.23	1.56	1.3	3.7	1.10
Females	3	0.33	0.78	0.91	1.1	0.40
Operators	18	0.49	1.72	1.45	3.7	1.04
Males	17	0.49	1.77	1.5	3.7	1.06
Females	1	0.91	0.91	0.91	0.91	-
Mechanics	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Laboratorians	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Supervision	5	0.23	0.50	0.39	1.1	0.35
Males	3	0.23	0.36	0.39	0.45	0.11
Females	2	0.33	0.72	0.72	1.1	0.54

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: December 6, 2004

DuPont Company
PFOA in Blood
Washington Works Teflon 2001

Teflon				
Operator		Supervision		
Male	Female	Male	Female	
0.49	0.91	0.23	0.33	
0.55		0.39	1.1	
0.76		0.45		
0.76				
0.79				
1.1				
1.2				
1.4				
1.5				
1.9				
1.9				
1.9				
2.6				
2.9				
2.9				
3.7				
3.7				
17	1	3	2	**Count**
1.77		0.36	0.72	**Average**
1.06		0.11	0.54	**Std Dev**
1.50		0.39	0.72	**Median**

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works Teflon
2001 Summary

	All	All Male	All Female	All Op	All Sup
	0.49	0.49	0.91	0.49	0.23
	0.55	0.55	0.33	0.55	0.39
	0.76	0.76	1.1	0.76	0.45
	0.76	0.76		0.76	0.33
	0.79	0.79		0.79	1.1
	1.1	1.1		1.1	
	1.2	1.2		1.2	
	1.4	1.4		1.4	
	1.5	1.5		1.5	
	1.9	1.9		1.9	
	1.9	1.9		1.9	
	1.9	1.9		1.9	
	2.6	2.6		2.6	
	2.9	2.9		2.9	
	2.9	2.9		2.9	
	3.7	3.7		3.7	
	3.7	3.7		3.7	
	0.91	0.23		0.91	
	0.23	0.39			
	0.39	0.45			
	0.45				
Count	21	20	3	18	5
Average	1.53	1.56	0.78	1.72	0.50
Std Dev	1.08	1.10	0.40	1.04	0.35
Median	1.2	1.3	0.91	1.45	0.39

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 2001

Matrix: PFOA in Whole Blood

Operation: Non-Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	8	0.07	0.66	0.41	1.6	0.62
Males	7	0.07	0.72	0.6	1.6	0.64
Females	1	0.22	0.22	0.22	0.22	-
Operators	3	0.12	0.16	0.14	0.22	0.05
Males	2	0.12	0.13	0.13	0.14	0.01
Females	1	0.22	0.22	0.22	0.22	-
Mechanics	1	0.07	0.07	0.07	0.07	-
Males	1	0.07	0.07	0.07	0.07	-
Females	0	-	-	-	-	-
Laboratorians	3	0.6	1.17	1.30	1.6	0.51
Males	3	0.6	1.17	1.30	1.6	0.51
Females	0	-	-	-	-	-
Supervision	1	1.2	1.2	1.2	1.2	-
Males	1	1.2	1.2	1.2	1.2	-
Females	0	-	-	-	-	-

Comments:

- Samples analyzed by National Medical Services
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: November 20, 2004

DuPont Company
PFOA in Blood
Washington Works - Non-Teflon - 2001

Non-Teflon					
Operator		Mechanic	Laboratorian	Supervision	
Male	Female	Male	Male	Male	
0.14	0.22	0.07	0.6	1.2	
0.12			1.3		
			1.6		
2	1	1	3	1	Count
0.13			1.17		Average
0.01			0.51		Std Dev
0.13			1.30		Median

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Non-Teflon
2001 Summary

	All	All Male	All Female	All Op
	0.14	0.14	0.22	0.14
	0.12	0.12		0.12
	0.22	0.07		0.22
	0.07	0.6		
	0.6	1.3		
	1.3	1.6		
	1.6	1.2		
	1.2			
Count	8	7	1	3
Average	0.66	0.72		0.16
Std Dev	0.62	0.64		0.05
Median	0.41	0.6		0.14

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 2002

Matrix: PFOA in Whole Blood

Operation: Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	43	0	1.67	1.27	5.16	1.38
Males	34	0.05	1.86	1.55	5.16	1.45
Females	9	0	0.96	0.86	2.29	0.81
Operators	32	0	2.00	1.58	5.16	1.42
Males	25	0.26	2.31	2.04	5.16	1.42
Females	7	0	0.92	0.86	2.29	0.82
Mechanics	5	0.05	0.68	0.53	1.67	0.60
Males	5	0.05	0.68	0.53	1.67	0.60
Females	0	-	-	-	-	-
Laboratorians	1	0.34	0.34	0.34	0.34	-
Males	0	-	-	-	-	-
Females	1	0.34	0.34	0.34	0.34	-
Supervision	5	0.05	0.81	0.64	1.83	0.69
Males	4	0.05	0.56	0.54	1.11	0.44
Females	1	1.83	1.83	1.83	1.83	-

Comments:

- Samples analyzed by Advion Laboratories
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: December 6, 2004

000609

DuPont Company
PFOA in Blood
Washington Works - Teflon - 2002

Teflon						
Operator		Mechanic	Laboratorian	Supervision		
Male	Female	Male	Female	Male	Female	
0.26	0	0.05	0.34	0.05	1.83	
0.49	0	0.47		0.43		
0.64	0.73	0.53		0.64		
0.86	0.86	0.7		1.11		
1.09	0.98	1.67				
1.1	1.58					
1.24	2.29					
1.27						
1.55						
1.55						
1.57						
1.65						
2.04						
2.2						
2.32						
2.47						
2.97						
3.12						
3.48						
3.59						
3.72						
3.81						
4.5						
5						
5.16						
25	7	5	1	4	1	**Count**
2.31	0.92	0.68	0.34	0.56	1.83	**Average**
1.42	0.82	0.60	0.34	0.44	1.83	**Std Dev**
2.04	0.86	0.53		0.54		**Median**

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
2002 Summary

	Teflon				
	All	Op	All Male	All Female	All Sup
	0	0	0.05	0	0.05
	0	0	0.05	0	0.43
	0.05	0.26	0.26	0.34	0.64
	0.05	0.49	0.43	0.73	1.11
	0.26	0.64	0.47	0.86	1.83
	0.34	0.73	0.49	0.98	
	0.43	0.86	0.53	1.58	
	0.47	0.86	0.64	1.83	
	0.49	0.98	0.64	2.29	
	0.53	1.09	0.7		
	0.64	1.1	0.86		
	0.64	1.24	1.09		
	0.7	1.27	1.1		
	0.73	1.55	1.11		
	0.86	1.55	1.24		
	0.86	1.57	1.27		
	0.98	1.58	1.55		
	1.09	1.65	1.55		
	1.1	2.04	1.57		
	1.11	2.2	1.65		
	1.24	2.29	1.67		
	1.27	2.32	2.04		
	1.55	2.47	2.2		
	1.55	2.97	2.32		
	1.57	3.12	2.47		
	1.58	3.48	2.97		
	1.65	3.59	3.12		
	1.67	3.72	3.48		
	1.83	3.81	3.59		
	2.04	4.5	3.72		
	2.2	5	3.81		
	2.29	5.16	4.5		
	2.32		5		
	2.47		5.16		
	2.97				
	3.12				
	3.48				
	3.59				
	3.72				
	3.81				
	4.5				
	5				
	5.16				

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works - Teflon
2002 Summary

	Teflon				
	All	Op	All Male	All Female	All Sup
Count	43	32	34	9	5
Average	1.67	2.00	1.86	0.96	0.81
Std Dev	1.38	1.42	1.45	0.81	0.69
Median	1.27	1.58	1.55	0.86	0.64

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DATA SUMMARY

Chemical: Perfluorooctanoic Acid

Site: Washington Works, Parkersburg, West Virginia

Date of Monitoring: 2002

Matrix: PFOA in Whole Blood

Operation: Non-Teflon®

Job Title	Number Sampled	Minimum Concentration (ppm)	Mean (ppm)	Median (ppm)	Maximum Concentration (ppm)	Standard Deviation
Entire Cohort	19	0.05	0.57	0.40	2.11	0.54
Males	11	0.16	0.76	0.84	2.11	0.63
Females	8	0.05	0.30	0.27	0.56	0.21
Operators	4	0.17	0.78	0.43	2.11	0.90
Males	2	0.17	1.14	1.14	2.11	1.37
Females	2	0.29	0.43	0.43	0.56	0.19
Mechanics	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Laboratorians	9	0.24	0.76	0.84	1.47	0.38
Males	6	0.4	0.93	0.89	1.47	0.35
Females	3	0.24	0.42	0.51	0.52	0.16
Supervision	6	0.05	0.13	0.16	0.17	0.06
Males	3	0.16	0.18	0.17	0.2	0.02
Females	3	0.05	0.09	0.05	0.16	0.06

Comments:

- Samples analyzed by Advion Laboratories
- Data extracted from WW site database by site industrial hygienist Tony Playtis
- Descriptive statistics calculated using Microsoft Excel
- Operation indicates work assignment of person at time of sample and does not reflect past work history

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: November 20, 2004

DuPont Company
PFOA in Blood
Washington Works - Non-Teflon - 2002

Non-Teflon						
Operator		Laboratorian		Supervision		
Male	Female	Male	Female	Male	Female	
0.17	0.29	0.4	0.24	0.16	0.05	
2.11	0.56	0.84	0.51	0.17	0.05	
		0.88	0.52	0.2	0.16	
		0.89				
		1.08				
		1.47				
2	2	6	3	3	3	Count
1.14	0.43	0.93	0.42	0.18	0.09	Average
1.37	0.19	0.35	0.16	0.02	0.06	Std Dev
1.14	0.43	0.89	0.51	0.17	0.05	Median

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Washington Works Non-Teflon
2002 Summary

	All	All Male	All Female	All Oper	All Lab	All Sup
	0.17	0.17	0.29	0.17	0.4	0.16
	2.11	2.11	0.56	2.11	0.84	0.17
	0.29	0.4	0.24	0.29	0.88	0.2
	0.56	0.84	0.51	0.56	0.89	0.05
	0.4	0.88	0.52		1.08	0.05
	0.84	0.89	0.05		1.47	0.16
	0.88	1.08	0.05		0.24	
	0.89	1.47	0.16		0.51	
	1.08	0.16			0.52	
	1.47	0.17				
	0.24	0.2				
	0.51					
	0.52					
	0.16					
	0.17					
	0.2					
	0.05					
	0.05					
	0.16					
Count	19	11	8	4	9	6
Average	0.57	0.76	0.30	0.78	0.76	0.13
Std Dev	0.54	0.63	0.21	0.90	0.38	0.06
Median	0.40	0.84	0.27	0.43	0.84	0.16

From Washington Works FLAIR Database

Prepared November 20, 2004
Barbara J. Dawson, CIH, CSP

February 2004 C-8 Campaign

#	Last Name	First Name, M.I.	PR#	Status	Date Sampled	Plant Location	C-8 Blood Result (ppm)	Date Result Communicated to Patient	Results Entered in Flair	Work Hx Comp & Entered in Flair	Results Documented on Lab Card	Other Address
1			10060	DuPont - Active	2/19/04	B-184	0.216	6/3/2004			X	
2			4031	DuPont - Active	2/19/04	B-22	1.620	6/3/2004			X	
3			30772	DuPont - Active	2/19/04	B-168	0.068	6/3/2004			X	
4			30654	DuPont - Active	2/18/04	B-168	0.094	6/3/2004			X	
5			4924	DuPont - Active	2/18/04	B-162	5.190	6/3/2004			X	
6			10147	DuPont - Active	2/19/04	B-184	1.280	6/3/2004			X	
7			30733	DuPont - Active	2/20/04	B-162	0.771	6/3/2004			X	
8			10098	DuPont - Active	2/19/04	B-184	0.270	6/3/2004			X	
9			10534	DuPont - Active	2/18/04	B-162	0.933	6/3/2004			X	
10			10450	DuPont - Active	2/20/04	B-22	0.329	6/3/2004			X	
11			4380	DuPont - Active	2/19/04	B-184	0.402	6/3/2004			X	
12			10897	DuPont - Active	2/18/04	B-184	1.250	6/3/2004			X	
13			10792	DuPont - Active	2/18/04	B-162	2.490	6/3/2004			X	
14			4522	DuPont - Active	2/20/04	B-162	1.440	6/3/2004			X	
15			30487	DuPont - Active	2/19/04	B-212	0.510	6/3/2004			X	
16			10530	DuPont - Active	2/20/04	B-169	1.330	6/3/2004			X	
17			4226	DuPont - Active	2/21/04	B-22	0.602	6/3/2004			X	
18			4696	DuPont - Active	2/20/04	B-184	0.753	6/3/2004			X	
19			4634	DuPont - Active	2/20/04	B-162	4.220	6/3/2004			X	
20			10626	DuPont - Active	2/18/04	B-162	2.550	6/3/2004			X	
21			10540	DuPont - Active	2/18/04	B-22	0.153	6/3/2004			X	
22			10382	DuPont - Active	2/20/04	B-195	0.191	6/3/2004			X	
23			4554	DuPont - Active	2/18/04	B-22	0.209	6/3/2004			X	
24			3979	DuPont - Active	2/19/04	B-212	0.427	6/3/2004			X	
25			4344	DuPont - Active	2/21/04	B-22	1.490	6/3/2004			X	
26			10127	DuPont - Active	2/19/04	B-22	0.318	6/3/2004			X	
27			10764	DuPont - Active	2/18/04	B-22	0.524	6/3/2004			X	
28			4885	DuPont - Active	2/20/04	B-162	1.550	6/3/2004			X	
29			4196	DuPont - Active	2/18/04	B-212	0.363	6/3/2004			X	
30			10672	DuPont - Active	2/22/04	B-184	0.240	6/3/2004			X	
31			4686	DuPont - Active	2/18/04	B-162	2.750	6/3/2004			X	
32			4880	DuPont - Active	2/19/04	B-195	1.100	6/3/2004			X	
33			4848	DuPont- Active	2/18/04	B-22	1.740	6/3/2004			X	
34			3743	DuPont - Active	2/19/04	B-123	0.897	6/3/2004			X	
35			10645	DuPont - Active	2/20/04	B-162	0.846	6/3/2004			X	
36			10116	DuPont - Active	2/20/04	B-168	1.060	6/3/2004			X	
37			4552	DuPont - Active	2/19/04	B-22	1.175	6/3/2004			X	
38			90914	DuPont - Pens.	2/19/04		0.108	6/3/2004			X	

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000616

February 2004 C-8 Campaign

#	Last Name	First Name, M.I.	PR#	Status	Date Sampled	Plant Location	C-8 Blood Result (ppm)	Date Result Communicated to Patient	Results Entered in Flair	Work Hx Comp & Entered in Flair	Results Documented on Lab Card	Other Address
39			4888	DuPont - Active	2/18/04	B-212	0.616	6/3/2004			X	
40			10434	DuPont - Active	2/20/04	B-195	2.690	6/3/2004			X	
41			30792	DuPont - Active	2/19/04	B-168	0.067	6/3/2004			X	
42			10163	DuPont - Active	2/19/04	B-164	0.655	6/3/2004			X	
43			4141	DuPont - Active	2/22/04	B-163	0.996	6/3/2004			X	
44			4442	DuPont - Active	2/21/04	B-184	0.260	6/3/2004			X	
45			4669	DuPont - Active	2/18/04	B-184	2.805	6/3/2004			X	
46			4452	DuPont - Active	2/19/04	B-184	0.259	6/3/2004			X	
47			10500	DuPont - Active	2/20/04	B-162	5.170	6/3/2004			X	
48			3769	DuPont - Active	2/18/04	B-182	0.547	6/3/2004			X	
49			4408	DuPont - Active	2/19/04	B-212	0.717	6/3/2004			X	
50			9516	DuPont - Active	2/20/04	B-168	0.515	6/3/2004			X	
51			10519	DuPont - Active	2/20/04	B-162	0.614	6/3/2004			X	
52			10516	DuPont - Active	2/18/04	B-212	0.765	6/3/2004			X	
53			10165	DuPont - Active	2/18/04	B-163	0.185	6/3/2004			X	
54			4177	DuPont - Active	2/20/04	B-212	0.520	6/3/2004			X	
55			4422	DuPont - Pens.	2/18/04	B-212	0.359	6/3/2004			X	
56			4584	DuPont - Active	2/20/04	B-182	0.490	6/3/2004			X	
57			30189	DuPont - Active	2/19/04	B-22	0.178	6/3/2004			X	
58			10300	DuPont - Active	2/18/04	B-22	0.406	6/3/2004			X	
59			7806	DuPont - Active	2/23/04	B-24	0.163	6/3/2004			X	
60			10120	DuPont - Active	2/20/04	B-212	0.173	6/3/2004			X	
61			10836	DuPont - Active	2/18/04	B-22	1.850	6/3/2004			X	
62			30569	DuPont - Active	2/19/04	B-184	1.510	6/3/2004			X	
63			4825	DuPont - Active	2/18/04	B-162	1.420	6/3/2004			X	
64			4151	DuPont - Active	2/18/04	B-22	0.551	6/3/2004			X	
65			10082	DuPont - Active	2/20/04	B-162	0.580	6/3/2004			X	
66			10775	DuPont - Active	2/21/04	B-163	0.657	6/3/2004			X	
67			10511	DuPont - Active	2/19/04	B-162	2.470	6/3/2004			X	
68			4824	DuPont - Active	2/18/04	B-162	7.160	6/3/2004			X	
69			4906	DuPont - Active	2/20/04	B-195	0.501	6/3/2004			X	
70			3842	DuPont - Active	2/18/04	B-212	0.970	6/3/2004			X	
71			10652	DuPont - Active	2/19/04	B-162	7.000	6/3/2004			X	
72			10714	DuPont - Active	2/22/04	B-184	0.158	6/3/2004			X	
73			10660	DuPont - Active	2/23/04	B-182	0.533	6/3/2004			X	
74			10029	DuPont - Active	2/19/04	B-162	2.530	6/3/2004			X	
75			10346	DuPont - Active	2/18/04	B-162	1.795	6/3/2004			X	
76			4146	DuPont - Active	2/18/04	B-162	1.990	6/3/2004			X	

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February 2004 C-8 Campaign

#	Last Name	First Name, M.I.	PR#	Status	Date Sampled	Plant Location	C-8 Blood Result (ppm)	Date Result Communicated to Patient	Results Entered in Flair	Work Hx Comp & Entered in Flair	Results Documented on Lab Card	Other Address
77			10227	DuPont - Active	2/19/04	B-164	1.470	6/3/2004			X	
78			10833	DuPont - Active	2/20/04	B-168	1.330	6/3/2004			X	
79			10372	DuPont - Active	2/19/04	B-162	4.815	6/3/2004			X	
80			3854	DuPont - Active	2/18/04	B-162	6.650	6/3/2004			X	
81			3976	DuPont - Active	2/18/04	B-163	2.010	6/3/2004			X	
82			10603	DuPont - Active	2/20/04	B-182	0.104	6/3/2004			X	
83			3690	DuPont - Active	2/18/04	B-22	0.917	6/3/2004			X	
84			4898	DuPont - Active	2/19/04	B-163	2.600	6/3/2004			X	
85			4623	DuPont - Active	2/20/04	B-212	0.743	6/3/2004			X	
86			10683	DuPont - Active	2/20/04	B-182	0.196	6/3/2004			X	
87			9285	DuPont - Active	2/18/04	B-168	0.409	6/3/2004			X	
88			3927	DuPont - Active	2/19/04	B-22	0.848	6/3/2004			X	
89			30621	DuPont - Active	2/18/04	B-22	0.164	6/3/2004			X	
90			10550	DuPont - Active	2/18/04	B-162	4.340	6/3/2004			X	
91			7902	DuPont - Active	2/19/04	B-21	0.430	6/3/2004			X	
92			10356	DuPont - Active	2/20/04	B-162	0.839	6/3/2004			X	
93			30031	DuPont - Active	2/18/04	B-35T	0.376	6/3/2004			X	
94			4093	DuPont - Active	2/19/04	B-123	0.759	6/3/2004			X	
95			10214	DuPont - Active	2/18/04	B-162	3.530	6/3/2004			X	
96			10177	DuPont- Active	2/19/04	B-164	2.210	6/3/2004			X	
97			10264	DuPont - Active	2/18/04	B-162	1.340	6/3/2004			X	
98			10232	DuPont - Active	2/20/04	B-212	1.960	6/3/2004			X	
99			4485	DuPont - Active	2/22/04	B-163	0.374	6/3/2004			X	
100			10719	DuPont - Active	2/21/04	B-22	0.244	6/3/2004			X	
101			30485	DuPont - Active	2/18/04	B-162	2.270	6/3/2004			X	
102			10068	DuPont - Active	2/19/04	B-184	1.510	6/3/2004			X	
103			30794	DuPont - Active	2/20/04	B-162	1.500	6/3/2004			X	
104			4201	DuPont - Active	2/19/94	B-195	0.954	6/3/2004			X	
105			10005	DuPont - Active	2/19/04	B-163	0.479	6/3/2004			X	
106			10145	DuPont - Active	2/19/04	B-184	0.779	6/3/2004			X	

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000618

2004 HEALTH SURVEY

#	Last Name	First Name, M.I.	PR#	Status	Date Sampled	Plant Location	C-B Blood Result (ppm)	Date Result Communicated to Patient	Results Entered in Flair	Work Hx Comp & Entered in Flair	Results Documented on Lab Card	Other Address
1			9993	Active	6/3/04	B-21	0.125	7/27/2004			X	
2			10785	Active	6/3/04	B-225	0.037	7/27/2004			X	
3			30633	Active	6/5/04	B-1	0.167	7/27/2004			X	
4			6210	Active	6/4/04	B-280	0.070	7/27/2004			X	
5			30235	Active	6/5/04	B-2	0.090	7/27/2004			X	
6			7966	Active	6/4/04	B-158	0.072	7/27/2004			X	
7			10562	Active	6/5/04	B-15	0.338	7/27/2004			X	
8			30754	Active	6/5/04	B-145	0.073	7/27/2004			X	
9			10526	Active	6/4/04	B-152F	0.746	7/27/2004			X	
10			30863	Active	6/4/04	B-102	0.013	7/27/2004			X	
11			4330	Active	6/3/04	B-18	0.163	7/27/2004			X	
12			10291	Active	6/4/04	B-184	2.090	7/27/2004			X	
13			6218	Active	6/4/04	B-5	0.399	7/27/2004			X	
14			6516	Active	6/3/04	B-4	0.096	7/27/2004			X	
15			30440	Active	6/3/04	B-152F	0.035	7/27/2004			X	
16			30475	Active	6/4/04	B-215	0.217	7/27/2004			X	
17			30406	Active	6/5/04	B-6	0.097	7/27/2004			X	
18			10670	Active	6/5/04	B-301	0.158	7/27/2004			X	
19			9640	Active	6/4/04	B-21	0.542	7/27/2004			X	
20			9678	Active	6/5/04	B-22	0.086	7/27/2004			X	
21			4775	Active	6/5/04	B-207	0.276	7/27/2004			X	
22			9949	Active	6/4/04	B-21	0.186	7/27/2004			X	
23			30753	Active	6/4/04	B-18	0.464	7/27/2004			X	
24			4605	Active	6/5/04	B-226	0.221	7/27/2004			X	
25			30508	Active	6/5/04	B-13	0.063	7/27/2004			X	
26			4380	Active	6/5/04	B-184	0.376	7/27/2004			X	
27			6544	Active	6/3/04	B-20	0.340	7/27/2004			X	
28			30321	Active	6/5/04	B-1	0.060	7/27/2004			X	
29			30507	Active	6/5/04	B-18	0.038	7/27/2004			X	
30			10244	Active	6/5/04	B-226	0.203	7/27/2004			X	
31			6271	Active	6/4/04	B-158	0.095	7/27/2004			X	
32			10070	Active	6/4/04	B-280	0.066	7/27/2004			X	
33			30245	Active	6/5/04	B-285	1.200	7/27/2004			X	
34			4748	Active	6/3/04	B-22	0.177	7/27/2004			X	
35			30312	Active	6/3/04	B-3	0.055	7/27/2004			X	
36			30333	Active	6/4/04	B-280	0.194	7/27/2004			X	
37			10579	Active	6/4/04	B-207	0.211	7/27/2004			X	
38			30501	Active	6/3/04	B-1	0.069	7/27/2004			X	

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#	Last Name	First Name, M.I.	PR#	Status	Date Sampled	Plant Location	C-B Blood Result (ppm)	Date Result Communicated to Patient	Results Entered in Flair	Work Hx Comp & Entered in Flair	Results Documented on Lab Card	Other Address
39			7655	Active	6/5/04	B-24	0.219	7/27/2004			X	
40			30663	Active	6/3/04	B-158	0.057	7/27/2004			X	
41			30550	Active	6/3/04	B-18	0.138	7/27/2004			X	
42			30858	Active	6/4/04	B-18	0.337	7/27/2004			X	
43			30708	Active	6/4/04	B-168	0.242	7/27/2004			X	
44			4732	Active	6/3/04	B-5	0.158	7/27/2004			X	
45			9211	Pensioner	6/4/04	B-21T	0.162	7/29/2004			X	
46			4208	Active	6/5/04	B-301	0.319	7/27/2004			X	
47			30706	Active	6/3/04	B-5	0.963	7/27/2004			X	
48			30220	Active	6/5/04	B-145	0.100	7/27/2004			X	
49			6541	Active	6/3/04	B-1	0.039	7/27/2004			X	
50			6539	Active	6/4/04	B-280	0.050	7/27/2004			X	
51			2503	Active	6/5/04	B-20T	0.589	7/27/2004			X	
52			9674	Active	6/5/04	B-150T	0.028	7/27/2004			X	
53			10821	Active	6/4/04	B-215	0.115	7/27/2004			X	
54			4880	Active	6/4/04	B-195	1.260	7/27/2004			X	
55			10628	Active	6/4/04	B-22	0.135	7/27/2004			X	
56			9435	Active	6/4/04	B-152F	0.317	7/27/2004			X	
57			9946	Active	6/4/04	B-285	0.176	7/27/2004			X	
58			9802/92241	Pensioner	6/5/04	B-102	0.108	7/27/2004			X	
59			30655/91637	Pensioner	6/3/04	B-158	0.054	7/27/2004			X	
60			30545	Active	6/5/04	B-250	0.142	7/27/2004			X	
61			30128	Active	6/5/04	B-1	0.382	7/29/2004			X	
62			10286	Active	6/3/04	B-18	0.169	7/29/2004			X	
63			10434	Active	6/4/04	B-195	3.265	7/29/2004			X	
64			4557	Active	6/4/04	B-207	0.176	7/29/2004			X	
65			9606	Active	6/4/04	B-22	0.164	7/29/2004			X	
66			10529	Active	6/5/04	B-225	0.178	7/29/2004			X	
67			30644	Active	6/3/04	B-152	0.097	7/29/2004			X	
68			10304	Active	6/3/04	B-15	0.262	7/29/2004			X	
69			30695	Active	6/5/04	B-154	0.316	7/29/2004			X	
70			30688	Active	6/5/04	B-13	0.407	7/29/2004			X	
71			9903	Active	6/5/04	B-145	0.712	7/29/2004			X	
72			10348	Active	6/5/04	B-184	0.671	7/29/2004			X	
73			4571	Active	6/5/04	B-3	0.278	7/29/2004			X	
74			30306	Active	6/3/04	B-5	0.181	7/29/2004			X	
75			30141	Active	6/3/04	B-13	1.110	7/29/2004			X	
76			30101	Active	6/4/04	B-226	0.366	7/29/2004			X	

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#	Last Name	First Name, M.I.	PR#	Status	Date Sampled	Plant Location	C-8 Blood Result (ppm)	Date Result Communicated to Patient	Results Entered in Flair	Work Hx Comp & Entered in Flair	Results Documented on Lab Card	Other Address
77			30911	Active	6/3/04	B-1	0.018	7/29/2004			X	
78			9105	Active	6/3/04	B-1	0.033	7/29/2004			X	
79			10300	Active	6/3/04	B-22	0.387	7/29/2004			X	
80			30465	Active	6/4/04	B-168	0.272	7/29/2004			X	
81			10423	Active	6/3/04	B-256	0.430	7/29/2004			X	
82			30170	Active	6/3/04	B-207	0.281	7/29/2004			X	
83			10074	Active	6/3/04	B-152F	1.270	7/29/2004			X	
84			6518	Active	6/4/04	B-253	0.048	7/29/2004			X	
85			7762	Active	6/3/04	B-35T	0.132	7/29/2004			X	
86			7319	Active	6/3/04	B-3	0.296	7/29/2004			X	
87			10398	Active	6/5/04	B-163	2.480	7/29/2004			X	
88			6280	Active	6/4/04	B-4	0.079	7/29/2004			X	
89			30193	Active	6/5/04	B-1	0.057	7/29/2004			X	
90			30454	Active	6/4/04	B-3	0.610	7/29/2004			X	
91			6409	Active	6/4/04	B-162	0.572	7/29/2004			X	
92			9091	Active	6/3/04	B-158	0.104	7/29/2004			X	
93			10008	Active	6/5/04	B-162	1.070	7/29/2004			X	
94			10394	Active	6/4/04	B-163	5.015	7/29/2004			X	
95			30031	Active	6/3/04	B-212	0.297	7/29/2004			X	
96			6329	Active	6/4/04	B-184	0.100	7/29/2004			X	
97			9155	Active	6/4/04	B-285	0.297	7/29/2004			X	
98			10520	Active	6/4/04	B-162	1.530	7/29/2004			X	
99			30902	Active	6/5/04	B-4	0.012	7/29/2004			X	
100			30530	Active	6/3/04	B-1	0.210	7/29/2004			X	
101			7946	Active	6/5/04	B-5	0.119	7/29/2004			X	
102			4377	Active	6/5/04	B-142	0.911	7/29/2004			X	
103			9916	Active	6/5/04	B-6	0.257	7/29/2004			X	
104			30877	Active	6/11/04	B-18	0.02865	8/18/2004			X	
105			30574	Active	6/11/04	B-200	0.164	8/18/2004			X	
106			9961	Active	6/14/04	B-150	0.06415	8/18/2004			X	
107			30628	Active	6/11/04	B-168	0.233	8/18/2004			X	
108			10889	Active	6/14/04	B-301	0.09855	8/18/2004			X	
109			30728	Active	6/10/04	B-13	0.0427	8/18/2004			X	
110			30843	Active	6/9/04	B-168	0.0828	8/18/2004			X	
111			10706	Active	6/14/04	B-152	0.147	8/18/2004			X	
112			30080	Active	6/11/04	B-1	0.151	8/18/2004			X	
113			9504	Active	6/10/04	B-215	0.17	8/18/2004			X	
114			30589	Active	6/9/04	B-200	0.7875	8/18/2004			X	

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#	Last Name	First Name, M.I.	PR#	Status	Date Sampled	Plant Location	C-8 Blood Result (ppm)	Date Result Communicated to Patient	Results Entered in Flair	Work Hx Comp & Entered in Flair	Results Documented on Lab Card	Other Address
115			7950	Active	6/9/04	B-293	0.126	8/18/2004			X	
116			30338	Active	6/9/04	B-215	0.177	8/18/2004			X	
117			30081	Active	6/11/04	B-250	0.178	8/18/2004			X	
118			30024	Active	6/14/04	B-285	0.119	8/18/2004			X	
119			10636	Active	6/10/04	B-162	0.772	8/18/2004			X	
120			4704	Active	6/10/04	B-293	0.09	8/18/2004			X	
121			30705	Active	6/14/04	B-1	0.08555	8/18/2004			X	
122			10837	Active	6/14/04	B-162	0.903	8/18/2004			X	
123			7018	Active	6/9/04	B-285	0.07	8/18/2004			X	
124			10643	Active	6/9/04	B-215	0.216	8/18/2004			X	
125			10691	Active	6/10/04	B-215	0.387	8/18/2004			X	
126			10593	Active	6/10/04	B-144	0.743	8/18/2004			X	
127			30371	Active	6/10/04	B-293	0.145	8/18/2004			X	
128			4925	Active	6/9/04	B-225	0.2295	8/18/2004			X	
129			6519	Active	6/9/04	B-215	0.107	8/18/2004			X	
130			10384	Active	6/9/04	B-301	0.0699	8/18/2004			X	
131			6546	Active	6/8/04	B-145	0.05935	8/18/2004			X	
132			10454	Active	6/9/04	B-152F	0.13	8/18/2004			X	
133			10867	Active	6/10/04	B-226	0.0611	8/18/2004			X	
134			10640	Active	6/11/04	B-142	0.03275	8/18/2004			X	
135			30809	Active	6/14/04	B-21	0.225	8/18/2004			X	
136			10522	Active	6/10/04	B-152F	0.319	8/18/2004			X	
137			10625	Active	6/14/04	B-301	0.572	8/18/2004			X	
138			10545	Active	6/8/04	B-22	0.186	8/18/2004			X	
139			4419	Active	6/14/04	B-22	0.31	8/18/2004			X	
140			30653	Active	6/8/04	B-RESPT	0.0917	8/18/2004			X	
141			9027	Active	6/9/04	B-225	0.222	8/18/2004			X	
142			30194	Active	6/10/04	B-6	0.116	8/18/2004			X	
143			9868	Active	6/9/04	B-20	0.783	8/18/2004			X	
144			9192 / 92242	Pensioner	6/9/04		0.282	8/18/2004			X	
145			30738	Active	6/14/04	B-200	0.32	8/18/2004			X	
146			30590	Active	6/8/04	B-5	0.21	8/18/2004			X	
147			30487	Active	6/11/04	B-35T	0.398	8/18/2004			X	
148			9411	Active	6/11/04	B-6	0.0592	8/18/2004			X	
149			9843	Active	6/9/04	B-2	0.7405	8/18/2004			X	
150			30525	Active	6/10/04	B-13	0.0376	8/18/2004			X	
151			10287	Active	6/9/04	B-144	0.279	8/18/2004			X	
152			9799	Active	6/9/04	B-293	0.2465	8/18/2004			X	

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#	Last Name	First Name, M.I.	PR#	Status	Date Sampled	Plant Location	C-8 Blood Result (ppm)	Date Result Communicated to Patient	Results Entered in Flair	Work Hx Comp & Entered in Flair	Results Documented on Lab Card	Other Address
153			9771	Active	6/10/04	B-21	0.292	8/18/2004			X	
154			10626	Active	6/10/04	B-162	2.63	8/18/2004			X	
155			10540	Active	6/14/04	B-22	0.151	8/18/2004			X	
156			30681	Active	6/10/04	B-22	0.0811	8/18/2004			X	
157			30613	Active	6/11/04	B-609	0.008625	8/18/2004			X	
158			10367	Active	6/11/04	B-162	1.04	8/18/2004			X	
159			10591	Active	6/8/04	B-152F	0.108	8/18/2004			X	
160			9345 / 92263	Pensioner	6/9/04		0.3925	8/18/2004			X	
161			4402	Active	6/11/04	B-293	0.0861	8/18/2004			X	
162			10905	Active	6/10/04	B-250	0.154	8/18/2004			X	
163			30287	Active	6/14/04	B-24	0.173	8/18/2004			X	
164			4827	Active	6/8/04	B-152F	0.109	8/18/2004			X	
165			7365	Active	6/10/04	B-21	0.534	8/18/2004			X	
166			6455	Active	6/10/04	B-4	0.149	8/18/2004			X	
167			30316	Active	6/9/04	B-158	0.22	8/18/2004			X	
168			10492	Active	6/10/04	B-162	0.769	8/18/2004			X	
169			30865	Active	6/14/04	B-168	0.0337	8/18/2004			X	
170			10610	Active	6/11/04	B-184	0.493	8/18/2004			X	
171			10156	Active	6/14/04	B-162	0.3525	8/18/2004			X	
172			10393	Active	6/10/04	B-22	0.252	8/18/2004			X	
173			9065	Active	6/11/04	B-22	0.426	8/18/2004			X	
174			10532	Active	6/14/04	B-22	0.236	8/18/2004			X	
175			6545	Active	6/14/04	B-170T	0.528	8/18/2004			X	
176			10328	Active	6/10/04	B-293	0.0495	8/18/2004			X	
177			30096	Active	6/10/04	B-142	0.132	8/18/2004			X	
178			10180	Active	6/11/04	B-164	2.38	8/18/2004			X	
179			30650	Active	6/11/04	B-195	0.273	8/18/2004			X	
180			3215	Active	6/14/04	B-5	0.109	8/18/2004			X	
181			10217	Active	6/8/04	B-3	0.334	8/18/2004			X	
182			4624	Active	6/11/04	B-200	0.199	8/18/2004			X	
183			4723	Active	6/14/04	B-152F	0.428	8/18/2004			X	
184			30125 / 92240	Pensioner	6/10/04		0.1385	8/18/2004			X	
185			9932	Active	6/9/04	B-280	0.183	8/18/2004			X	
186			30722	Active	6/9/04	B-226	0.0351	8/18/2004			X	
187			30277	Active	6/8/04	B-35T	0.206	8/18/2004			X	
188			3743	Active	6/14/04	B-185	0.947	8/18/2004			X	
189			30202	Active	6/10/04	B-12	0.0902	8/18/2004			X	
190			30666	Active	6/11/04	B-184T	0.101	8/18/2004			X	

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#	Last Name	First Name, M.I.	PR#	Status	Date Sampled	Plant Location	C-8 Blood Result (ppm)	Date Result Communicated to Patient	Results Entered in Flair	Work Hx Comp & Entered in Flair	Results Documented on Lab Card	Other Address
191			30607	Active	6/9/04	B-6	0.275	8/18/2004			X	
192			30250	Active	6/9/04	B-3	0.294	8/18/2004			X	
193			30249	Active	6/10/04	B-293	0.094	8/18/2004			X	
194			4619	Active	6/14/04	B-152F	0.189	8/18/2004			X	
195			9365	Active	6/11/04	B-150	0.0631	8/18/2004			X	
196			9795	Active	6/10/04	B-145	0.156	8/18/2004			X	
197			4912	Active	6/11/04	B-142	0.0935	8/18/2004			X	
198			30766	Active	6/11/04	B-168	0.208	8/18/2004			X	
199			4888	Active	6/11/04	B-212	0.496	8/18/2004			X	
200			9416	Active	6/9/04	B-21	0.204	8/18/2004			X	
201			30370	Active	6/11/04	B-207	0.206	8/18/2004			X	
202			4768	Active	6/10/04	B-207	0.1345	8/18/2004			X	
203			7834 / 92338	Pensioner	6/14/04		0.179	8/18/2004			X	
204			3933	Active	6/11/04	B-280	0.0899	8/18/2004			X	
205			6497	Active	6/11/04	B-1	0.106	8/18/2004			X	
206			30606	Active	6/8/04	B-22	0.136	8/18/2004			X	
207			6493 / 92270	Pensioner	6/14/04		0.0845	8/18/2004			X	
208			1384 / 92272	Pensioner	6/8/04		0.0763	8/18/2004			X	
209			10666	Active	6/11/04	B-293	0.0328	8/18/2004			X	
210			30396	Active	6/8/04	B-21T	0.24	8/18/2004			X	
211			10013	Active	6/8/04	B-215	0.416	8/18/2004			X	
212			30303 / 92258	Pensioner	6/9/04		0.15	8/18/2004			X	
213			4836	Active	6/9/04	B-164	2.59	8/18/2004			X	
214			7271	Active	6/10/04	B-6	0.389	8/18/2004			X	
215			3910	Active	6/10/04	B-609	0.23	8/18/2004			X	
216			10418	Active	6/8/04	B-301	0.208	8/18/2004			X	
217			10270	Active	6/11/04	B-293	0.0373	8/18/2004			X	
218			6502	Active	6/10/04	B-150	0.139	8/18/2004			X	
219			4462	Active	6/11/04	B-152	0.076	8/18/2004			X	
220			30203	Active	6/14/04	B-1	0.152	8/18/2004			X	
221			9780	Active	6/8/04	B-215	0.457	8/18/2004			X	
222			10401	Active	6/14/04	B-142	0.219	8/18/2004			X	
223			9670	Active	6/8/04	B-21	0.28	8/18/2004			X	
224			10330	Active	6/11/04	B-293	0.0233	8/18/2004			X	
225			30803	Active	6/8/04	B-5	0.0788	8/18/2004			X	
226			10012	Active	6/8/04	B-22	0.131	8/18/2004			X	
227			30408	Active	6/10/04	B-21T	0.254	8/18/2004			X	
228			30436	Active	6/8/04	B-215	0.204	8/18/2004			X	

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#	Last Name	First Name, M.I.	PR#	Status	Date Sampled	Plant Location	C-8 Blood Result (ppm)	Date Result Communicated to Patient	Results Entered in Flair	Work Hx Comp & Entered in Flair	Results Documented on Lab Card	Other Address
229			9293	Active	6/14/04	B-145	0.1925	8/18/2004			X	
230			10148	Active	6/10/04	B-162	1.47	8/18/2004			X	
231			6515	Active	6/9/04	B-150	0.142	8/18/2004			X	
232			30675	Active	6/9/04	B-195	0.89	8/18/2004			X	
233			9378	Active	6/10/04	B-158	0.191	8/18/2004			X	
234			30230	Active	6/14/04	B-6	0.107	8/18/2004			X	
235			6551	Active	6/11/04	B-200	0.193	8/18/2004			X	
236			30034	Active	6/14/04	B-150	0.308	8/18/2004			X	
237			7177	Active	6/8/04	B-22	0.314	8/18/2004			X	
238			10080	Active	6/11/04	B-22	0.2005	8/18/2004			X	
239			7806	Active	6/9/04	B-24	0.179	8/18/2004			X	
240			4128	Active	6/8/04	B-3	0.2225	8/18/2004			X	
241			30424	Active	6/8/04	B-150	0.4655	8/18/2004			X	
242			9641	Active	6/9/04	B-285	0.0675	8/18/2004			X	
243			4760	Active	6/14/04	B-163	2.8	8/18/2004			X	
244			4130	Active	6/8/04	B-163	0.540	8/18/2004			X	
245			10631	Active	6/10/04	B-250	0.134	8/18/2004			X	
246			30402	Active	6/11/04	B-200	0.424	8/18/2004			X	
247			7841	Active	6/10/04	B-150	0.197	8/18/2004			X	
248			6081	Active	6/14/04	B-168	0.488	8/18/2004			X	
249			4399	Active	6/11/04	B-293	0.1225	8/18/2004			X	
250			4448	Active	6/11/04	B-293	0.114	8/18/2004			X	
251			30893	Active	6/10/04	B-35T	0.112	8/18/2004			X	
252			4855	Active	6/10/04	B-152F	0.226	8/18/2004			X	
253			4884	Active	6/8/04	B-142	0.516	8/18/2004			X	
254			9227	Active	6/11/04	B-1	0.00745	8/18/2004			X	
255			9468	Active	6/14/04	B-21	0.137	8/18/2004			X	
256			30233	Active	6/11/04	B-162	1.18	8/18/2004			X	
257			10894	Active	6/10/04	B-225	0.128	8/18/2004			X	
258			30672	Active	6/14/04	B-1	0.35	8/18/2004			X	
259			10276	Active	6/11/04	B-293	0.05765	8/18/2004			X	
260			7030	Active	6/10/04	B-35T	0.17	8/18/2004			X	
261			10368	Active	6/11/04	B-162	0.6	8/18/2004			X	
262			4146	Active	6/14/04	B-162	3.02	8/18/2004			X	
263			10371	Active	6/14/04	B-22	0.497	8/18/2004			X	
264			30102	Active	6/14/04	B-250	0.196	8/18/2004			X	
265			9343	Active	6/10/04	B-35T	0.181	8/18/2004			X	
266			10325	Active	6/14/04	B-15	0.231	8/18/2004			X	

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#	Last Name	First Name, M.I.	PR#	Status	Date Sampled	Plant Location	C-8 Blood Result (ppm)	Date Result Communicated to Patient	Results Entered In Flair	Work Hx Comp & Entered in Flair	Results Documented on Lab Card	Other Address
267			10541	Active	6/9/04	B-162	0.554	8/18/2004			X	
268			9706	Active	6/11/04	B-158	0.1155	8/18/2004			X	
269			30484	Active	6/8/04	B-5	0.27	8/18/2004			X	
270			10602	Active	6/9/04	B-195	0.685	8/18/2004			X	
271			10645	Active	6/14/04	B-226	0.106	8/18/2004			X	
272			10331	Active	6/10/04	B-293	0.0613	8/18/2004			X	
273			3854	Active	6/9/04	B-163	7.31	8/18/2004			X	
274			3791	Active	6/8/04	B-295	0.0987	8/18/2004			X	
275			10858	Active	6/14/04	B-215	0.0913	8/18/2004			X	
276			3690	Active	6/9/04	B-22	0.644	8/18/2004			X	
277			4623	Active	6/11/04	B-212	0.708	8/18/2004			X	
278			30860	Active	6/10/04	B-6	0.00807	8/18/2004			X	
279			10273	Active	6/11/04	B-15	0.244	8/18/2004			X	
280			9739	Active	6/9/04	B-250	0.229	8/18/2004			X	
281			4504	Active	6/10/04	B-170	3.13	8/18/2004			X	
282			10882	Active	6/8/04	EPC	0.148	8/18/2004			X	
283			30810	Active	6/10/04	B-35T	0.0317	8/18/2004			X	
284			30901	Active	6/11/04	B-158	0.00458	8/18/2004			X	
285			2912	Active	6/14/04	B-168	0.239	8/18/2004			X	
286			30839	Active	6/14/04	B-152F	0.127	8/18/2004			X	
287			30703	Active	6/14/04	B-293	0.36	8/18/2004			X	
288			4593	Active	6/9/04	B-609	0.165	8/18/2004			X	
289			4340	Active	6/9/04	B-163	1.27	8/18/2004			X	
290			4935	Active	6/8/04	B-215	0.4295	8/18/2004			X	
291			10093	Active	6/8/04	B-12	0.348	8/18/2004			X	
292			10338	Active	6/11/04	B-152F	0.657	8/18/2004			X	
293			30874	Active	6/8/04	B-200	0.0928	8/18/2004			X	
294			10249	Active	6/9/04	B-163	0.546	8/18/2004			X	
295			10152	Active	6/14/04	B-142	0.0765	8/18/2004			X	
296			10664	Active	6/9/04	B-163	0.294	8/18/2004			X	
297			30485	Active	6/11/04	B-163	3.18	8/18/2004			X	
298			4201	Active	6/8/04	B-195	0.952	8/18/2004			X	
299			30247	Active	6/6/04	B-168	0.242	8/18/2004			X	
300			4583	Active	6/30/04	B-3	0.352	9/17/2004				
301			30050	Active	6/24/04	B-168	1.57	9/17/2004				
302			4329	Active	7/2/04	B-163	0.429	9/16/2004				
303			10364	Active	7/12/04	B-152	0.15	9/15/2004				
304			3861	Active	6/23/04	B-293	0.1545	9/17/2004				

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#	Last Name	First Name, M.I.	PR#	Status	Date Sampled	Plant Location	C-8 Blood Result (ppm)	Date Result Communicated to Patient	Results Entered in Flair	Work Hx Comp & Entered in Flair	Results Documented on Lab Card	Other Address
305			9681	Active	6/18/04	B-145	0.107	9/16/2004				
306			10491	Active	6/24/04	B-163	1.1	9/17/2004				
307			7682	Active	6/23/04	B-22	0.2325	9/17/2004				
308			30062	Active	7/9/04	B-200	0.0199	9/15/2004				
309			9723	Active	7/8/04	B-145	0.0956	9/16/2004				
310			4159	Active	7/1/04	B-12	0.221	9/15/2004				
311			9119	Active	7/14/04	B-21	0.0583	9/17/2004				
312			10723	Active	7/19/04	B-163	0.8055	9/17/2004				
313			10453	Active	6/24/04	B-12	0.351	9/17/2004				
314			10561	Active	7/1/04	B-250	0.192	9/15/2004				
315			4468	Active	6/15/04	B-27	0.315	9/16/2004				
316			4031	Active	7/9/04	B-22	1.38	9/17/2004				
317			30696	Active	7/6/04	B-21	0.083	9/16/2004				
318			10572	Active	7/13/04	B-16	0.256	9/15/2004				
319			30772	Active	6/16/04	B-168	0.118	9/16/2004				
320			9860	Active	6/29/04	B-18	0.104	9/15/2004				
321			10438	Active	7/12/04	B-295	0.0673	9/16/2004				
322			4034	Active	6/15/04	B-301	0.133	9/15/2004				
323			10066	Active	6/21/04	B-22	0.165	9/15/2004				
324			10212	Active	7/13/04	B-295	0.369	9/15/2004				
325			30568	Active	7/14/04	B-168	0.157	9/17/2004				
326			30654	Active	7/6/04	B-168	0.0657	9/17/2004				
327			4924	Active	6/17/04	B-162	5.09	9/16/2004				
328			10449	Active	7/13/04	B-200	0.2365	9/15/2004				
329			6417	Active	6/22/04	B-21	0.184	9/16/2004				
330			4616	Active	7/9/04	B-163	3.16	9/17/2004				
331			6433	Active	7/9/04	B-285	0.231	9/17/2004				
332			6187	Active	7/1/04	B-293	0.0906	9/15/2004				
333			3991	Active	6/30/04	B-27	0.537	9/17/2004				
334			7953	Active	6/29/04	B-5	0.1455	9/17/2004				
335			4777	Active	7/19/04	B-142	0.05225	9/17/2004				
336			7050/92247	Pensioner	6/24/04		0.715	9/17/2004				
337			10184	Active	6/22/04	B-3	0.0695	9/15/2004				
338			6547	Active	6/23/04	B-13	0.0264	9/15/2004				
339			9679	Active	7/9/04	B-21T	0.169	9/17/2004				
340			30258	Active	6/16/04	B-184	0.29	9/16/2004				
341			30013	Active	6/24/04	B-24	0.38	9/17/2004				
342			30390	Active	6/26/04	B-163	0.558	9/16/2004				

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#	Last Name	First Name, M.I.	PR#	Status	Date Sampled	Plant Location	C-8 Blood Result (ppm)	Date Result Communicated to Patient	Results Entered in Flair	Work Hx Comp & Entered in Flair	Results Documented on Lab Card	Other Address
343			4623	Active	7/9/04	B-142	0.09	9/17/2004				
344			9992	Active	6/23/04	B-102	0.0684	9/16/2004				
345			10588	Active	6/26/04	B-152F	0.164	9/15/2004				
346			9487	Active	6/21/04	B-226	0.0584	9/16/2004				
347			4275	Active	7/9/04	B-163	0.149	9/17/2004				
348			30637	Active	6/21/04	B-293	0.03445	9/15/2004				
349			30649	Active	6/18/04	B-285	0.0191	9/16/2004				
350			30326	Active	6/26/04	B-6	0.171	9/16/2004				
351			10629	Active	6/22/04	B-182	0.349	9/16/2004				
352			30760	Active	6/24/04	B-5	0.411	9/16/2004				
353			10825	Active	6/23/04	B-40	0.435	9/15/2004				
354			30910	Active	6/15/04	B-145	0.00573	9/16/2004				
355			10303	Active	7/7/04	B-22	0.055	9/15/2004				
356			10413	Active	7/13/04	B-226	0.0748	9/15/2004				
357			3764	Active	6/26/04	B-207	0.411	9/15/2004				
358			9956	Active	7/16/04	B-200	0.14	9/17/2004				
359			30425	Active	7/6/04	B-158	0.0483	9/17/2004				
360			10194	Active	6/17/04	B-163	1.49	9/17/2004				
361			10676	Active	6/16/04	B-250	0.116	9/16/2004				
362			30360	Active	6/24/04	B-150	0.187	9/17/2004				
363			10226	Active	6/29/04	B-250	0.0298	9/17/2004				
364			4691	Active	7/16/04	B-22	0.279	9/17/2004				
365			4695	Active	7/19/04	B-152	0.114	9/17/2004				
366			30033	Active	7/1/04	B-285	0.511	9/17/2004				
367			30309	Active	7/6/04	B-6	0.0781	9/17/2004				
368			4108	Active	7/8/04	B-163	0.372	9/17/2004				
369			4348	Active	6/24/04	B-142	0.0924	9/16/2004				
370			10534	Active	6/15/04	B-162	0.708	9/16/2004				
371			10823	Active	6/22/04	B-609	0.0986	9/16/2004				
372			10057	Active	6/16/04	B-152F	0.0768	9/16/2004				
373			30832	Active	6/22/04	B-21	0.0398	9/15/2004				
374			10854	Active	7/13/04	B-142	0.655	9/15/2004				
375			30841	Active	7/15/04	B-168	0.0254	9/17/2004				
376			10708	Active	6/21/04	B-226	0.0651	9/15/2004				
377			10690	Active	6/23/04	B-225	0.0256	9/15/2004				
378			10168	Active	6/15/04	B-163	0.204	9/16/2004				
379			30533	Active	6/16/04	B-22	0.261	9/16/2004				
380			4587	Active	7/8/04	B-22	0.2495	9/16/2004				

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#	Last Name	First Name, M.I.	PR#	Status	Date Sampled	Plant Location	C-8 Blood Result (ppm)	Date Result Communicated to Patient	Results Entered in Flair	Work Hx Comp & Entered in Flair	Results Documented on Lab Card	Other Address
381			4658	Active	7/8/04	B-22	0.209	9/16/2004				
382			9880	Active	6/30/04	B-150	0.0952	9/17/2004				
383			6117	Active	6/25/04	B-13	0.0478	9/15/2004				
384			30411	Active	6/24/04	B-280	0.1125	9/17/2004				
385			10826	Active	7/15/04	B-215	0.0926	9/17/2004				
386			10315	Active	6/24/04	B-40	0.136	9/16/2004				
387			10353	Active	6/21/04	B-301	0.445	9/16/2004				
388			4621	Active	6/15/04	B-163	0.7075	9/16/2004				
389			10907	Active	6/15/04	B-250	0.332	9/16/2004				
390			10757	Active	6/23/04	B-40	0.384	9/15/2004				
391			10828	Active	7/6/04	B-609	0.07795	9/15/2004				
392			10838	Active	6/21/04	B-226	0.0775	9/16/2004				
393			10125	Active	7/8/04	B-225	0.0571	9/17/2004				
394			9596	Active	7/13/04	B-35T	0.0356	9/15/2004				
395			4065	Active	7/9/04	B-295	0.316	9/17/2004				
396			4755	Active	7/15/04	B-15	0.232	9/17/2004				
397			10442	Active	7/19/04	B-18	1.15	9/17/2004				
398			30882	Active	6/16/04	B-200	0.04355	9/16/2004				
399			10075	Active	6/17/04	B-158	0.104	9/16/2004				
400			30817	Active	6/16/04	B-170	0.1035	9/16/2004				
401			4501	Active	7/16/04	B-21	0.114	9/15/2004				
402			10406	Active	7/12/04	B-158	0.0661	9/15/2004				
403			4721	Active	6/17/04	B-152F	0.05125	9/16/2004				
404			10692	Active	7/19/04	B-22	0.0721	9/17/2004				
405			30095	Active	6/21/04	B-182	0.198	9/15/2004				
406			30552	Active	6/15/04	B-35T	0.136	9/15/2004				
407			4062/92236	Pensioner	6/25/04	B-15	0.128	9/17/2004				
408			4674	Active	7/14/04	B-152	0.287	9/15/2004				
409			4085	Active	7/2/04	B-207	0.445	9/15/2004				
410			7817	Active	6/15/04	B-6	0.248	9/16/2004				
411			6400	Active	6/18/04	B-21	0.171	9/16/2004				
412			30669	Active	6/18/04	B-20T	0.562	9/16/2004				
413			30209	Active	6/22/04	B-158	0.0695	9/15/2004				
414			10637	Active	6/29/04	B-162	0.797	9/17/2004				
415			30463	Active	7/15/04	B-184T	0.336	9/17/2004				
416			10607	Active	7/12/04	B-152F	0.252	9/15/2004				
417			30837	Active	7/6/04	B-12	0.279	9/17/2004				
418			4247	Active	7/8/04	B-163	1.05	9/17/2004				

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2004 HEALTH SURVEY

#	Last Name	First Name, M.I.	PR#	Status	Date Sampled	Plant Location	C-8 Blood Result (ppm)	Date Result Communicated to Patient	Results Entered in Flair	Work Hx Comp & Entered in Flair	Results Documented on Lab Card	Other Address
419			10334	Active	6/18/04	B-225	0.1535	9/16/2004				
420			30894	Active	7/15/04	B-293	0.0271	9/17/2004				
421			10176	Active	6/23/04	B-22	0.289	9/15/2004				
422			6423	Active	7/15/04	B-21	0.1185	9/17/2004				
423			10322	Active	6/18/04	B-162	1.53	9/16/2004				
424			10897	Active	6/23/04	B-162	1.38	9/17/2004				
425			10447	Active	7/8/04	B-295	0.211	9/16/2004				
426			4666	Active	6/29/04	B-152F	0.218	9/15/2004				
427			4210	Active	6/21/04	B-226	0.18	9/15/2004				
428			30797	Active	7/14/04	B-163	0.123	9/17/2004				
429			10196	Active	6/29/04	B-142	0.1255	9/15/2004				
430			9834	Active	6/22/04	B-168	0.837	9/16/2004				
431			30293	Active	6/24/04	B-168	2.07	9/17/2004				
432			6161	Active	6/22/04	B-3	0.252	9/16/2004				
433			10555	Active	7/6/04	B-180T	0.5315	9/16/2004				
434			10874	Active	7/16/04	B-250	0.13	9/16/2004				
435			4767	Active	6/17/04	B-152F	0.195	9/16/2004				
436			10644	Active	6/18/04	B-18	0.311	9/16/2004				
437			4752	Active	6/30/04	B-152	0.134	9/17/2004				
438			10407	Active	7/15/04	B-250	0.113	9/17/2004				
439			4828	Active	7/9/04	B-144	0.069	9/15/2004				
440			10888	Active	6/16/04	B-22	0.0616	9/16/2004				
441			10021	Active	6/17/04	B-142	0.189	9/16/2004				
442			4650	Active	7/19/04	B-301	0.0633	9/17/2004				
443			30755	Active	7/16/04	B-18	0.0979	9/15/2004				
444			10277	Active	6/24/04	B-609	0.133	9/15/2004				
445			30756	Active	6/30/04	B-226	0.0423	9/17/2004				
446			4751	Active	6/25/04	B-142	0.102	9/16/2004				
447			4467	Active	7/1/04	B-15	0.231	9/17/2004				
448			6499	Active	6/24/04	B-200	0.595	9/17/2004				
449			9877	Active	6/15/04	B-285	0.0353	9/16/2004				
450			10457	Active	7/19/04	B-22	0.56	9/17/2004				
451			30795	Active	6/17/04	B-163	1.12	9/16/2004				
452			10658	Active	6/16/04	B-22	0.127	9/16/2004				
453			30403	Active	6/18/04	B-142	0.7695	9/16/2004				
454			10137	Active	6/21/04	B-142	0.0953	9/15/2004				
455			4226	Active	7/13/04	B-22	0.489	9/17/2004				
456			30864	Active	6/21/04	B-21	0.025	9/16/2004				

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2004 HEALTH SURVEY

#	Last Name	First Name, M.I.	PR#	Status	Date Sampled	Plant Location	C-8 Blood Result (ppm)	Date Result Communicated to Patient	Results Entered in Flair	Work Hx Camp & Entered in Flair	Results Documented on Lab Card	Other Address
457			9756	Active	7/1/04	B-8	0.439	9/15/2004				
458			30048	Active	7/14/04	B-35T	0.137	9/15/2004				
459			10812	Active	6/25/04	B-144	0.06265	9/17/2004				
460			9669	Active	6/16/04	B-22	0.357	9/16/2004				
461			7060	Active	6/17/04	B-24	0.143	9/16/2004				
462			7819	Active	6/15/04	B-293	0.0579	9/16/2004				
463			10053	Active	6/22/04	B-250	0.0973	9/15/2004				
464			10197	Active	6/23/04	B-152F	0.211	9/15/2004				
465			9697	Active	6/24/04	B-162	0.728	9/17/2004				
466			30808	Active	6/30/04	B-226	0.0342	9/17/2004				
467			30873	Active	7/16/04	B-152	0.115	9/17/2004				
468			10284	Active	6/30/04	B-35T	0.193	9/17/2004				
469			10416	Active	6/18/04	B-226	0.0742	9/16/2004				
470			6550	Active	6/16/04	B-13	0.0698	9/16/2004				
471			4098	Active	7/1/04	B-3	0.1366	9/15/2004				
472			10327	Active	6/22/04	B-152	0.206	9/15/2004				
473			4659	Active	7/8/04	B-225	0.197	9/17/2004				
474			30818	Active	7/19/04	B-285	0.237	9/17/2004				
475			10653	Active	6/21/04	B-142	0.0575	9/15/2004				
476			4712	Active	6/24/04	B-163	0.155	9/17/2004				
477			30210	Active	6/29/04	B-158	0.048	9/17/2004				
478			4305	Active	6/15/04	B-250	0.0931	9/16/2004				
479			4787	Active	6/17/04	B-142	0.266	9/16/2004				
480			4634	Active	6/16/04	B-170	4.415	9/17/2004				
481			10161	Active	7/8/04	B-280	0.0255	9/17/2004				
482			10461	Active	7/16/04	B-250	0.22	9/16/2004				
483			4264	Active	6/24/04	B-200	0.3175	9/17/2004				
484			10383	Active	7/9/04	B-5	0.619	9/17/2004				
485			4861	Active	7/16/04	B-5	0.052	9/15/2004				
486			9202	Active	6/24/04	B-168	0.467	9/16/2004				
487			4569	Active	6/16/04	B-22	0.4425	9/16/2004				
488			9661	Active	6/30/04	B-6	0.167	9/17/2004				
489			10865	Active	6/21/04	B-22	0.0702	9/15/2004				
490			30002	Active	7/1/04	B-158	0.0548	9/15/2004				
491			30229	Active	6/18/04	B-6	0.467	9/16/2004				
492			4720	Active	6/21/04	B-207	0.18	9/15/2004				
493			10902	Active	7/8/04	B-301	0.0281	9/17/2004				
494			10576	Active	6/26/04	B-15	0.503	9/16/2004				

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2004 HEALTH SURVEY

#	Last Name	First Name, M.I.	PR#	Status	Date Sampled	Plant Location	C-8 Blood Result (ppm)	Date Result Communicated to Patient	Results Entered in Flair	Work Hx Comp & Entered in Flair	Results Documented on Lab Card	Other Address
495			10382	Active	7/6/04	B-195	0.159	9/16/2004				
496			10635	Active	6/30/04	B-163	0.173	9/17/2004				
497			7869	Active	6/30/04	B-22	0.174	9/17/2004				
498			10452	Active	6/25/04	B-162	0.422	9/15/2004				
499			10028	Active	6/21/04	B-142	0.0576	9/15/2004				
500			30857	Active	6/26/04	B-21	0.0429	9/15/2004				
501			10468	Active	6/30/04	B-215	0.242	9/17/2004				
502			7835	Active	6/18/04	B-293	0.311	9/16/2004				
503			7879	Active	6/24/04	B-168	0.369	9/17/2004				
504			7830	Active	7/16/04	B-21	0.559	9/17/2004				
505			9242	Active	6/23/04	B-166	0.198	9/15/2004				
506			10799	Active	6/23/04	B-162	0.281	9/16/2004				
507			3808	Active	6/24/04	B-3	0.271	9/15/2004				
508			4344	Active	7/16/04	B-22	1.21	9/15/2004				
509			10414	Active	6/21/04	B-163	6.81	9/15/2004				
510			30421	Active	7/2/04	B-35T	0.2815	9/17/2004				
511			4221	Active	6/30/04	B-301	0.309	9/17/2004				
512			10665	Active	6/30/04	B-225	0.0822	9/17/2004				
513			30583	Active	6/18/04		0.1	9/17/2004				
514			30491	Active	7/8/04	B-265	0.19	9/17/2004				
515			7135/92261	Pensioner	6/16/04		0.067	9/17/2004				
516			10903	Active	7/12/04	B-144	0.145	9/15/2004				
517			4192	Active	6/16/04	B-609	0.241	9/16/2004				
518			10475	Active	6/29/04	B-152F	0.213	9/15/2004				
519			10363	Active	6/30/04	B-142	0.254	9/17/2004				
520			10086	Active	6/21/04	B-163	0.401	9/16/2004				
521			10542	Active	6/25/04	B-163	1.52	9/17/2004				
522			30848	Active	6/26/04	B-226	0.0451	9/16/2004				
523			9957	Active	6/26/04	B-200	0.251	9/16/2004				
524			9677	Active	7/8/04	B-163	2.39	9/17/2004				
525			10797	Active	7/16/04	B-152	0.4	9/17/2004				
526			9804	Active	6/15/04	B-142	0.1215	9/16/2004				
527			4179	Active	6/17/04	B-18	0.192	9/16/2004				
528			4675	Active	6/30/04	B-15	0.579	9/17/2004				
529			9422	Active	6/22/04	B-1	0.363	9/15/2004				
530			10790	Active	6/15/04	B-226	0.182	9/16/2004				
531			30833	Active	7/1/04	B-150	0.0128	9/15/2004				
532			4851	Active	6/21/04	B-215	0.159	9/16/2004				

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2004 HEALTH SURVEY

#	Last Name	First Name, M.I.	PR#	Status	Date Sampled	Plant Location	C-8 Blood Result (ppm)	Date Result Communicated to Patient	Results Entered in Flair	Work Hx Comp & Entered in Flair	Results Documented on Lab Card	Other Address
533			10835	Active	7/1/04	B-152F	0.0235	9/15/2004				
534			10154	Active	7/8/04	B-301	0.272	9/17/2004				
535			10014	Active	6/23/04	B-22	0.131	9/17/2004				
536			9921	Active	6/23/04	B-12	0.147	9/15/2004				
537			4482	Active	6/23/04	B-18	0.212	9/15/2004				
538			30144	Active	6/23/04	B-2	0.0999	9/17/2004				
539			30519	Active	6/23/04	B-142	0.0944	9/15/2004				
540			10839	Active	7/6/04	B-22	0.0359	9/17/2004				
541			30825	Active	6/26/04	B-4	0.0577	9/16/2004				
542			30311	Active	6/17/04	B-22	0.31	9/16/2004				
543			4019	Active	7/1/04	B-152F	0.154	9/17/2004				
544			4068	Active	6/23/04	B-152F	0.196	9/15/2004				
545			30393	Active	6/23/04	B-163	0.6095	9/15/2004				
546			2927	Active	7/19/04	B-3	0.249	9/17/2004				
547			10090	Active	7/14/04	B-18	0.315	9/17/2004				
548			6446	Active	6/23/04	B-4	0.127	9/17/2004				
549			10296	Active	6/25/04	B-226	0.163	9/15/2004				
550			10762	Active	6/21/04	B-152F	0.0916	9/15/2004				
551			10601	Active	6/18/04	B-184	1.095	9/16/2004				
552			30103	Active	6/29/04	B-35T	0.244	9/15/2004				
553			10410	Active	7/12/04	B-280	0.119	9/15/2004				
554			3953	Active	6/22/04	B-22	0.45	9/15/2004				
555			30679	Active	6/23/04	B-152F	0.144	9/16/2004				
556			10056	Active	6/26/04	B-162	8.27	9/16/2004				
557			10742	Active	6/30/04	B-15	0.207	9/17/2004				
558			10677	Active	6/25/04	B-152	0.0378	9/16/2004				
559			10107	Active	7/9/04	B-170	1.31	9/15/2004				
560			4225	Active	7/6/04	B-225	0.104	9/17/2004				
561			4606	Active	6/24/04	B-226	0.189	9/17/2004				
562			30261	Active	7/16/04	B-5	0.231	9/15/2004				
563			31000	Active	7/14/04	B-168	0.574	9/17/2004				
564			30184	Active	7/8/04	B-24	0.234	9/17/2004				
565			6500	Active	6/23/04	B-3	0.0543	9/16/2004				
566			10099	Active	7/12/04	B-184	0.307	9/15/2004				
567			4525	Active	6/30/04	B-207	0.22	9/17/2004				
568			30609	Active	7/9/04	B-301	0.186	9/15/2004				
569			4917	Active	7/2/04	B-225	0.169	9/15/2004				
570			30264	Active	8/22/04	B-285	0.0842	9/16/2004				

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2004 HEALTH SURVEY

#	Last Name	First Name, M.I.	PR#	Status	Date Sampled	Plant Location	C-8 Blood Result (ppm)	Date Result Communicated to Patient	Results Entered in Flair	Work Hx Comp & Entered in Flair	Results Documented on Lab Card	Other Address
571			6181	Active	7/1/04	B-168	0.127	9/17/2004				
572			10292	Active	6/17/04	B-22	0.151	9/16/2004				
573			30671	Active	6/18/04	B-168	0.166	9/16/2004				
574			4345	Active	7/1/04	B-22	1.04	9/15/2004				
575			10584	Active	6/26/04	B-162	0.852	9/15/2004				
576			9844	Active	7/8/04	B-168	0.231	9/16/2004				
577			4885	Active	7/12/04	B-162	3.92	9/15/2004				
578			30097	Active	7/15/04	B-182	0.307	9/17/2004				
579			10390	Active	7/8/04	B-5	0.1895	9/17/2004				
580			4902	Active	6/29/04	B-162	1.38	9/17/2004				
581			9577	Active	7/14/04	B-5	0.17	9/17/2004				
582			30100	Active	7/8/04	B-280	0.06455	9/17/2004				
583			10606	Active	7/16/04	B-152F	0.096	9/17/2004				
584			4196	Active	6/26/04	B-163	0.272	9/15/2004				
585			4262	Active	6/29/04	B-250	0.172	9/15/2004				
586			10718	Active	7/16/04	B-158	0.101	9/15/2004				
587			10027	Active	7/16/04	B-184	0.778	9/17/2004				
588			10684	Active	7/2/04	B-162	0.199	9/17/2004				
589			3628	Active	6/24/04	B-152F	0.189	9/16/2004				
590			10832	Active	6/29/04	B-15	0.0824	9/15/2004				
591			4255	Active	6/21/04	B-256	0.1	9/16/2004				
592			10140	Active	7/8/04	B-163	0.24435	9/17/2004				
593			10470	Active	7/9/04	B-15	0.256	9/17/2004				
594			10760	Active	7/9/04	B-15	0.449	9/17/2004				
595			4848	Active	7/6/04	B-22	0.767	9/15/2004				
596			30677	Active	6/30/04	B-162	0.628	9/17/2004				
597			9822	Active	6/26/04	B-250	0.128	9/16/2004				
598			30718	Active	6/17/04	B-20	0.202	9/16/2004				
599			10651	Active	7/14/04	B-18	2.04	9/17/2004				
600			10901	Active	7/19/04	B-226	0.0738	9/17/2004				
601			10633	Active	7/14/04	B-280	0.109	9/17/2004				
602			10679	Active	7/16/04	B-164	0.941	9/15/2004				
603			10429	Active	7/9/04	B-12	0.04425	9/15/2004				
604			30726	Active	7/6/04	B-168	0.172	9/15/2004				
605			4588	Active	6/15/04	B-162	0.984	9/16/2004				
606			9164	Active	6/30/04	B-168	0.3865	9/17/2004				
607			9195	Active	6/25/04	B-21	0.581	9/15/2004				
608			7864	Active	7/13/04	B-22	0.525	9/15/2004				

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2004 HEALTH SURVEY

#	Last Name	First Name, M.I.	PR#	Status	Date Sampled	Plant Location	C-8 Blood Result (ppm)	Date Result Communicated to Patient	Results Entered in Flair	Work Hx Comp & Entered in Flair	Results Documented on Lab Card	Other Address
609			7250	Active	6/23/04	B-22	0.13	9/15/2004				
610			4602	Active	6/18/04	B-162	7.66	9/16/2004				
611			4636	Active	6/25/04	B-207	0.164	9/17/2004				
612			4864	Active	6/25/04	B-260	0.121	9/17/2004				
613			9377	Active	6/18/04	B-285	0.672	9/16/2004				
614			2963/92249	Pensioner	6/24/04		0.194	9/17/2004				
615			10198	Active	6/30/04	B-226	0.128	9/17/2004				
616			10402	Active	6/26/04	B-225	0.195	9/15/2004				
617			3989	Active	7/9/04	B-18	0.419	9/17/2004				
618			3868	Active	7/8/04	B-225	0.1705	9/17/2004				
619			4358	Active	6/22/04	B-215	0.376	9/15/2004				
620			10058	Active	6/24/04	B-226	0.141	9/16/2004				
621			30490	Active	6/15/04	B-215	0.24	9/16/2004				
622			30749	Active	7/12/04	B-168	0.196	9/15/2004				
623			10645	Active	6/25/04	B-162	0.708	9/16/2004				
624			10769	Active	6/25/04	B-18	0.143	9/15/2004				
625			30819	Active	6/25/04	B-18	0.289	9/15/2004				
626			10116	Active	6/21/04	B-195	1.13	9/16/2004				
627			10035	Active	7/15/04	B-250	0.0473	9/17/2004				
628			2939	Active	6/30/04	B-168	0.471	9/17/2004				
629			7960	Active	6/26/04	B-5	0.358	9/16/2004				
630			30676	Active	6/16/04	B-293	0.02565	9/16/2004				
631			10415	Active	6/18/04	B-152	0.114	9/16/2004				
632			7212	Active	7/14/04	B-35T	1.46	9/17/2004				
633			30751	Active	6/24/04	B-5	0.0677	9/17/2004				
634			7309	Active	7/13/04	B-22	0.329	9/15/2004				
635			4845	Active	6/25/04	B-152F	0.106	9/17/2004				
636			7998	Active	7/12/04	B-21	0.0982	9/15/2004				
637			30829	Active	6/22/04	B-168	0.103	9/15/2004				
638			4200	Active	6/16/04	B-293	0.0586	9/16/2004				
639			2935	Active	6/16/04	B-145	0.058	9/16/2004				
640			10205	Active	7/13/04	B-226	0.08485	9/15/2004				
641			3621	Active	7/16/04	B-164	0.77	9/17/2004				
642			4453	Active	7/16/04	B-163	2.78	9/17/2004				
643			10003	Active	6/22/04	B-250	0.0802	9/15/2004				
644			10686	Active	6/26/04	B-609	0.1375	9/16/2004				
645			6436	Active	6/21/04	B-293	0.0615	9/16/2004				
646			10064	Active	7/13/04	B-609	0.0807	9/15/2004				

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2004 HEALTH SURVEY

#	Last Name	First Name, M.I.	PR#	Status	Date Sampled	Plant Location	C-8 Blood Result (ppm)	Date Result Communicated to Patient	Results Entered in Flair	Work Hx Comp. & Entered in Flair	Results Documented on Lab Card	Other Address
647			30762	Active	6/24/04	B-215	0.356	9/17/2004				
648			9894	Active	6/16/04	B-200	0.562	9/16/2004				
649			30851	Active	7/9/04	B-21	0.0313	9/15/2004				
650			30821	Active	6/18/04	B-3	0.659	9/16/2004				
651			4575	Active	7/19/04	B-200	0.315	9/17/2004				
652			10362	Active	6/21/04	B-22	0.1565	9/15/2004				
653			9798	Active	6/25/04	B-22	0.359	9/15/2004				
654			30736	Active	6/22/04	B-102	0.172	9/16/2004				
655			4484	Active	6/16/04	B-207	0.132	9/16/2004				
656			30796	Active	7/15/04	B-21	0.0947	9/17/2004				
657			30792	Active	7/6/04	B-168	0.114	9/15/2004				
658			30622	Active	6/16/04	B-18	0.148	9/16/2004				
659			3499	Active	6/30/04	B-256	0.117	9/17/2004				
660			30694	Active	7/8/04	B-35T	0.049	9/17/2004				
661			30428	Active	7/9/04	B-226	0.131	9/15/2004				
662			30619	Active	7/13/04	B-226	0.0855	9/15/2004				
663			10309	Active	6/18/04	B-162	2.09	9/16/2004				
664			10163	Active	7/8/04	B-163	0.6	9/17/2004				
665			30862	Active	6/29/04	B-1	0.0116	9/17/2004				
666			7770	Active	6/24/04	Ltl. Hocking	0.135	9/17/2004				
667			4442	Active	6/15/04	B-185	0.2885	9/16/2004				
668			9102	Active	6/30/04	B-21T	0.308	9/17/2004				
669			10360	Active	6/23/04	B-162	0.739	9/16/2004				
670			30448	Active	6/16/04	B-158	0.18	9/16/2004				
671			9720	Active	6/15/04	B-145	0.282	9/16/2004				
672			6529	Active	6/18/04	B-280	0.3935	9/16/2004				
673			4669	Active	7/16/04	B-185	2.06	9/17/2004				
674			30319	Active	6/23/04	B-285	0.148	9/17/2004				
675			3711	Active	7/9/04	B-225	0.235	9/15/2004				
676			4105	Active	6/25/04	B-162	0.803	9/17/2004				
677			10592	Active	7/15/04	B-152F	0.116	9/17/2004				
678			4860	Active	7/1/04	B-207	0.2565	9/17/2004				
679			4436	Active	7/1/04	B-22	0.07715	9/15/2004				
680			4116	Active	7/16/04	B-195	1.49	9/17/2004				
681			4692	Active	7/2/04	B-293	0.0349	9/15/2004				
682			30520	Active	6/26/04	B-168	0.331	9/17/2004				
683			9470	Active	6/22/04	B-168	0.421	9/16/2004				
684			4835	Active	7/13/04	B-150	0.169	9/15/2004				

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2004 HEALTH SURVEY

#	Last Name	First Name, M.I.	PR#	Status	Date Sampled	Plant Location	C-B Blood Result (ppm)	Date Result Communicated to Patient	Results Entered in Flair	Work Hx Comp & Entered in Flair	Results Documented on Lab Card	Other Address
685			10500	Active	6/24/04	B-162	9.55	9/16/2004				
686			10726	Active	7/19/04	B-215	0.111	9/17/2004				
687			3775	Active	6/24/04	B-225	0.0219	9/17/2004				
688			30704	Active	6/25/04	B-200	0.0916	9/15/2004				
689			3769	Active	7/13/04	B-169	0.439	9/15/2004				
690			10864	Active	7/15/04	B-152F	0.0822	9/17/2004				
691			6298	Active	6/25/04	B-145	0.652	9/15/2004				
692			30828	Active	6/30/04	B-35T	0.941	9/17/2004				
693			3719	Active	7/12/04	B-22	0.513	9/16/2004				
694			6537	Active	7/6/04	B-163	0.444	9/17/2004				
695			4408	Active	6/15/04	B-212	0.586	9/16/2004				
696			9820	Active	7/19/04	B-18	1.69	9/17/2004				
697			9567	Active	6/22/04	B-158	0.204	9/16/2004				
698			9516	Active	7/12/04	B-168	0.689	9/15/2004				
699			4570	Active	6/24/04	B-3	0.3515	9/17/2004				
700			30299	Active	7/2/04		0.2295	9/17/2004				
701			30605	Active	7/1/04	B-22	0.04215	9/15/2004				
702			9666	Active	6/26/04	B-1	0.096	9/17/2004				
703			4842	Active	7/8/04	B-250	0.137	9/17/2004				
704			4162	Active	6/25/04	B-301	0.559	9/15/2004				
705			6464	Active	6/30/04	B-1	0.0403	9/17/2004				
706			10710	Active	6/25/04	B-162	3.88	9/16/2004				
707			10519	Active	7/12/04	B-162	0.482	9/15/2004				
708			7942	Active	6/24/04	B-21	0.247	9/17/2004				
709			30297	Active	7/6/04	B-5	0.062	9/17/2004				
710			10807	Active	7/16/04	B-163	0.2095	9/17/2004				
711			30642	Active	6/23/04	B-168	0.138	9/15/2004				
712			7794/92246	Pensioner	6/22/04		0.0566	9/17/2004				
713			4580	Active	7/1/04	B-22	0.201	9/15/2004				
714			30049	Active	6/26/04	B-1	0.179	9/16/2004				
715			9041	Active	6/22/04	B-168	0.309	9/16/2004				
716			9173	Active	6/18/04	B-21	0.296	9/16/2004				
717			10166	Active	7/15/04	B-22	0.197	9/17/2004				
718			10570	Active	7/1/04	B-40	0.569	9/15/2004				
719			30204	Active	7/15/04	B-21T	0.0322	9/17/2004				
720			10368	Active	6/18/04	B-226	0.178	9/16/2004				
721			30147	Active	6/16/04	B-215	0.135	9/16/2004				
722			3997	Active	6/21/04	B-225	0.138	9/16/2004				

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2004 HEALTH SURVEY

#	Last Name	First Name, M.I.	PR#	Status	Date Sampled	Plant Location	C-8 Blood Result (ppm)	Date Result Communicated to Patient	Results Entered in Flair	Work Hx Comp & Entered in Flair	Results Documented on Lab Card	Other Address
723			30486	Active	6/25/04	B-22	0.159	9/17/2004				
724			10852	Active	7/16/04	B-250	0.1	9/17/2004				
725			4728	Active	6/23/04	B-225	0.2	9/17/2004				
726			4407	Active	6/21/04	B-226	0.07025	9/15/2004				
727			4025	Active	7/9/04	B-152	0.127	9/15/2004				
728			30890	Active	7/12/04	B-166	0.0373	9/15/2004				
729			10551	Active	7/15/04	B-215	0.166	9/17/2004				
730			10818	Active	6/15/04	B-142	0.0898	9/16/2004				
731			4282	Active	6/25/04	B-3	0.225	9/16/2004				
732			4622	Active	6/17/04	B-250	0.207	9/17/2004				
733			9396	Active	7/16/04	B-293	0.09775	9/15/2004				
734			30593	Active	7/8/04	B-102T	0.304	9/17/2004				
735			10234	Active	7/13/04	B-164	0.195	9/15/2004				
736			10786	Active	6/24/04	B-226	0.0604	9/17/2004				
737			4049	Active	6/16/04	B-185	0.839	9/16/2004				
738			10518	Active	6/30/04	B-22	0.172	9/17/2004				
739			30343	Active	7/16/04	B-152F	0.0967	9/17/2004				
740			30232	Active	7/16/04	B-226	0.0559	9/17/2004				
741			3755	Active	7/16/04	B-40	0.0882	9/17/2004				
742			10361	Active	7/2/04	B-250	0.0552	9/15/2004				
743			30085	Active	7/15/04	B-35T	0.408	9/17/2004				
744			10020	Active	6/22/04	B-280	0.0837	9/15/2004				
745			30664	Active	6/24/04	B-20T	0.106	9/17/2004				
746			30504	Active	6/21/04	B-285	0.0812	9/15/2004				
747			30471	Active	7/13/04	B-150	0.023	9/15/2004				
748			10299	Active	7/2/04	B-207	0.13	9/15/2004				
749			10155	Active	7/16/04	B-162	0.242	9/17/2004				
750			30785	Active	7/6/04	B-207	0.165	9/16/2004				
751			4107	Active	7/6/04	B-280	0.207	9/16/2004				
752			4689	Active	6/26/04	B-18	0.135	9/16/2004				
753			4798	Active	6/21/04	B-280	0.0478	9/16/2004				
754			9956	Active	7/1/04	B-6	0.33	9/15/2004				
755			4528/92269	Pensioner	6/17/04		1.73	9/17/2004				
756			10160	Active	6/17/04	B-163	1.24	9/16/2004				
757			9018	Active	6/17/04	B-12	0.445	9/16/2004				
758			10289	Active	6/25/04	B-163	3.18	9/16/2004				
759			10819	Active	7/19/04	B-22	0.0632	9/17/2004				
760			10793	Active	7/6/04	B-152F	0.05025	9/17/2004				

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2004 HEALTH SURVEY

#	Last Name	First Name, M.I.	PR#	Status	Date Sampled	Plant Location	C-8 Blood Result (ppm)	Date Result Communicated to Patient	Results Entered in Flair	Work Hx Comp & Entered in Flair	Results Documented on Lab Card	Other Address
761			2484	Active	7/6/04	B-6	0.1476	9/17/2004				
762			4422	Active	6/26/04	B-163	0.267	9/16/2004				
763			30667	Active	6/16/04	B-1	0.123	9/16/2004				
764			10040	Active	7/14/04	B-15	1.9	9/15/2004				
765			10743	Active	6/29/04	B-18	0.159	9/15/2004				
767			4584	Active	6/15/04	B-180T	0.492	9/16/2004				
768			9861	Active	6/17/04	B-150	0.243	9/16/2004				
769			10787	Active	6/22/04	B-152F	0.1915	9/15/2004				
770			4385	Active	6/26/04	B-295	0.05	9/17/2004				
771			6469	Active	7/8/04	B-12	0.0589	9/16/2004				
772			6232	Active	6/17/04	B-234	0.107	9/16/2004				
773			4701	Active	7/1/04	B-215	0.437	9/15/2004				
774			30447	Active	6/17/04	B-6	0.35	9/16/2004				
775			30189	Active	7/14/04	B-22	0.171	9/17/2004				
776			6424	Active	6/18/04	B-35T	0.0509	9/16/2004				
777			30331/92251	Pensioner	6/22/04		0.576	9/17/2004				
778			4783	Active	7/2/04	B-207	0.403	9/15/2004				
779			30301	Active	6/17/04	B-35T	1.59	9/16/2004				
780			10105	Active	7/15/04	B-22	0.163	9/17/2004				
781			10630	Active	6/18/04	B-256	0.296	9/16/2004				
782			9215	Active	6/22/04	B-5	0.0932	9/15/2004				
783			10004	Active	6/26/04	B-250	0.1685	9/15/2004				
784			10220	Active	7/12/04	B-144	0.476	9/15/2004				
785			10216	Active	7/19/04	B-144	0.161	9/17/2004				
786			10133	Active	6/18/04	B-207	0.227	9/16/2004				
787			30473	Active	6/23/04	B-168	0.196	9/15/2004				
789			10734	Active	6/25/04	B-152	0.143	9/17/2004				
790			30148	Active	7/14/04	B-285	0.0819	9/15/2004				
791			10091	Active	7/6/04	B-12	0.263	9/17/2004				
792			10472	Active	7/15/04	B-158	0.2435	9/17/2004				
793			10863	Active	7/1/04	B-225	0.07615	9/17/2004				
794			6068	Active	6/16/04	B-1	0.0372	9/16/2004				
795			10409	Active	6/26/04	B-163	0.6895	9/17/2004				
796			30838	Active	7/1/04	B-21	0.0556	9/15/2004				
797			10682	Active	6/21/04	B-250	0.196	9/15/2004				
798			30314	Active	7/16/04	B-3	0.116	9/17/2004				
799			31005	Active	7/16/04	B-150	0.167	9/17/2004				
800			10263	Active	7/6/04	B-180T	0.188	9/16/2004				

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2004 HEALTH SURVEY

#	Last Name	First Name, M.I.	PR#	Status	Date Sampled	Plant Location	C-8 Blood Result (ppm)	Date Result Communicated to Patient	Results Entered in Flair	Work Hx Comp & Entered in Flair	Results Documented on Lab Card	Other Address
801			30742	Active	6/25/04	B-200	0.0754	9/15/2004				
802			7235	Active	6/23/04	B-1	0.0591	9/15/2004				
803			30612	Active	6/16/04	B-150	0.04	9/16/2004				
804			30407	Active	6/17/04	B-293	0.067	9/16/2004				
805			30916	Active	6/26/04	B-162	0.881	9/15/2004				
806			30405	Active	7/6/04	B-5	0.0615	9/15/2004				
807			30423	Active	7/9/04	B-168	0.133	9/17/2004				
808			4343	Active	7/13/04	B-3	0.322	9/15/2004				
809			10306	Active	7/1/04	B-3	0.0769	9/15/2004				
810			10728	Active	6/16/04	B-280	0.257	9/16/2004				
811			10443	Active	7/16/04	B-193	0.0567	9/17/2004				
812			10836	Active	6/17/04	B-162	2.095	9/16/2004				
813			30757	Active	7/16/04	B-21	0.4045	9/17/2004				
814			10693	Active	6/18/04	B-22	0.161	9/16/2004				
815			10609	Active	6/29/04	B-226	0.05355	9/17/2004				
816			4791	Active	6/16/04	B-280	0.089	9/16/2004				
817			30569	Active	7/1/04	B-163	1.19	9/15/2004				
818			10167	Active	6/29/04	B-256	0.302	9/15/2004				
819			3969	Active	7/12/04	B-22	1.225	9/15/2004				
820			10257	Active	6/30/04	B-22	0.17	9/17/2004				
821			4818	Active	6/21/04	B-152F	0.102	9/15/2004				
822			4825	Active	7/9/04	B-163	0.877	9/17/2004				
823			10752	Active	6/25/04	B-152F	0.03995	9/17/2004				
824			4151	Active	6/23/04	B-22	0.427	9/17/2004				
825			30594	Active	7/19/04	B-152F	0.158	9/17/2004				
826			9185	Active	7/9/04	B-1	0.0557	9/17/2004				
827			4802	Active	7/19/04	B-142	0.481	9/17/2004				
828			4443	Active	6/21/04	B-207	0.206	9/16/2004				
829			30591	Active	6/30/04	B-5	0.297	9/17/2004				
830			10082	Active	6/22/04	B-162	0.604	9/15/2004				
831			10017	Active	7/15/04	B-18	0.918	9/17/2004				
832			4788	Active	7/13/04	B-152F	0.208	9/15/2004				
833			4568	Active	7/16/04	B-22	0.4945	9/17/2004				
834			10733	Active	7/13/04	B-18	0.203	9/15/2004				
835			4785	Active	7/8/04	B-207	0.0941	9/17/2004				
837			10775	Active	6/24/04	B-163	0.669	9/15/2004				
838			10495	Active	6/21/04	B-195	5.98	9/15/2004				
839			4171	Active	7/19/04	B-207	0.202	9/17/2004				

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2004 HEALTH SURVEY

#	Last Name	First Name, M.I.	PR#	Status	Date Sampled	Plant Location	C-B Blood Result (ppm)	Date Result Communicated to Patient	Results Entered in Flair	Work Hx Comp & Entered in Flair	Results Documented on Lab Card	Other Address
840			4438	Active	6/23/04	B-250	0.094	9/17/2004				
841			10392	Active	6/18/04	B-215	0.202	9/16/2004				
842			6447	Active	6/23/04	B-3	0.1275	9/15/2004				
843			10647	Active	7/6/04	B-152F	0.173	9/17/2004				
844			2821	Active	7/15/04	B-22	0.455	9/17/2004				
845			9450	Active	6/16/04	B-3	0.153	9/16/2004				
846			30502	Active	6/17/04	B-20	0.3765	9/16/2004				
847			4906	Active	6/21/04	B-195	0.494	9/15/2004				
848			10352	Active	7/9/04	B-250	0.654	9/15/2004				
849			30896	Active	??	B-168	0.0241	9/16/2004				
850			30460	Active	6/22/04	B-21T	0.286	9/16/2004				
851			30444	Active	6/16/04	B-207	0.21	9/16/2004				
852			4456	Active	6/29/04	B-152F	0.291	9/15/2004				
853			30648	Active	6/17/04	B-6	0.154	9/16/2004				
854			4820	Active	7/19/04	B-301	0.248	9/17/2004				
855			2775	Active	6/25/04	B-13	0.0991	9/17/2004				
856			30826	Active	7/15/04	B-168	0.11	9/17/2004				
857			30859	Active	6/23/04	B-5	0.0194	9/15/2004				
858			10720	Active	6/29/04	B-226	0.0374	9/15/2004				
859			10314	Active	7/6/04	B-163	0.331	9/17/2004				
860			9375	Active	6/17/04	B-6	0.316	9/16/2004				
861			10659	Active	6/25/04	B-152F	0.174	9/17/2004				
862			30468	Active	6/16/04	B-293	0.377	9/16/2004				
863			10848	Active	6/17/04	B-215	0.124	9/16/2004				
864			10370	Active	6/22/04	B-22	0.238	9/16/2004				
865			10647	Active	6/18/04	B-226	0.0335	9/16/2004				
866			10652	Active	7/6/04	B-163	5.08	9/16/2004				
867			10088	Active	7/12/04	B-144	0.0941	9/15/2004				
868			9931	Active	7/14/04	B-6	0.0174	9/17/2004				
869			30134	Active	6/18/04	B-35T	0.255	9/16/2004				
870			10317	Active	6/21/04	B-280	0.06755	9/15/2004				
871			10439	Active	6/18/04	B-152	0.114	9/16/2004				
872			4754	Active	7/6/04	B-152F	0.129	9/16/2004				
873			30482	Active	6/18/04	B-152	0.0764	9/16/2004				
874			7622	Active	6/25/04	B-21T	0.208	9/15/2004				
875			4743	Active	7/2/04	B-142	0.0413	9/17/2004				
876			10663	Active	6/15/04	B-226	0.1115	9/16/2004				
877			10158	Active	6/21/04	B-280	0.119	9/15/2004				

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2004 HEALTH SURVEY

#	Last Name	First Name, M.I.	PR#	Status	Date Sampled	Plant Location	C-8 Blood Result (ppm)	Date Result Communicated to Patient	Results Entered in Flair	Work Hx Comp & Entered in Flair	Results Documented on Lab Card	Other Address
878			10164	Active	6/26/04	B-162	0.299	9/17/2004				
879			10660	Active	6/16/04	B-160T	0.499	9/16/2004				
880			30881	Active	6/26/04	B-20	0.099	9/15/2004				
881			10450	Active	7/16/04	B-22	0.258	9/15/2004				
882			10892/92281	Pensioner	6/24/04		0.196	9/17/2004				
883			3967	Active	7/9/04	B-150	0.0413	9/17/2004				
884			30850	Active	6/30/04	B-158	0.007125	9/17/2004				
885			30375	Active	6/30/04	B-21	0.462	9/17/2004				
886			7839	Active	6/18/04	B-5	0.255	9/16/2004				
887			4682	Active	6/17/04	B-22	0.121	9/16/2004				
888			10359	Active	7/1/04	B-162	0.509	9/17/2004				
889			30611	Active	7/8/04	B-225	0.117	9/16/2004				
890			4113	Active	6/16/04	B-215	0.122	9/16/2004				
891			10712	Active	7/12/04	B-158	0.0707	9/15/2004				
892			4873	Active	7/14/04	B-162	6.54	9/15/2004				
893			30398	Active	7/1/04	B-163	0.96	9/15/2004				
894			4506	Active	6/26/04	B-200	0.215	9/17/2004				
895			6133	Active	6/15/04	B-3	0.186	9/16/2004				
896			30394	Active	6/17/04	B-22	0.246	9/16/2004				
897			30709	Active	6/21/04	B-13	0.03	9/16/2004				
898			10227	Active	7/8/04	B-163	1.61	9/17/2004				
899			10346	Active	7/8/04	B-163	1.64	9/17/2004				
900			10224	Active	7/19/04	B-22	0.123	9/17/2004				
901			10758	Active	6/29/04	B-40	0.367	9/15/2004				
902			4586	Active	6/22/04	B-22	0.172	9/15/2004				
903			30361	Active	6/30/04	B-6	0.249	9/17/2004				
904			4047	Active	7/16/04	B-22	0.27	9/17/2004				
905			4573	Active	6/25/04	B-3	0.238	9/17/2004				
906			30179	Active	6/18/04	B-13	0.152	9/16/2004				
907			30804	Active	6/18/04	B-162	1.14	9/16/2004				
908			30840	Active	6/29/04	B-18	0.268	9/17/2004				
909			10571	Active	7/15/04	B-15	0.189	9/17/2004				
910			4921	Active	6/17/04	B-250	0.5465	9/16/2004				
911			7189	Active	7/9/04	B-6	0.148	9/17/2004				
912			4895	Active	6/18/04	B-163	0.876	9/16/2004				
913			10347	Active	8/28/04	B-301	1.73	9/16/2004				
914			10106	Active	7/16/04	B-3	0.09	9/17/2004				
915			10587	Active	6/30/04	B-250	0.376	9/17/2004				

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2004 HEALTH SURVEY

#	Last Name	First Name, M.I.	PR#	Status	Date Sampled	Plant Location	C-8 Blood Result (ppm)	Date Result Communicated to Patient	Results Entered in Flair	Work Hx Comp & Entered in Flair	Results Documented on Lab Card	Other Address
916			10162	Active	7/16/04	B-609	0.164	9/17/2004				
917			4413	Active	7/16/04	B-164	1.82	9/17/2004				
918			10203	Active	6/23/04	B-301	1.69	9/17/2004				
919			4821	Active	7/14/04	B-152F	0.202	9/15/2004				
920			10337	Active	7/12/04	B-22	0.1155	9/15/2004				
921			10372	Active	7/9/04	B-163	5.09	9/17/2004				
922			10813	Active	6/25/04	B-152F	0.169	9/15/2004				
923			10222	Active	6/21/04	B-225	0.06745	9/15/2004				
924			4693	Active	7/19/04	B-152	0.102	9/17/2004				
925			30493	Active	7/9/04	B-168	0.204	9/17/2004				
926			10765	Active	6/22/04	B-152	0.164	9/17/2004				
927			10627	Active	7/12/04	B-184	0.484	9/15/2004				
928			30674	Active	6/26/04	B-21	0.0803	9/17/2004				
929			10774	Active	6/25/04	B-27	0.0633	9/15/2004				
930			4898	Active	6/29/04	B-163	2.48	9/15/2004				
931			7997	Active	7/1/04	B-6	0.146	9/15/2004				
932			7701	Active	7/19/04	B-24	0.106	9/17/2004				
933			30886	Active	7/15/04	B-150	0.0118	9/17/2004				
934			10730	Active	6/28/04	B-152F	0.182	9/15/2004				
935			10250	Active	7/6/04	B-207	0.233	9/15/2004				
936			4795	Active	6/26/04	B-250	0.0516	9/17/2004				
936			10738	Active	7/14/04	B-18	0.662	9/17/2004				
937			10553	Active	7/1/04	B-22	0.134	9/15/2004				
938			10399	Active	7/15/04	B-163	0.166	9/17/2004				
939			10269	Active	7/1/04	B-225	0.0421	9/15/2004				
940			10448	Active	6/26/04	B-18	0.316	9/16/2004				
941			4202	Active	6/29/04	B-170	1.44	9/17/2004				
942			9285	Active	6/18/04	B-6	0.412	9/16/2004				
943			4543	Active	6/23/04	B-163	4.12	9/16/2004				
944			4613	Active	6/26/04	B-15	0.225	9/16/2004				
945			10095	Active	7/12/04	B-18	0.286	9/15/2004				
946			3927	Active	6/18/04	B-22	0.788	9/16/2004				
947			30603	Active	6/18/04	B-168	0.134	9/16/2004				
948			4651	Active	7/16/04	B-152	0.0783	9/17/2004				
949			10678	Active	7/1/04	B-162	0.218	9/15/2004				
950			30621	Active	6/16/04	B-22	0.137	9/16/2004				
951			10051	Active	7/12/04	B-162	3.11	9/15/2004				
952			4564	Active	7/19/04	B-152	0.253	9/17/2004				

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2004 HEALTH SURVEY

#	Last Name	First Name, M.I.	PR#	Status	Date Sampled	Plant Location	C-8 Blood Result (ppm)	Date Result Communicated to Patient	Results Entered in Flair	Work Hx Comp & Entered in Flair	Results Documented on Lab Card	Other Address
953			9463	Active	6/24/04	B-168	0.248	9/17/2004				
954			10159	Active	7/8/04	B-180T	0.524	9/16/2004				
955			10536	Active	6/25/04	B-162	0.7	9/16/2004				
956			4737	Active	7/1/04	B-293	0.0648	9/17/2004				
957			30584	Active	6/25/04	B-226	0.264	9/15/2004				
958			10791	Active	7/19/04	B-22	0.0726	9/17/2004				
959			30702	Active	6/21/04	B-301	0.239	9/16/2004				
960			10550	Active	6/15/04	B-162	3.66	9/16/2004				
961			7902/92246	Pensioner	6/15/04		0.378	9/17/2004				
962			30539	Active	6/22/04	B-5	0.0446	9/16/2004				
963			30526	Active	6/23/04	B-163	0.26	9/15/2004				
964			10048	Active	6/15/04	B-3	0.215	9/16/2004				
965			3706	Active	6/22/04	B-207	0.467	9/16/2004				
966			10581	Active	7/14/04	B-15	0.0953	9/17/2004				
967			10661	Active	7/12/04	B-163	0.11	9/15/2004				
968			3987	Active	6/26/04	B-162	3.085	9/17/2004				
969			30451	Active	6/16/04	B-22	0.1325	9/16/2004				
970			4093	Active	7/8/04	B-185	0.591	9/17/2004				
971			30145	Active	6/17/04	B-152	0.454	9/16/2004				
972			4852	Active	6/18/04	B-293	0.136	9/16/2004				
973			10041	Active	7/14/04	B-35T	1.3	9/15/2004				
974			4288	Active	7/1/04	B-22	0.165	9/15/2004				
975			30146	Active	6/25/04	B-5	0.0789	9/17/2004				
976			10214	Active	6/23/04	B-163	4.46	9/16/2004				
977			10177	Active	7/2/04	B-170	1.52	9/15/2004				
978			10895	Active	7/1/04	B-301	0.191	9/17/2004				
979			10727	Active	7/8/04	B-142	0.0964	9/16/2004				
980			9823	Active	6/30/04	B-158	0.152	9/17/2004				
981			10761	Active	7/1/04	B-144	0.05	9/15/2004				
982			10803	Active	6/15/04	B-250	0.0545	9/16/2004				
983			10369	Active	6/17/04	B-152F	0.1425	9/16/2004				
984			10569	Active	7/13/04	B-609	0.411	9/15/2004				
985			30362	Active	6/17/04	B-168	0.151	9/16/2004				
986			3725	Active	6/22/04	B-144	0.6895	9/16/2004				
987			30059	Active	7/6/04	B-1	0.168	9/15/2004				
988			4846	Active	6/21/04	B-280	0.162	9/15/2004				
989			30731	Active	7/1/04	B-162	0.131	9/15/2004				
990			10206	Active	7/12/04	B-18	0.483	9/15/2004				

(Professional Health Services)

/gjs 11/9/2004

Redacted - Privacy

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2004 HEALTH SURVEY

#	Last Name	First Name, M.I.	PR#	Status	Date Sampled	Plant Location	C-8 Blood Result (ppm)	Date Result Communicated to Patient	Results Entered in Flair	Work Hx Comp & Entered in Flair	Results Documented on Lab Card	Other Address
991			10114	Active	6/29/04	B-152F	0.215	9/15/2004				
992			10736	Active	6/21/04	B-22	0.605	9/15/2004				
993			10464	Active	6/24/04	B-22	0.774	9/17/2004				
994			10104	Active	6/17/04	B-22	0.0617	9/16/2004				
995			9301	Active	6/29/04	B-21T	0.184	9/17/2004				
996			30884	Active	6/16/04	B-16	0.455	9/16/2004				
997			4002	Active	7/16/04	B-207	0.205	9/17/2004				
998			4485	Active	6/21/04	B-163	0.408	9/15/2004				
999			4510	Active	7/15/04	B-22	0.192	9/17/2004				
1000			10124	Active	7/13/04	B-22	0.168	9/15/2004				
1001			10719	Active	6/29/04	B-22	0.216	9/15/2004				
1002			6513	Active	6/29/04	B-1	0.172	9/15/2004				
1003			10515	Active	6/24/04	B-215	0.1246	9/15/2004				
1004			30497	Active	6/24/04	B-163	1.28	9/16/2004				
1005			10831	Active	7/6/04	B-225	0.0343	9/16/2004				
1006			2432/92274	Pensioner	6/17/04		0.0669	9/17/2004				
1007			4318	Active	6/25/04	B-256	0.069	9/15/2004				
1008			7865	Active	7/14/04	B-6	0.06725	9/15/2004				
1009			10068	Active	6/21/04	B-163	1.66	9/15/2004				
1010			30680	Active	6/30/04	B-250	0.0487	9/17/2004				
1011			9409	Active	6/23/04	B-200	0.287	9/17/2004				
1012			10574	Active	7/16/04	B-15	0.667	9/17/2004				
1013			4372	Active	7/15/04	B-22	0.244	9/17/2004				
1014			9364	Active	6/24/04	B-1	0.166	9/16/2004				
1015			4901	Active	7/15/04	B-142	0.0693	9/17/2004				
1016			10662	Active	6/23/04	B-163	1.41	9/15/2004				
1017			30794	Active	6/24/04	B-166	1.63	9/15/2004				
1018			10005	Active	6/17/04	B-164	0.445	9/16/2004				
1019			10505	Active	7/1/04	B-162	0.527	9/17/2004				
1020			30088	Active	6/25/04	B-145	0.047	9/17/2004				
1021			10763	Active	7/9/04	B-22	0.0595	9/17/2004				
1022			30130	Active	6/4/04	B-102	0.105	10/8/2004				
1023			9809	Active	6/3/04	B-293	0.0814	10/8/2004				
1024			30061	Active	6/5/04	B-21	0.136	10/8/2004				
1025			3962	Active	6/4/04	B-3	0.232	10/8/2004				
1026			7289	Pensioner	6/3/04		0.506	10/8/2004				
1027			30263	Active	6/3/04	B-35T	0.12	10/8/2004				

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2pp

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RECYCLED

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AR226-3461

WW APFO in Blood, 1985 and 1984

Job Category	Employee Number	ppm APFO 1984	ppm APFO 1985	Job Averages 1984	Job Averages 1985
08PE	[redacted]	2.5	2.4		
08PE		0.24	0.26		
08PE		1.1	0.76		
08PE		24	18		
08PE		4	2.9	6.368	4.864
08PF		2.6	2.6		
08PF		0.07	0.06		
08PF		4	2.7		
08PF		1.9	1.2		
08PF		8.7	9.2	3.454	3.152
08PF			2		2
08PH			4.2		
08PH		0.75	0.5	0.75	2.35
08PI		2			
08PI		0.5	0.4	1.25	0.4
18PA		0.76	0.76		
18PA			0.55		
18PA			0.4	0.76	0.57
18PB		1.3	1.2		
18PB		3.6			
18PB		0.77	0.62		
18PB		4.5		2.5425	0.91
18PC			0.52		0.52
18PD			0.09		0.09
18PJ		0.93		0.93	
18PK			0.06		
	Number of samples	19	22		
	Average	3.38	2.34		
	Minimum	0.07	0.06		
	Maximum	24	18		

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HALF LIFE RESULTS FROM PENSIONERS

C8 DATE	C8 PPM	RET. DATE	C8 DATE	C8 PPM	1/2 LIFE (YEARS)
4/89	5.7	4/91	3/95	4.3	9.7
3/87	1.2	6/92	3/95	1.1	22
9/81	6.5	4/85	3/95	1.1	3.9
3/88	2.8	12/92	3/95	2.2	6.5
8/84	2.4	4/85	3/95	.72	5.7*
7/84	5.9	12/81	3/95	.94	4.0*
3/85	3.0	4/85	3/95	.14	2.3*
9/82	6.3	12/82	3/95	.57	3.5*
3/88	1.7	12/93	3/95	2.4	---

For * results,

n = 4
average = 3.9
sigma = 1.4

using

$$\log \frac{n}{n_0} = \frac{-.301\ t}{t_{1/2}}$$

2pp

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WW APFO in Blood, 1989-90			
Job Category	Employee Number	ppm APFO	
08PE		0.66	
08PE		6	
08PE		1.4	
08PE		4.3	
08PE		1.5	
08PE		5.6	
08PE		11.1	
08PE		5.7	
08PE		2.9	4.35
08PF		2.9	
08PF		0.08	
08PF		2.7	
08PF		0.81	
08PF		5.4	
08PF		1.3	2.20
08PH		1.3	
08PH		0.67	
08PH		0.72	0.90
08PI		2.5	
08PI		0.71	
08PI		2.8	
08PI		1	1.75
08PJ		0.19	
08PJ		0.12	
08PJ		0.06	0.12
18PB		0.65	
18PB		0.67	
18PB		0.58	
18PB		11	
18PB		0.72	2.72
18PC		1.7	
18PC		0.42	1.06
18PK		4	4.00
	Number of samples	33	
	Average	2.49	
	Minimum	0.06	
	Maximum	11.1	

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2pp

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	Average for Job			
Job Code	1984	1985	1989-1990	1995
08PE	6.4	4.9	4.4	2.5
08PF	3.5	3.2	2.2	2.9
08PH	0.8	2.4	0.7	1.7
08PI	1.3	0.4	1.4	2.0
08PJ			0.1	0.5
08PM				1.7
18PA	0.8	0.6		2.3
18PB	2.5	0.9	2.7	1.6
18PC		0.5	1.1	3.3
18PD		0.1		0.1
18PJ	0.9			0.7
18PK			0.4	2.1
Mechanics				1.0

11 pp

AR226-3465

C-8 IN BLOOD - HISTORICAL

1978	Informed by 3M that C-8 is found in the blood of exposed workers and persists for a long time.
1979	C-8 found in blood of DuPont workers.
1980	Workers with blood C-8 found to have normal liver function.
1981	Birth defects scare - additional sampling.
1982	Blood program continues on voluntary basis - no trends noted.
1990	Formal review of blood data.
1993	Journal Of Occupational Medicine study of 3M workers.
1995	First 5-year "snapshot".

BLOOD MONITORING

THIS IS THE ONLY MEASURE WE HAVE OF TOTAL EMPLOYEE EXPOSURE

PROBLEMS

- BIOPERSISTENCE MAKES DATA INTERPRETATION DIFFICULT
- SAMPLING IS INVASIVE
- LENGTHY ANALYSIS IS RUN BY ONLY ONE LAB
- NO AEL

WASHINGTON WORKS
VOLUNTARY BLOOD TESTING

	1993	1994
0 - <1 ppm	9	47
1 - <3 ppm	2	5
>3 ppm	2	1
TOTAL	13	53

- No systematic comparison with air sampling is possible.
- C-8 specific GC analysis run by National Medical Services.
- Correlates well with new 3M analysis.

1995 C-8 IN BLOOD "SNAPSHOT"

PURPOSES

Monitor the overall effectiveness of our C-8 industrial hygiene programs.

Create and maintain a continuous data base for epidemiologic surveillance of our exposed population.

Provide closure for issues raised by the 1990 data review.

Honor employee requests for voluntary testing.

TEST POPULATIONS

Employees in C-8 jobs (82 of 140)

Employees not in C-8 jobs with a previous result >3 ppm (9 of 12)

Pensioners with a high previous result (9 of 19)

Volunteers (18)

RESULTS SUMMARY - OPERATORS

JOB	DESCRIPTION	1995 AVERAGE (n)	1989 AVERAGE (n)
08PE	autoclave	2.3 (7)	3.0 (4), 7.0 (3)
08PF	polykettle	2.6 (6)	2.5 (3), 8.5 (1)
08PH	dispersion	0.5 (2)	1.0 (2), 7.5 (1)
08PI	FP finishing	2.0 (6)	2.0 (6)
08PJ	FP packout	0.7 (7)	
08PM	C-8 dryer recovery	1.7 (2)	
18PA	FEP polykettle	2.3 (4)	
18PB	FEP extruder/oven	1.5 (6)	0.5 (3)
18PC	FEP wet finishing	3.0 (1)	
18PD	FEP packout	0.1 (4)	
18PJ	PFA/FEP bead	0.7 (2)	
18PK	FEP safety/disp	2.1 (2)	

RESULTS SUMMARY - MECHANICS

58MC	FP/disp/gran/TA	1.4 (1)
58MD	general shift	1.1 (8)
58MG	process E&I	0.8 (7)
68MA	general shift	1.1 (5)
68MB	FEP E&I	0.9 (7)

HALF LIFE RESULTS FROM PENSIONERS

C8 DATE	C8 PPM	RET. DATE	C8 DATE	C8 PPM	1/2 LIFE (YEARS)
4/89	5.7	4/91	3/95	4.3	9.7
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8/84	2.4	4/85	3/95	.72	5.7*
7/84	5.9	12/81	3/95	.94	4.0*
3/85	3.0	4/85	3/95	.14	2.3*
9/82	6.3	12/82	3/95	.57	3.5*
3/88	1.7	12/93	3/95	2.4	---

For * results,

$n = 4$
average = 3.9
sigma = 1.4

using

$$\log \frac{n}{n_0} = \frac{-.301\ t}{t_{1/2}}$$

OTHER OBSERVATIONS

1. VOLUNTEERS

   a) One of 17 is above 1 PPM

   b) Average of other 16 is 0.4 PPM

2. ACTIVE EMPLOYEES WITH PREVIOUS HIGH RESULTS

	Down	Same	Up
in C-8 job	2	3	4
not in C-8 job	6	2	1

3. THREE EMPLOYEES OVER 3 PPM FOR THE FIRST TIME

TEST POPULATIONS

1. Employees in C-8 jobs (82 of 140)
2. Employees not in C-8 jobs with a previous result >3 ppm (9 of 12)
3. Pensioners with a high previous result (9 of 19)
4. Volunteers (18)

OTHER OBSERVATIONS

1. HALFLIFE ESTIMATES FROM PENSIONERS

Average = 3.8 years
Sigma = 1.2 years
n = 4

2. VOLUNTEERS

a) One of 17 is above 1 PPM

b) Average of other 16 is 0.4 PPM

3. ACTIVE EMPLOYEES WITH PREVIOUS HIGH RESULTS

	Down	Same	Up
in C-8 job	2	3	4
not in C-8 job	6	2	1

4. THREE EMPLOYEES OVER 3 PPM FOR THE FIRST TIME

PATH FORWARD

Finish Data Analysis

Employee Communication

Site Industrial Hygiene Efforts

Toxicology Work (Do we need a BEI?)

Continue Annual Voluntary Testing

Take Another Snapshot In 2000

2988

AR226_3466

AR226-3466

CONTAINS CONFIDENTIAL INFORMATION.
RESPONSIBILITY OF RECIPIENT.
WHEN NO LONGER NEEDED, DESTROY BY
BURNING OR SHREDDING.

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JACKSON LABORATORY
RESEARCH AND DEVELOPMENT DIVISION TECHNICAL REPORT
CHEMICALS AND PIGMENTS DEPARTMENT
E. I. DU PONT DE NEMOURS & COMPANY

KINETICS OF SORPTION AND ELIMINATION OF FLUORINATED SURFACTANTS IN BLOOD

Work done by: Erik Kissa
Report written by: Erik Kissa
Approved by: C. J. Hensler
Patent situation approved by: F. R. Ortolani [redacted]

Type of technical work: RD
Period covered: August 1984 to February 1986 [redacted]
Personnel: Ward Gibson and Paul A. Saincon

ABSTRACT

Blood samples of a Haskell Laboratory inhalation subchronic study on [redacted] have been analyzed for organic fluorine and inorganic fluoride. The kinetics of sorption and elimination of [redacted] in blood have been determined. The concentration of [redacted] related organic fluorine in blood was found to increase approximately with the square root of the increasing [redacted] concentration in the air inhaled. The elimination of [redacted] from blood appears to obey first-order kinetics, but the rate coefficient decreases with the square root of the increasing postexposure time.

The elimination rate coefficients of [redacted] and perfluorooctanoic acid in blood do not differ greatly. However, [redacted] is less volatile than perfluorooctanoic acid and the concentrations of [redacted] in air and consequently in blood are therefore likely to be lower than those of perfluorooctanoic acid.

EK:jve
0074J

Company Sanitized. Does not contain TSCA CBI

OBJECTIVES

To determine fluorine in rat blood samples, submitted by [redacted] at Haskell Laboratory, of the inhalation subchronic study on [redacted] to estimate the [redacted] levels in blood following exposure and the rate of elimination from blood.

BACKGROUND

The observation by Taves (1,2) that human blood serum contains both inorganic fluoride and organic fluorine have increased the interest in the retention of organic fluorochemicals in blood. In a study on the exposure of industrial workers to fluorochemicals (3), elevated fluorine concentrations, ranging from 1 to 71 ppm, were found in the blood of workers handling the ammonium salt of perfluorooctanoic acid. The long retention time of perfluorooctanoic acid in blood has lead to efforts to replace perfluorooctanoic acid salts by less volatile fluorinated surfactants. [redacted] an ammonium salt of a sulfonic acid derived from Telomer B, was designed to replace ammonium perfluorooctanoate in Teflon® polymerization processes.

CONCLUSIONS

1. The amount of organic fluorine in blood increases with the square root of increasing [redacted] concentration in the air inhaled.

2. The elimination of [redacted] from blood approximates first-order kinetics. However, the rate coefficient is not a constant, but decreases with the square root of the increasing postexposure time.

3. The elimination rate coefficients of [redacted] and that of perfluorooctanoic acid do not differ markedly. However, [redacted] is less volatile and its concentrations in air and consequently in blood are likely to be lower than those of perfluorooctanoic acid.

4. The inorganic fluoride levels in blood increased slightly, if significantly, after exposure to [redacted] in air but decreased to normal values in a relatively short time.

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PATENT SITUATION

Patent Protection

A patent application [redacted] has been filed.

Proposed Filing Action

Patent action, related to this study, is not planned.

PUBLICATION STATUS

The kinetic interpretation of sorption and desorption of fluorosurfactants in blood is novel and probably of general validity. Publication will be considered.

The method for the determination of inorganic fluoride in blood has been published (E. Kissa, Clin. Chem. 33, 253 [1987]).

FUTURE WORK

The [redacted] inhalation study has been completed and further work is not planned.

SAFETY

No unusual considerations.

ENVIRONMENTAL CONSIDERATIONS

No unusual environmental considerations.

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DISCUSSION

1. Sorption of [redacted] in Blood.

Haskell Laboratory conducted an inhalation subchronic study on [redacted] using rats as the test animals. Blood samples were collected after the tenth exposure, after two weeks, six weeks, and twelve weeks of recovery. We analyzed the blood specimen for total fluorine by the oxyhydrogen torch method [6] and for inorganic fluoride by our analyte addition method [4]. The concentration of organic fluorine in blood was calculated as the difference between the total fluorine concentration and the inorganic fluoride concentration in blood.

The concentration of organic fluorine in blood, c_b, was found to increase exponentially with the increasing concentration of [redacted] in air, c_a, expressed as

$$c_b = k\, c_a^{\,n} \qquad (1)$$

A plot of c_b versus c_a on logarithmic scales yields straight lines with the slope n (Fig. 1). The plot shows that the values of the coefficient, k, decreased with the increasing recovery time (Table I). The value of the exponent n is appoximately 0.5, suggesting that c_b may be a function of the square root of c_a (Table II). A plot of the organic fluorine concentration in blood versus the square root of [redacted] concentration in air yields indeed a straight line, the slope of which decreases with the increasing recovery time. The lines do not pass through the origin, however, but intercept the x-axis at distances which decrease with the increasing recovery time (Fig. 2). The nonlinearity of this relationship at very low [redacted] concentrations requires more data for a definite interpretation.

2. Elimination of [redacted] from Blood.

The presence of organic fluorine in blood has been attributed to fluorinated carboxylic acids which are volatile and absorbed in the body mainly by inhalation [3,6]. Because of concern about their long residence time in blood, perfluorooctanoic acid, used as the dispersant in the Teflon® process, was replaced, by [redacted] a fluorinated surfactant of low volatility.

The subchronic inhalation study on [redacted] showed that [redacted] like perfluooctanoic acid, also has a long residence time in blood. Twelve weeks after exposure to a low concentration (7.6 mg/m3) of [redacted] in air the organofluorine concentration in blood returned to a normal level. However, rats exposed to higher [redacted] concentrations in air had a significantly elevated organofluorine concentration in their blood still after twelve weeks (Table I).

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In order to compare the rate at which [redacted] is eliminated from blood to the elimination rate of perfluoro-octanoic acid, the data have to be fitted to a kinetic expression which permits the calculation of rate constants or rate coefficients. This is, however, not straightforward, because the elimination of fluorinated surfactants from blood does not obey simple kinetics.

It is usually assumed that the elimination of fluorocompounds from blood obeys, like a mass transport process, first-order kinetics. The half-life of the fluorocompound in blood has been used to express the elimination rate. However, the calculation of the half-life assumes uncomplicated first-order kinetics and this assumption is not always valid.

I have reported [6] that the decrease of organic fluorine in blood during the postexposure period of a perfluorooctanoic acid feeding study approximates first-order kinetics:

$$\log c_b/c_o = k_r t \qquad (2)$$

where c_b is the concentration of the fluorinated surfactant in blood at time t, c_o the initial concentration of the fluorinated surfactant in blood, and k_r the rate coefficient of the elimination of the fluorinated surfactant from blood. If the fluorinated surfactant is not metabolized, which is a reasonable asssumption, then the organic fluorine concentrations in blood can represent the concentrations of fluorinated surfactants.

A plot of log c_b versus time (Fig. 3) exhibits considerable curvature and consequently a significant departure from uncomplicated first-order kinetics. The elimination rate of perfluorooctanoic acid from blood is more rapid in the beginning than during the latter part of the recovery period. This suggests that the desorption rate of perfluorooctanoic acid molecules in blood may vary. Perfluorooctanoic acid is known to adsorb on protein in blood [7,8]. It is possible that the unadsorbed and the less strongly held perfluorooctanoic acid molecules are eliminated at a faster rate, leaving the more strongly held perfluorooctanoic acid molecules back. It is also possible that the strength of the adsorptive bond of perfluorooctanoic acid molecules varies, depending on the adsorption site in blood.

A first-order plot of [redacted] elimination from blood also shows curvature (Fig. 4). This deviation from uncomplicated first-order kinetics can be explained by an adsorptive site dependent variation of adsorptive bonding, similar to that of the perfluorooctanoic acid. The heterogeneous composition of [redacted] may also complicate its elimination kinetics. [redacted] consists of molecules (telomers) of different chain length which may affect the desorption and the diffusion rate of [redacted] molecules.

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The average rate coefficient k_t for the elimination of a fluorinated surfactant from blood during a time interval Δt is given by the general kinetic expression

$$\Delta c/\Delta t = k_t\ c_t^{\ z} \qquad (3)$$

where Δc is the average organofluorine concentration decrease and c_t the average organofluorine concentration during the postexposure time interval Δt.

It follows that

$$\log (\Delta c/\Delta t) = \log k_t + z \log c_t \qquad (4)$$

The organofluorine concentrations in blood are plotted according to equation (4) in Fig. 5 for [redacted] and in Fig. 6 for perfluorooctanoic acid. The plot yields lines with the slope of about one, indicating that the elimination process is kinetically of first-order. However, the values of k_t are not constant, as expected for an uncomplicated first-order process, but decrease with the increasing recovery time (Table III). Consequently,

$$\log (c_b/c_o) = k_t\ t \qquad (5)$$

where k_t is a time dependent rate coefficient at time t.

The logarithm of organofluorine concentration in blood plotted against the square root of time yields straight lines (Fig. 7). Hence

$$\log (c_b/c_o) = k_r\ t^{0.5} \qquad (6)$$

The question remains, why does the organofluorine concentration in blood fit the equation (5) and also equation (6). Since the left sides of the equations are identical, the right sides have to be equal

$$k_t\ t = k_r\ t^{0.5} \qquad (7)$$

It follows that

$$k_t = k_r\ /\ t^{0.5} \qquad (8)$$

and the equation (5) becomes equation (7):

$$\log (c_b/c_o) = k_r\ t\ /\ t^{0.5} = k_r\ t^{0.5} \qquad (9)$$

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Although the time intervals, at which the [redacted] concentration in blood was determined, were not selected for determining the time dependence of the elimination rate coefficient, it is apparent that the values of k_t vary approximately with the square root of time (Table IV).

In summary, the elimination of fluorinated surfactants from blood is a first-order kinetic process having a time dependent rate coefficient. A logarithmic plot , according to equation (4) yields the average rate coefficient, k_t, for the time interval Δt.

A comparison of the [redacted] and perfluorooctanoic acid concentrations in blood suggests that the rate coefficient values for anionic fluorinated surfactants may be similar. However, [redacted] is much less volatile than perfluorooctanoic acid and poses therefore a lesser environmental problem.

It should be remembered that the disappearance of organofluorine from blood does not necessarily indicate that the fluorinated surfactant has been completely eliminated from the body. Organs, especially liver and spleen, may also harbor organic fluorine.

3. Inorganic Fluoride in Blood.

The inorganic fluoride in the blood increased slightly, but perhaps significantly, as a result of exposure to [redacted] (Table V). The average inorganic fluoride value increased from 0.017 ppm in control samples to 0.051 ppm after exposure to 480 mg/m3 [redacted] in air. If this increase was significant, the inorganic fluoride concentration in blood returned to normal values in a relatively short time.

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EXPERIMENTAL

The oxyhydrogen torch method (CD&P Method CW-9-8-3) for combustion of blood has been described in our report [6]. Total fluorine was determined as fluoride in the combusted analyte with an ion-selective electrode [4]. Inorganic fluoride in blood was determined by an analyte addition method we developed [5].

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TABLE I

ORGANIC FLUORINE IN RAT BLOOD

Exposure Conc. of [redacted] (mg/m^3)	ppm Organic Fluorine in Blood*			
	Initial	2-Weeks Recovery	6-Weeks Recovery	12-Weeks Recovery
0	2.0	0.9	0.9	0.4
7.6	10.2	4.0	1.8	0.6
58.0	42.0	13.0	7.2	2.2
480.0	147.0	40.5	16.6	4.4

*Average values for blood samples of five rats.

TABLE II

SORPTION OF [redacted] IN RAT BLOOD: THE COEFFICIENT k_t AND THE EXPONENT n

Recovery time (weeks)	k_t	n
0	2.87	0.64
2	1.31	0.56
6	0.67	0.53

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TABLE III

KINETICS OF FLUORINE ELIMINATION FROM RAT BLOOD

Recovery Period (weeks)	Fluorochemical	Rate Coefficient k_t	Exponent z
0-2	[redacted]	0.36	1.10
2-6	(inhalation)	0.17	1.03
6-12		0.16	1.07
		Average	1.07
0-2	Perfluorooctanoic	0.73	0.92
2-6	acid (feeding)	0.33	1.03
		Average	0.98

TABLE IV

RATE COEFFICIENTS AS A FUNCTION OF TIME

Recovery Period (weeks)	Average Recovery Time (weeks)	Square Root of Average Recovery Time	Rate Coefficients			
			[redacted]		Perfluorooctanoic Acid	
			Found	Calc.*	Found	Calc.*
0-2	1	1	0.36	-	0.73	-
2-6	4	2	0.17	0.18	0.33	0.37
6-12	9	3	0.16	0.12		

* Calculated by the equation (8).

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TABLE V

INORGANIC (IONIC) FLUORINE IN RAT BLOOD

Exposure [redacted] Conc. in Air (mg./m^3)	Recovery Time (Weeks)	Organic Fluorine (ppm)	Inorganic Fluorine (ppm)	Rat No.
0	0	1.4	0.016	376 840
0	2	0.7	0.025	376 849
0	2	1.1	0.019	376 835
0	2	0.7	0.007	376 841
480	0	140.0	0.055	376 854
480	0	112.0	0.034	376 828
480	0	168.0	0.063	376 879
480	2	41.2	0.020	376 858

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FIGURE 1
CONCENTRATION OF ORGANIC FLUORINE IN BLOOD AS AN EXPONENTIAL FUNCTION OF [redacted] CONCENTRATION IN AIR

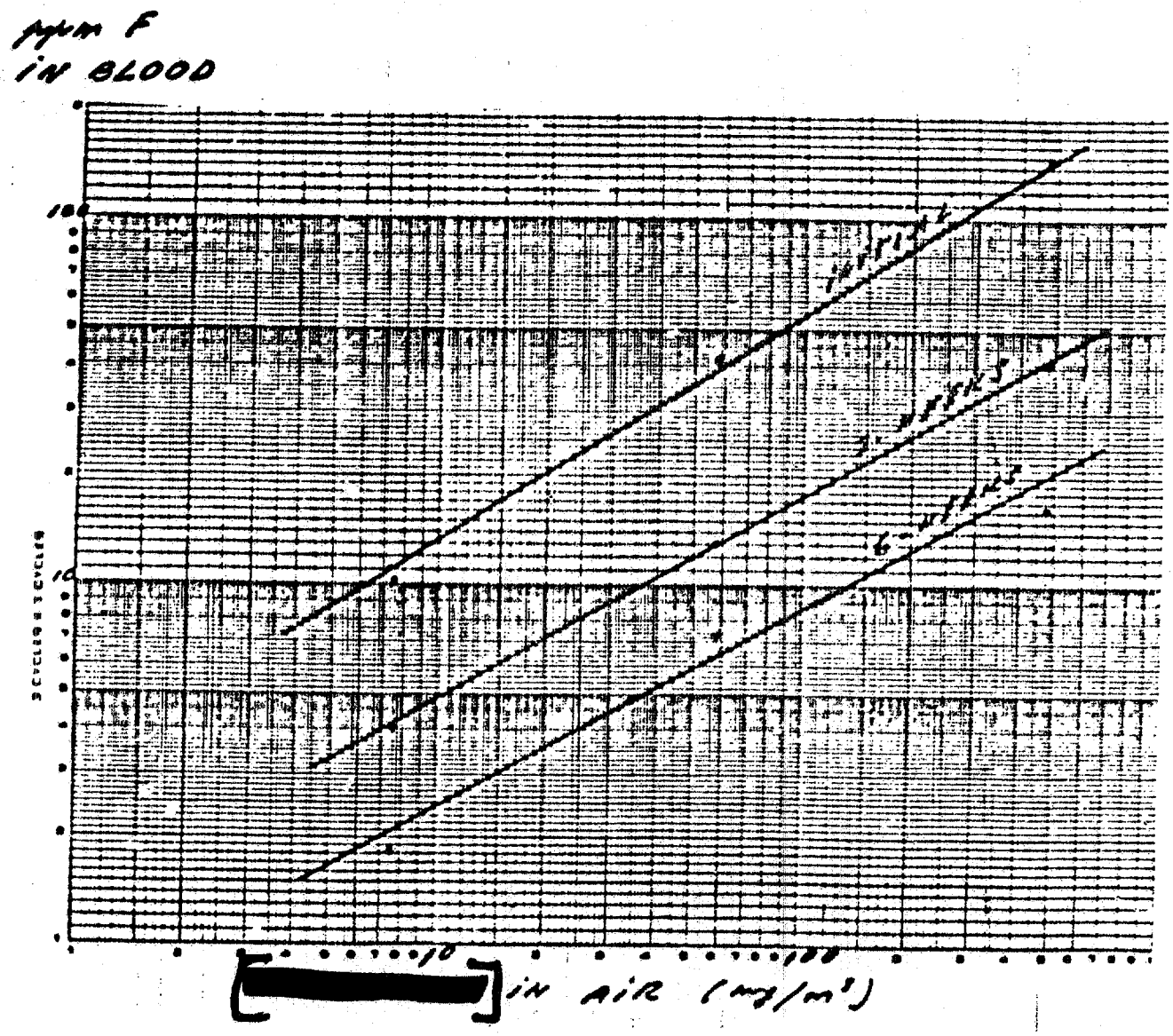

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FIGURE 2
CONCENTRATION OF ORGANIC FLUORINE IN BLOOD VS.
THE SQUARE ROOT OF [redacted] CONCENTRATION IN AIR.

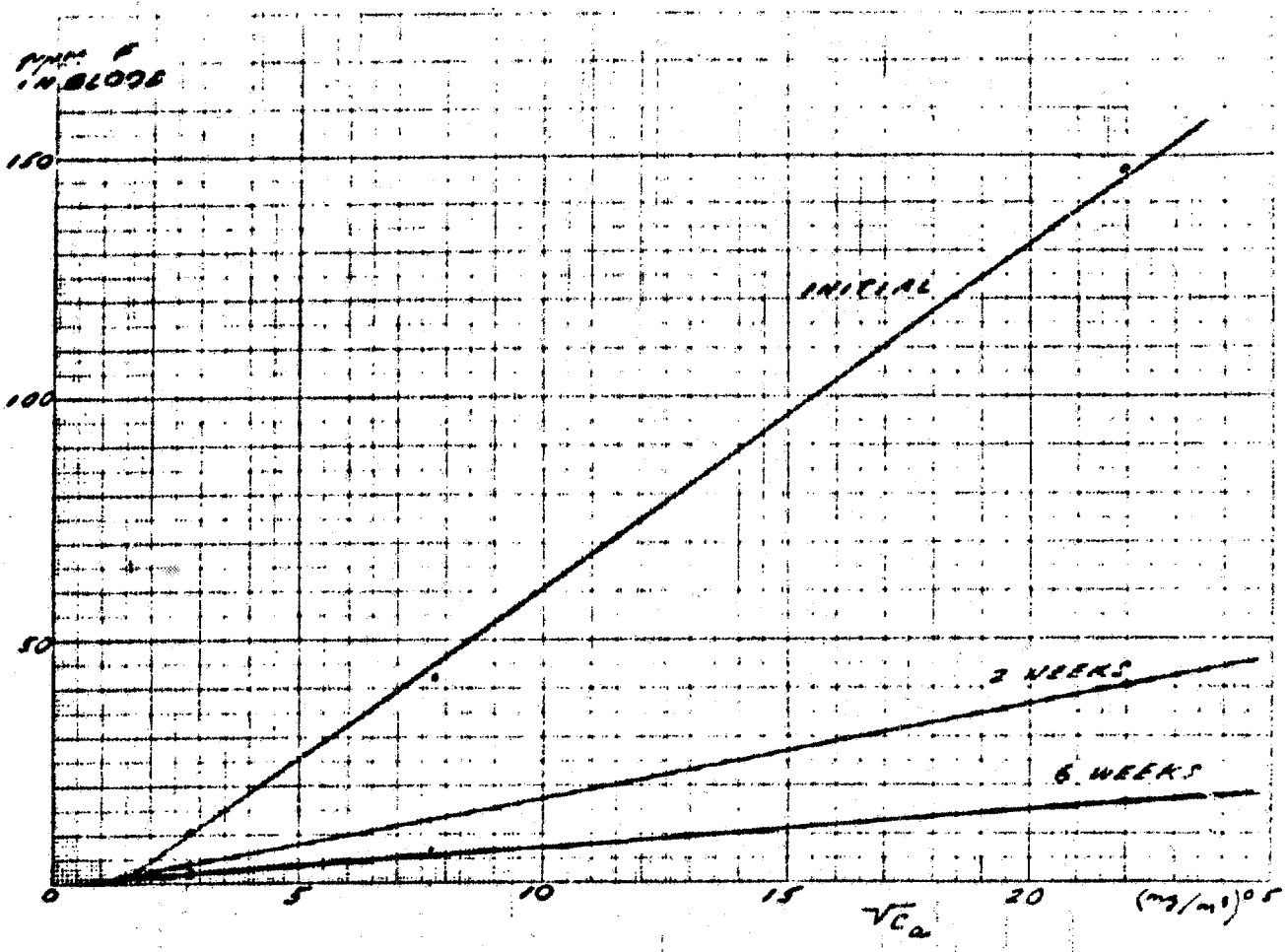

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FIGURE 3
A FIRST-ORDER PLOT OF PERFLUOROOCTANOIC ACID
ELIMINATION FROM BLOOD

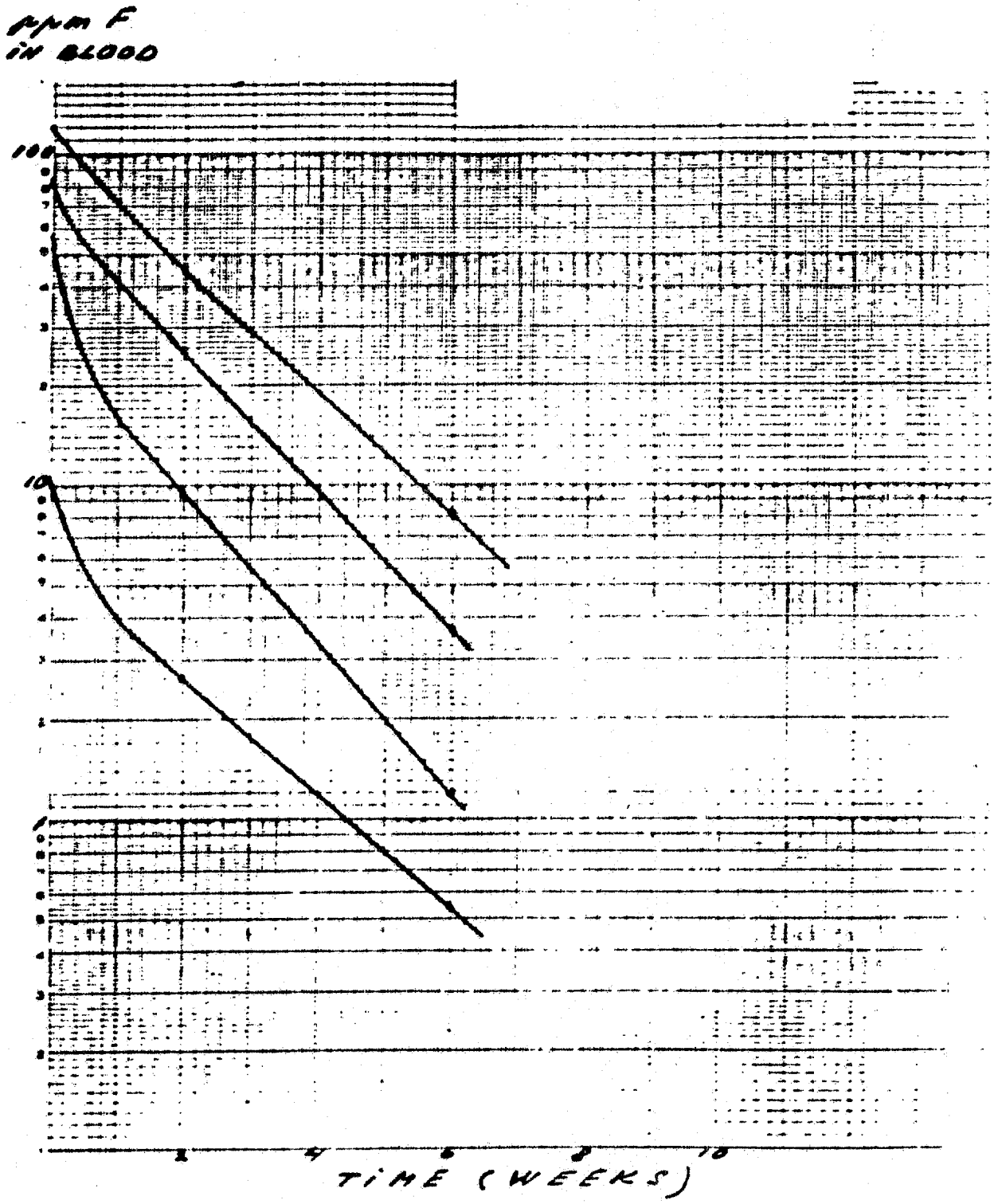

FIGURE 4

A FIRST-ORDER PLOT OF [redacted] ELIMINATION FROM BLOOD

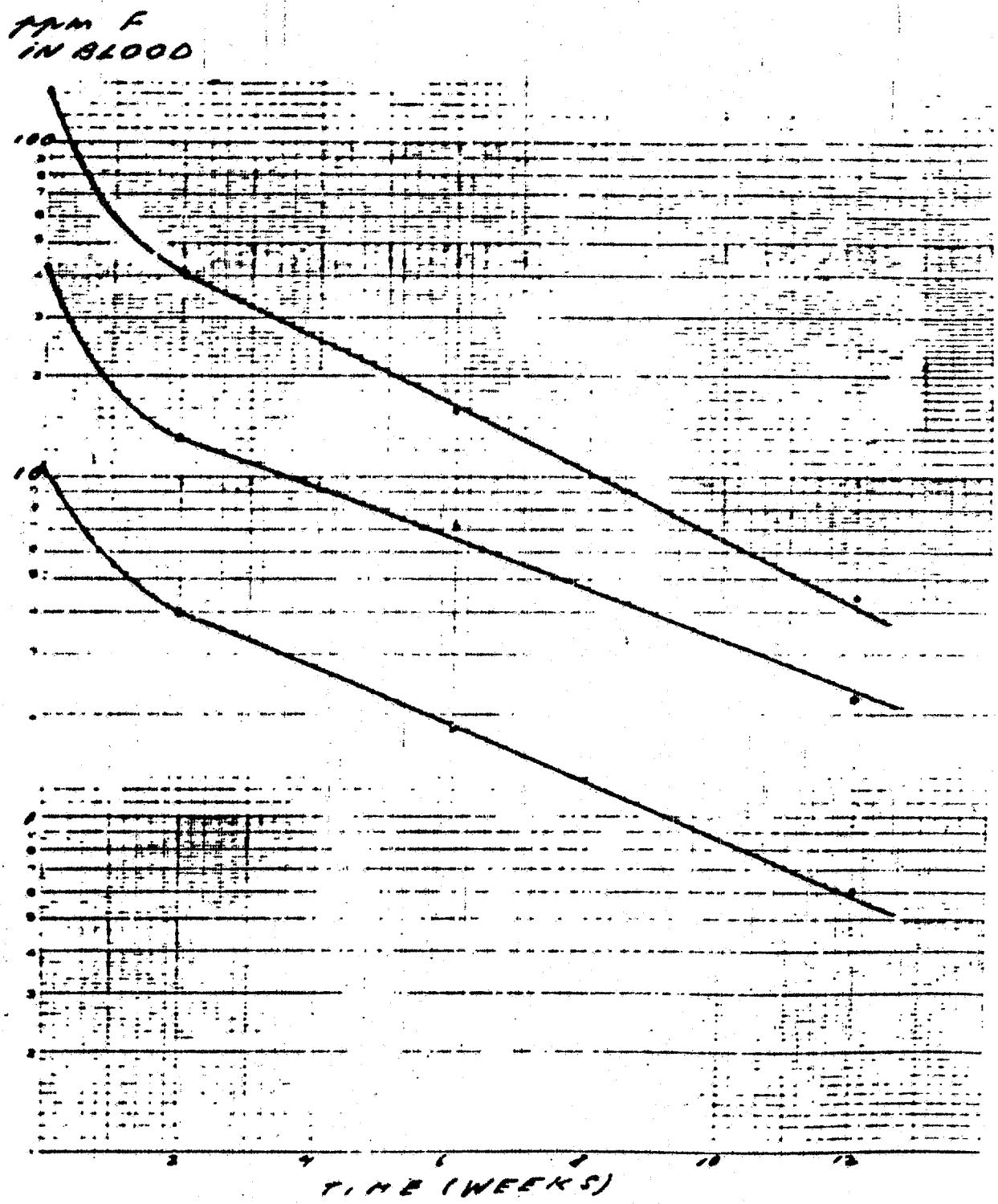

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FIGURE 5
THE ELIMINATION RATE OF [redacted]
AS A FUNCTION OF ITS CONCENTRATION IN BLOOD

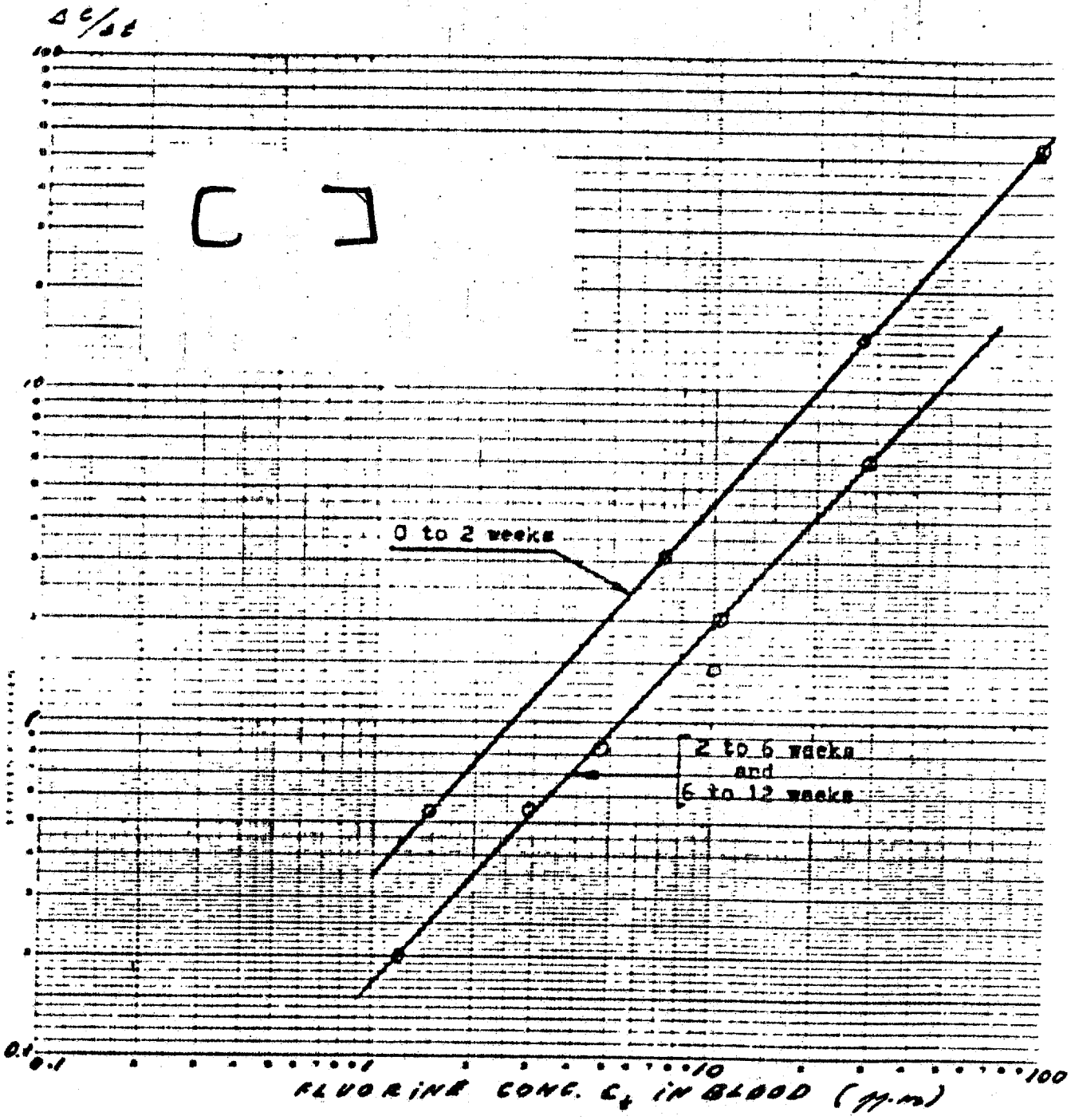

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FIGURE 6
THE ELIMINATION RATE OF PERFLUOROOCTANOIC ACID
AS A FUNCTION OF ITS CONCENTRATION IN BLOOD.

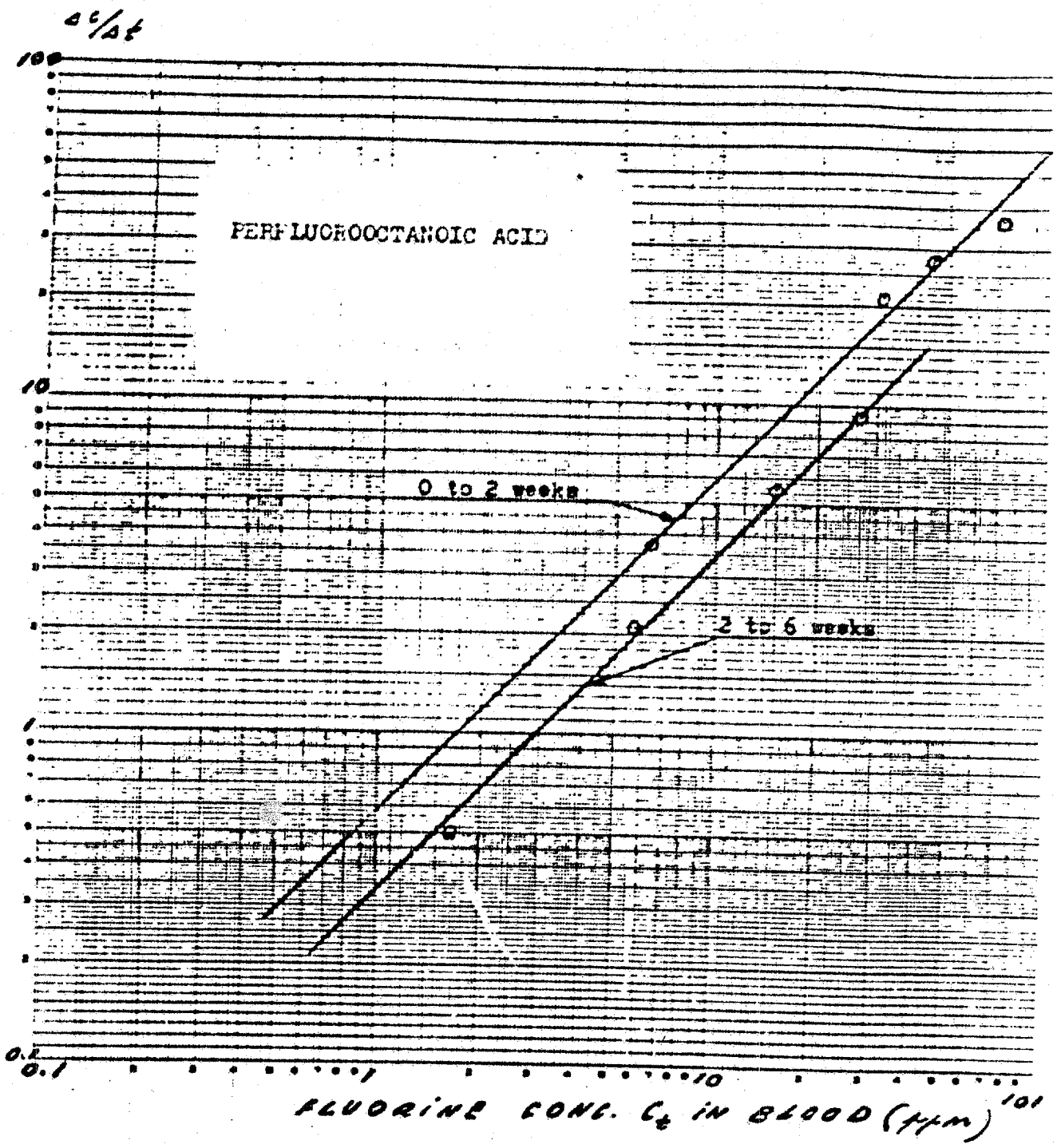

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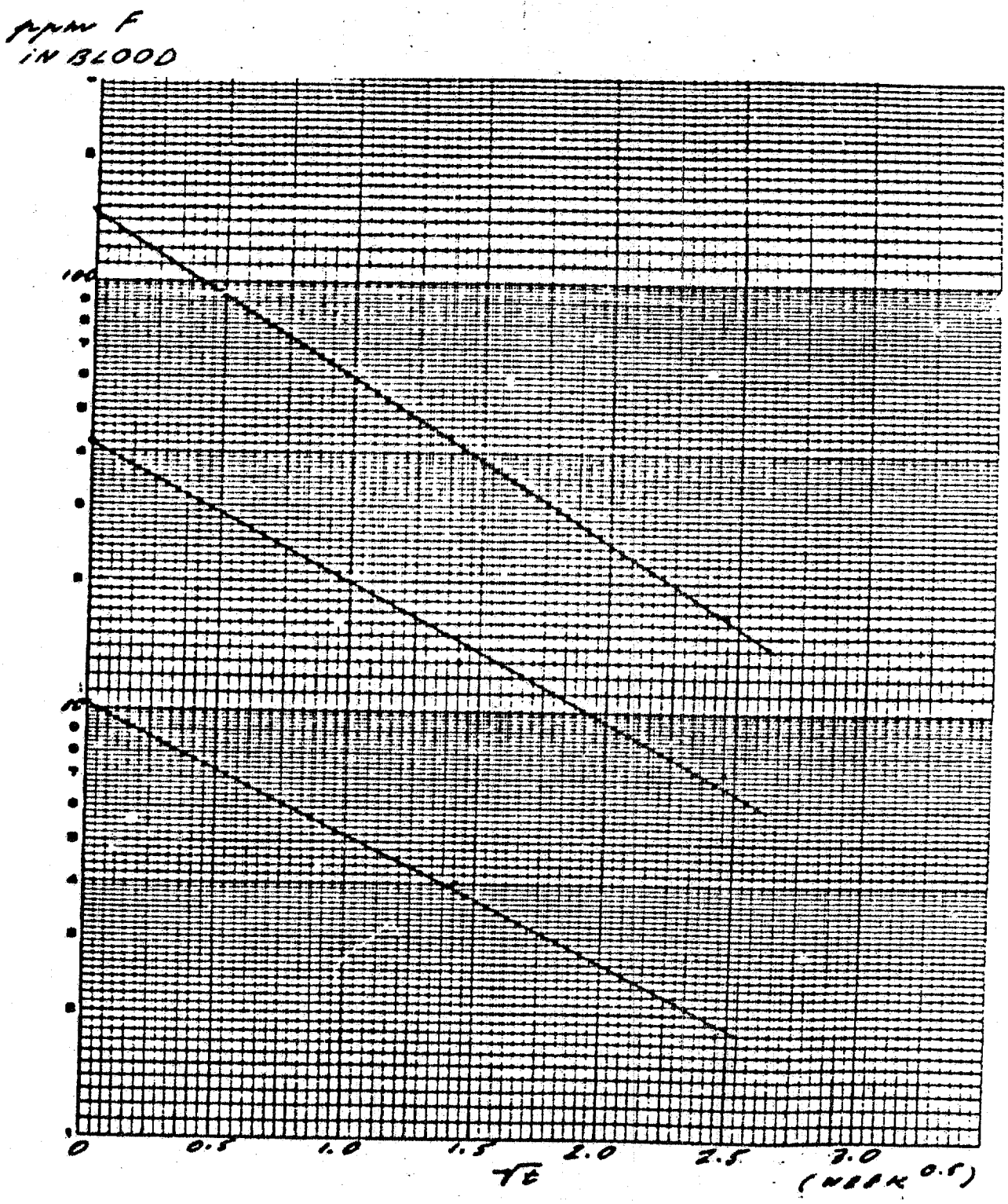
FIGURE 7

[redacted] RELATED FLUORINE IN BLOOD AS A FUNCTION OF TIME



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III. REFERENCES

1. D. R. Taves, Nature, 217, 1050 (1968).
2. W. S. Guy, D. R. Taves, and W. S. Brey, Am.Chem.Soc.Symp.Ser.28, 117 (1976).
3. F. A. Ubel, S. D. Sorenson, and D. E. Roach, Am.Ind.Hyg.Assoc.J., 41, 584, (1980).
4. E. Kissa, Anal.Chem. 55, 1445 (1983).
5. E. Kissa, Clin. Chem. 33, 253 (1987).
6. E. Kissa, CP-JL-80-14 (1980).
7. R. H. Ophaug and L. Singer, Proc. Soc. Exp. Biol. Med. 163, 19 (1980).
8. J. Belisle and D. F. Hagen, Anal. Biochem. 101, 369 (1980).

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PUBLICATIONS

E. Kissa

BOOKS

W. G. Cutler and E. Kissa, Editors. "Detergency. Theory and Technology". Marcel Dekker, New York (1986).

BOOK CHAPTERS

Erik Kissa -- Evaluation of Detergency, pp. 1 to 89, in "Detergency. Theory and Technology", W. G. Cutler and E. Kissa eds., Marcel Dekker, New York (1986).

Erik Kissa -- Kinetics and Mechanisms of Soiling and Detergency, pp. 193 to 331, in "Detergency. Theory and Technology",
W. G. Cutler and E. Kissa eds., Marcel Dekker, New York (1986).

Erik Kissa -- Soil Release, pp. 333 to 369, in "Detergency. Theory and Technology", W. G. Cutler and E. Kissa eds., Marcel Dekker, New York (1986).

Erik Kissa -- Repellent Finishes, pp. 143 to 210, in "Handbook of Fiber Science and Technology", Vol. 2, M. Lewin and S. S. Sello, eds., Marcel Dekker, New York (1984).

Erik Kissa -- Soil Release Finishes, pp. 211 to 289, in "Handbook of Fiber Science and Technology", Vol. 2, M. Lewin and S. S. Sello, eds., Marcel Dekker, New York (1984).

Erik Kissa -- Quantitative Analysis, pp. 519 to 553, in "The Analytical Chemistry of Synthetic Dyes", K. Venkataraman, ed., Wiley-Interscience, New York (1977).

JOURNAL ARTICLES

[1] Erik Kissa -- Single author, unless noted otherwise.

Determination of Inorganic Fluoride in Blood, Clin. Chem., 33, 253 (1987).

Determination of Organofluorine in Air, Environm. Science Technol., 20, 1254 (1986).

Tinctorial Efficacy of Dyes and Dyeing Processes. Colourage Annual, 1984-85.

000687

E. Kissa

JOURNAL ARTICLES (Cont'd.)

Determination of 2H-hexafluoropropanol-2 in Air. J. Chromatography, 319, 407 (1985).

Soil Release - Past, Present, and Future, Colourage Annual, Colour Publications (Bombay, India), (1984).

Tinctorial Efficacy of Dyes in Polyester Fibers, Textile Res. J., 54, 497 (1984).

Determination of Fluoride at Low Concentrations with the Ion-Selective Electrode, Anal. Chem., 55, 1445 (1983).

Determination of Hexachloroacetone in Air, Anal. Chem., 55, 1222 (1983).

Determination of Trace Amounts of Sulfur in Organic Solvents, Anal. Chem., 54, 1450 (1982).

A. M. Dave and E. Kissa, A Rapid and Reproducible Transfer Soiling Method, Textile Res. J., 51, 650 (1981).

Mechanisms of Soil Release, Textile Res. J., 51, 508 (1981).

Wetting and Detergency, J. Pure and Applied Chemistry (IUPAC) 53, 2255 (1981).

Capillary Sorption in Fibrous Assemblies, J. Colloid and Interface Sci., 83, 265 (1981).

A. M. Dave and E. Kissa, Comparative Studies of Two Soiling Methods, Textile Chem. Color. 12, 255 (1980).

Determination of Disperse Dyes in Polyethylene Terephthalate Fibers. Textile Research Journal, 49, 245 (1979).

Kinetics and Mechanisms of Detergency III. Effect of Soiling Conditions on Particulate Soil Detergency. Textile Research Journal 49, 384 (1979).

Kinetics and Mechanisms of Detergency II. Particulate Soil. Textile Research Journal 48, 395 (1978).

Determination of Cationic Dyes in Acrylic Fibers, Textile Chem. Col. 9, 148 (1977).

000688

E. Kissa

JOURNAL ARTICLES (Cont'd.)

Quantitative Determination of Dyes in Textile Fibers IV. Determination of Disperse and Cationic Dyes in Polyester Fibers by Selective Extraction, Textile Res. J. 46, 483 (1976).

Erik Kissa and Robert H. Dettre, Sorption of Surfactants in Polyester Fibers, Textile Res. J. 45, 773 (1975).

Kinetics and Mechanisms of Detergency I. Liquid Hydrophobic (Oily) Soils, Textile Res. J. 45, 736 (1975).

Quantitative Determination of Dyes in Textile Fibers III. Cationic Dyes in Polyester and Polyacrylic Substrates, Textile Res. J. 45, 488 (1975).

Quantitative Determination of Dyes in Textile Fibers II. Nonionic Dyes in Polyester, Polyamide, Acrylic, Acetate and Cellulosic Substrates, Textile Res. J. 45, 290 (1975).

Quantitative Determination of Dyes in Textile Fibers II. Nonionic Dyes in Polyester, Polyamide, Acrylic, Acetate and Cellulosic Substrates, Textile Res. J. 45, 290 (1975).

Quantitative Determination of Dyes in Textile Fibers I. Cationic and Nonionic (Disperse) Dyes in Polyacrylonitrile Polymers, Textile Res. J. 44, 997 (1974).

Comments on Soil Release Mechanism of Acrylic Polymers, Textile Chem. Col. 5, 232 (1973).

Model Particulate Soils for Soil Release Evaluation, Textile Chem. Col. 5, 250 (1973).

Adsorption of Particulate Soils on Textiles, Textile Res. J. 45, 86 (1973)

Kinetics of Oily Soil Release, Textile Res. J. 41, 760 (1971).

A Reproducible Method for the Evaluation of Soil Release, Textile Chem. Col. 3, 225 (1971).

A Rapid and Reproducible Method for the Determination of Dry Soil Resistance, Textile Res. J. 41, 621 (1971).

Lightfastness of Reactive Dyes, Textile Res. J. 41, 715 (1971).

Urea in Reactive Dyeing, Textile Res. J. 39, 734 (1969).

E. Kissa

JOURNAL ARTICLES (Cont'd.)

Thermofixation of Vinylsulfone Type Reactive Dyes on Cotton, Amer. Dyest. Rep. 56, 106 (1967).

Erik Kissa and Maimu Seepere-Yllo, Tungsten Trioxide and Inorganic Salts as Sample Additives in Carbon and Hydrogen Analysis, Mikrochem. Acta 1967, 287.

Conductivity Anomalies of Dimethyl Sulfone, J. Electrochem. Soc. 112, 716 (1965).

Solutions of Alkali Metal Carboxylate Mixtures in Hydrocarbons, J. Colloid Science 19, 279 (1964).

Solubilization of Lithium Carboxylates with Carboxylic Acids in Hydrocarbon Solvents, J. Colloid Science 18, 147 (1963).

Solubility of Alkali Metal Carboxylates in Hydrocarbons, J. Colloid Science 17, 857 (1962).

The Isolation of Microbalances Against Vibrations, Microchem.J. 4, 89 (1960).

The Microdetermination of Carbon and Hydrogen in Compounds Containing Alkali and Alkaline Earth Metals, Microchem.J.1, 203 (1957).

000690

INVITED PAPERS PRESENTED

Erik Kissa -- Single author, unless noted otherwise.

Determination of Organofluorine in Air, 190th American Chemical Society National Meeting, Chicago, Ill., Sept. 1985.

Wetting and Detergency, 186th American Chemical Society National Meeting, Washington, D.C., Aug. 1983.

Mechanisms of Soiling and Detergency. Soil Release Finishes. Evaluation of Detergency: Natural and Model Soils, Visual and Spectrophotometric Soil Evaluation. Conference on Soiling and Detergency, Clemson University, February 1983.

Wetting and Detergency. (Topical lecture.) The Fourth International Conference on Surface and Colloic Science, Jerusalem, July 1981. (Sponsored by IUPAC).

Evaluation of Detergency, American Oil Chemists Society Annual Meeting, New Orleans, May 1981.

Capillary Sorption in Textiles. Second Chemical Congress of the North American Continent incl. the 180th ACS National Meeting, Aug. 1980. Symposium on Reactions at Fiber Surfaces, Las Vegas.

A. M. Dave and Erik Kissa, Dry Soiling and its Prevention, Nultinational Symposium on Cotton Finishing, sponsored by UNIDO. ACS/CSJ Chemical Congress in Honolulu, Hawaii, April 1979.

Mechanisms of Soil Release. Multinational Symposium on Cotton Finishing, sponsored by UNIDO. ACS/CSJ Chemical Congress in Honolulu, Hawaii, April 1979.

Kinetics of Detergency. Particulate Soils, 174th ACS National Meeting, Chicago, Ill., Aug. 1977.

Soiling and Detergency, Gordon Research Conference, Textiles: Fiber Science, 1975.

Sorption of Surfactants in Polyester Fibers, 169th ACS National Meeting, Philadelphia, Pa., April 1975.

Kinetics of Detergency, 168th ACS National Meeting, Atlantic City, N.J., Sept. 1974.

U.S. PATENTS ISSUED

Erik Kissa

1961	US 3 013 869	Hydrocarbon soluble alkali metal compositions
1965	US 3 184 284	Dye-pad, hot-chemical-treatment dyeing process
1966	US 3 290 282	Fiber-reactive dyes
1967	US 3 313 797	Stabilized fiber-reactive dyes
1967	US 3 321 457	Water soluble dyes of the phenylazopyrazolone series containing a 2,3-dichloro-6-quinoxalinylcarbonylamino substituent
1969	US 3 453 038	Compartmented electrochromic device (Coinventors P. Manos and C. Wahlig)
1970	US 3 507 850	Polymeric fugitive dyes derived from methacrylate alkyl ester, methacrylic acid and a dye monomer containing sulfonic acid groups and a methacryloyl group (Coinventor W. Cohen)
1972	US 3 660 008	Dyeing sulfonated anionic polymeric fibers with an aqueous dispersion of a salt and an arylsulfonate
1973	US 3 765 835	Anionic dispersion of a salt of a cationic dye and a selected arylsulfonate
1973	US 3 778 226	Durable-press and soil-release compositions
1977	US 4 063 889	Halosolvent dyeing process for polyester with cationic dyes having sulfosuccinate anions.

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RESEARCH AND DEVELOPMENT
ANALYTICAL -- SPECTROSCOPY AND PHYSICAL TESTING

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ORGANIC FLUOROCOMPOUNDS IN BLOOD

In May, 1978, 3M informed Du Pont of findings of organic fluorocompounds in blood of employees exposed to long-chain perfluoro-surface active materials. 3M reported airborne contaminant levels up to 81 ppm in their operations and organic fluorine blood levels of 1 to 71 ppm for exposed workers. 3M reports that some level of organic fluorine in humans is normal, i.e. equal to or less than 1 ppm.

Chambers Works makes functional equivalents to the 3M fluorosurfactants and plant employees were informed of the 3M findings in June 1978. Also a program was initiated to define exposure potential in the Chambers Works fluorocompound manufacturing and use operations, review the medical records of employees assigned to these operations, determine organic fluorine levels in the blood of such employees and to gather additional toxicity information on selected plant fluorocompounds. Program results are summarized below:

- Airborne contaminant monitoring results show that the highest potential for employee fluorocompound exposure to be in the manufacturing facilities. Eight hour time weighted average measurements ranged from <0.3 ppm (5 mg/m^3) to 2 ppm (40 mg/m^3). The drumming, dedrumming and sampling operations are major contributors to exposures above 0.3 ppm. Engineering control programs to reduce contaminant emissions from these sources is underway.

.3 to 2 ppm

- Blood samples were taken from a representative sample of exposed employees and analyzed for organic fluorine. The mean organic fluorine value for Chambers Works employees was slightly higher than the Wilmington control group (0.15 ppm versus 0.094 ppm) but all values for exposed employees were less than 1 ppm. This program has been discontinued.

- A review and comparison of the medical records of active fluorocompound exposed plant employees with a control group showed no adverse health effects. However, while the difference is not statistically significant, the number of employees with abnormal liver function tests was notably higher in the exposed group (6 compared to 1). Medical surveillance will be continued with study update December, 1979.

- 10-day subacute feeding tests carried out by Haskell showed compound related non-reversible effects for three of the eight fluorocompounds tested. Non-reversible liver and testes effects were noted in rats fed 4,470 mg/kg/day [redacted] and 850 mg/kg/day [redacted]. Decreased sperm production was found in rats fed 5,000 mg/kg/day [redacted]. The need for further toxicity testing is being studied.

A meeting is being arranged through Haskell Laboratory to inform 3M of the results of our program.

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RECYCLED

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[redacted]

E. I. DU PONT DE NEMOURS & COMPANY
INCORPORATED
WILMINGTON, DELAWARE

EMPLOYEE RELATIONS DEPARTMENT

March 15, 1979

PERSONAL AND CONFIDENTIAL

P. G. GILBY
CD&P
B-13265

CHAMBERS WORKS
FLUOROSULFACTANT STUDY
(Ref. Letter from RDR to PGG, 1/23/79)

In response to our request to the plant for additional information to analyze the data statistically, we received a tabulation of the Dispensary Visits and Disability Wage incidents in the exposed and control groups (Attachment V). These data were broken down by body systems. We were also informed of the number of employees in each group who had abnormal liver function tests.

We performed a "chi-square" test to test the significance of differences between the exposed and control groups. The attached table shows only those differences that were found to be statistically significant.

In the category, "Allergic, Endocrine, and Metabolic" disorders, a significantly higher incidence was found in the exposed group for both Dispensary Visits and Disability Wage incidents. This was attributed in the report to a higher number of diabetics in the exposed group.

The exposed group also showed significantly higher numbers for "mental and psychoneurotic" disorders and for disorders of "skin and cellular tissues."

The control group, on the other hand, had considerably more Disability Wage incidents for circulatory diseases, 25 compared to 5. This difference is highly significant ($P < 0.001$).

Explanations for these differences cannot be found from the available data. It would be helpful to find out what specific diagnosis within these general categories accounted for the differences between the two groups.

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Although the number of employees with abnormal liver function tests was notably higher in the exposed group (6 compared to 1), the difference is not statistically significant ($P < 0.05$). Nevertheless, the data do suggest that the exposed group may be at an excess risk of developing liver disease, so continued surveillance would be advisable.

MEDICAL DIVISION

Sidney Pell

Sidney Pell
Manager
Epidemiology Section

SP:msd
Attach.

ORGANIC FLUORINE IN BLOOD

GROUP (SAMPLE SIZE)	PPM ORGANIC FLUORINE*
3M DATA	
GENERAL POPULATION (106)	0.002 TO 0.13 [0.02]**
PLANT OFFICE WORKER	0.01 TO 0.06
PLANT WORKER - GENERAL	0.13 TO 1.18
PLANT WORKER - LONG SERVICE IN F/C AREA	
NEWER PLANT	0.9 TO 9.1
OLDER PLANT	5.9 TO 71
DU PONT DATA	
WILMINGTON CONTROL GROUP (25)	(23 OF 25) 0 - 0.38 *** [0.094]
CHAMBERS WORKS GROUP (55)	(54 OF 55) 0 - 0.37 **** [0.15]

CONCLUSIONS

- CHAMBERS WORKS EMPLOYEES DO NOT HAVE ELEVATED LEVELS OF ORGANIC FLUORINE IN THEIR BLOOD AS WAS REPORTED FOR 3M WORKERS.
- THE MEAN VALUE FOR CHAMBERS WORKS EMPLOYEES WAS SLIGHTLY HIGHER THAN THE WILMINGTON CONTROL GROUP [0.15 VERSUS 0.094], BUT ALL VALUES ARE CONSIDERED TO BE "NORMAL" (<1 PPM) EXCEPT ONE VALUE IN THE WILMINGTON CONTROL GROUP (10.6 PPM).

* BY DIFFERENCE BETWEEN TOTAL AND INORGANIC FLUORINE

** [MEDIAN VALUES]

*** EXCEPT 2 VALUES 10.6; 0.78

**** EXCEPT 1 VALUE 0.89 PPM

TABLE I

7/13/81

CONCENTRATION OF PERFLUOROOCTANOATE IN BLOOD (a)

Sample	Date Sampled	GC Analysis Date Analyzed	$[C_8]$, ug F/g b
[redacted]	6/16/81	6/26/81	0.007
	6/16/81	6/26/81	0.011
	6/17/81	6/26/81	n.d.
	6/23/81	6/26/81	0.096

(a) Analysis as described in Lab Method ES-567 ("Determination of Perfluorooctanoic Acid in Blood, Gas Chromatographic Method", S. Stafford, 4/3/81), using the packed column GC analysis with perfluoro-n-octanoic acid as calibration standard.

(b) Although the analysis is specifically for perfluorooctanoate (acid or salts), concentrations are given in ppm fluorine for comparison with the results of total organic fluorine analyses. (ppm F = 0.688 x ppm perfluorooctanoic acid) Estimated uncertainty is $\pm$ 10% relative standard deviation. The lower limit for quantitation is 0.007 μgF/g. The detection limit is $\sim$ 0.004 μgF/g, but concentrations in that range cannot be well quantitated and are reported as < 0.007. None detected (n.d.) is reported for samples with $[C_8] \lesssim 0.004$ ppm. which cannot be distinguished from reagent background.

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8/3/81

TABLE I

CONCENTRATION OF PERFLUOROOCTANOATE IN BLOOD (a)

Sample	Date Sample	GC Analysis Date Analyzed	[C8], µg F/g b
[redacted]	7/14/81	7/28/81 & 7/29/81	0.014
[redacted]	7/14/81	7/28/81	0.25
[redacted]	7/15/81	7/28/81	0.11
[redacted]	7/22/81	7/28/81	0.015
[redacted]	7/22/81	7/29/81	0.033
[redacted]	7/22/81	7/29/81	n.d.
[redacted]	7/22/81	7/29/81	0.010
[redacted]	7/22/81	7/28/81	0.12
[redacted]	7/22/81	7/28 & 7/29/81	0.015
[redacted]	7/22/81	7/29/81	0.062
[redacted]	7/22/81	7/29/81	< 0.007
[redacted]	7/23/81	7/29/81	0.016
[redacted]	7/23/81	7/29/81	0.14
[redacted]	7/23/81	7/29/81	0.007
[redacted]	7/23/81	7/29/81	0.15
[redacted]	7/23/81	7/30/81	0.032
[redacted]	7/24/81	7/30/81	0.084
[redacted]	7/24/81	7/30/81	0.027
[redacted]	6/23/81	7/28/81	0.10[c]

(a) Analysis as described in Lab Method ES-567 ("Determination of Perfluorooctanoic Acid in Blood, Gas Chromatographic Method", S. Stafford, 4/3/81), using the packed column GC Analysis with perfluoro-n-octanoic acid as calibration standard.

(b) Although the analysis is specifically for perfluorooctanoate (acid or salts), concentrations are given in ppm fluorine for comparison with the results of total organic fluorine analyses. (ppm F = 0.688 x ppm perfluorooctanoic acid) Estimated uncertainty is ± 10% relative standard deviation. The lower limit for quantitation is 0.007 µgF/g. The detection limit is ∿ 0.004 µgF/g, but concentrations in that range cannot be well quantitated and are reported as < 0.007. None detected (n.d.) is reported for samples with [C8] ≲ 0.004 ppm, which cannot be distinguished from reagent background.

(c) Previously analyzed sample, re-analyzed for comparison with repeat sample 81-3189; result of the initial analysis on 81-2779 was 0.096, reported 7/13/81.

Company Sanitized. Does not contain TSCA CBI

8/20/81

ANALYTICAL RESULTS AS MICROGRAMS FLUORINE/GRAM BLOOD

Group A	Group B	Group C	Group D*	Group E	Group F
0.032	0.059	0.013	(0.013)	0.020	N.D.**
.015		.016	(.015)	N.D.**	
.033		N.D.**	(.007)	<.007***	
.014			(.007)	<.007***	
.062			(.011)	.010	
.077			(.016)		
.140			(.096)		
.025			(.120)		
.084					
.150					
.110					
.039					
.027					
.250					
.150					
Range 0.014-.25	-	0-.016	0.007-.12	0-.020	-
Mean 0.0805	0.0590	0.0097	0.0356	0.0088	0
Samples 15	1	3	8	5	1
Employees 15	1	3	4	5	1

Overall: Range 0-.25 Mean 0.049 Samples 33 Employees 29

* Pre-work and post-work specimens were taken from 4 employees in Group D (Pre). Time lapse between samples was 2-5 weeks. (Post)

** None detected. Zero concentration used in computing means.

*** The lower limit for quantitation is 0.007 and lower values are reported simply as <0.007; however, the 0.007 value was used in calculating means.

SPECIAL EXAMS

FLUORIDE-IN-URINE SAMPLE FOR MAC

TO VISIT SP.EX. ON DATE:

EMPLOYEE	BASE-LINE URINE	FOLLOW-UP URINE
	1 11/8 AM ✓	2 11/10 PM ✓
	3 11/8 AM ✓	4 11/10 PM ✓
	5 11/9 AM ✓	6 11/11 PM ✓
	7 11/10 AM ✓	8 very little sample 11/12 PM ✓
	11-10 PM ✓	11-12 PM ✓
	9 36217	

Cost Codes

Cost Codes [redacted]

Company Sanitized. Does not contain TSCA CBI

11/16/76

NAME & NUMBER	FLUORIDATED WATER SUPPLY	FLUORIDATED TOOTH PASTE	DATE & TIME URINE VO BASE-LINE	DATE & TIME URINE VO FINAL SAMPLE
	yes	no	11/8 AM	11/10 PM
	yes	no	11/8 AM	11/10 PM
	yes	yes	11/9 AM	11/11 PM
	yes	yes	11/10 AM	11/12 PM
	yes	yes	11/10 PM	11/12 PM

The base-line urine sample was voided after worker had been away from worksite potential exposure to fluorides for at least 48 hours.

The final urine sample was voided after worker had been subjected to worksite potential exposure for a minimum of 48 hours clock time.

RESULTS

HRS. ON JOB BETWEEN SAMPLES	MILLIGRAMS F per LITER BEFORE	AFTER	PICK-UP
22	4.8	5.9	1.1
22	3.2	2.8	0
23	3.6	4.0	0.4
23	3.9	6.6	2.7
15	6.1	4.2	0

NIOSH RECOMMENDATION (Criteria Document, 4-8-76) = The postwork specimen shall not exceed 7.0 and shall not exceed the pre-work specimen by a pick-up greater than 3.0 milligrams F per liter of urine

PERSONAL AND CONFIDENTIAL

ORGANIC FLUORIDES IN BLOOD SAMPLES

NAME	P.R. NO.	ZONE	ORGANIC FLUORIDE PPM	COMMENTS
GRANULAR OPERATORS				
Polymerization				
[redacted]	501	6	0.47	8/60-6/71, 12/72 to present
[redacted]	3520	6	2.33	Exposure since 1968, granular polymerization since 2/74.
[redacted]	598	6F	0.52	Special job. Relief on granular polymerization about 1 day/week 2/69 to present.
[redacted]	3097	6	3.54	F.P. P.O. 8/62 to 3/69, FEP polymerization 8/69 to 7/70, polymerization 12/71 to present
[redacted]	380	6	5.61	12/72 to present, others jobs since 5/55
[redacted]	3120	6	3.91	9/71 to present.
[redacted]	3417	6	6.84	FP, P.O. 9/65 to 12/72, polymerization 9/73 to present
[redacted]	3278	6	2.23	3/76 to present.
Finishing				
[redacted]	3720	4	2.06	Disp. P.O. 9/71 to 7/72, details to polymerization 5/76 to present.
[redacted]	4335	4	0.69	Detailed to polymerization 65 days in past 5 months.
[redacted]	4278	4	0.72	Detailed to granular polymerization 8 of last 10 weeks as of 9/13/79.
FINE POWDER/DISPERSION OPERATOR				
Polymerization				
[redacted]	4214	6	4.39	F.P. Dryers and Disp. P.O. 9/76 to 4/79, Polymerization 4/79 to present.
[redacted]	1484	6(22.17)	21.22	Service operator jobs 6/56 to 6/60, polymerization since 2/63.

( ) Previous blood samples taken in June.

Redacted - Privacy

NAME	P.R. NO.	ZONE	ORGANIC FLUORIDE PPM	COMMENTS
Polymerization (Cont.)				
[redacted]	3352	6	0.17	8/76 to present.
	953	6	(9.53) 8.25	4/62 to present, others job previous 6 years.
	3522	6	1.52	F.P. P.O. and Dryer 6/66 to 3/72, polymerization 2/74 to present.
	1482	6F	0.59	3/63 to present, except monomer operator 10/77-4/79.
	426	6	20.81	1960 to present.
	1508	6F	$\bar{x}$ = 9.63 (10.56) 8.70	11/75 to present.
	943	6	$\bar{x}$ = 14.4 (15.02) 13.75	4/62 to present. Service operator jobs previous 4 years.
	3564	6	1.60	11/75 to present.
	3994	6	3.55	3/76 to 8/78 F.P. dryer, polymerization 8/78 to present.
	1951	6	5.90	5/65 to present, service operator jobs additional 5 years.
	4146	6	0.38	3/79 to present.
	3485	6	6.91	4/77 to present, FEP service operator 2/75 to 4/77
	3854	6	16.89	F.P. dryer 10/75 to 4/77, polymerization 8/78 to present.
	3568	6	0.98	F.P. dryer and P.O. 2/75-5/76, some granular polymerization. F.P./disp. polymerization 4/79 to present.
	3987	6	3.81	Service operator jobs 9/72-11/77. Polymerization 11/77 to present.
	3424	6	3.23	8/76 to present
			15	

( ) Previous blood samples taken in June.

0-1	4
1-5	5
5-10	4
10-15	1
15-20	1
> 20	1

Redacted - Privacy

NAME	P.R. NO.	ZONE	ORGANIC FLUORIDE PPM	COMMENTS
Service Operator				
[redacted]	3613	4	4.97	F.P. dryer and P.O. 6/66 to 12/69, Polymerization 10/77 to 10/78.
[redacted]	4390	4	1.98	F.P. Dryer since 11/78.
[redacted]	4153	4	4.84	F.P. Dryer and Disp. P.O. 9/76 to present.
[redacted]	1591	4F	2.24	Service Operator jobs 5/57 to present.
[redacted]*	4300	4	1.03	
[redacted]	4111	4	2.92	12/78 to present F.P. Dryer, detailed to polymerization.
[redacted]	4452	4	0.50	3/79 to present all 3 jobs.
[redacted]	4216	4	1.04	
[redacted]*	4331	4	1.80	F.P. packout.
[redacted]	1498	4	2.97	F.P. Dryer 12 years, F.P. P.O 8 years, other 3 years.
[redacted]	3490	4	3.89	12/72 to present F.P. Dryer and P.O.
[redacted]	4266	4	2.30	1/79 to present Disp. and Polymerization.
[redacted]*	4299	4	1.78	F.P. packout.
[redacted]	4202	4	1.81	F.P. P.O. 11/76 to present, Details to polymerization.
MONOMER OPERATORS				
[redacted]	370	7	0.35	
[redacted]	432	7	0.39	
[redacted]	932	7	0.08	
[redacted]	858	6E	0.54	
[redacted]	1447	7	0.17	
[redacted]	625	7	0.37	
[redacted]	864	7	0.52	

Redacted - Privacy

NAME	P.R. NO.	ZONE	ORGANIC FLUORIDE PPM	COMMENTS
PEP OPERATORS				
Polymerization				
[redacted]	1743	6	(1.36) 0.99	1976 to present. Additional exposure in homopolymers
	707	6F	1.72	1976 to present. Additional exposure in homopolymers
	3223	6	2.71	Disp. 1964-1971; polymerization 1976 to present.
	1920	6	0.91	1976 to present.
	1510	6	2.10	1976 to present.
	1572	6	4.64	Disp. 10/60-11/63; polymerization 1976 to present.
	1978	6	3.70	1976 to present. Additional exposure to homopolymers
	1761	6	(3.61) 1.99	1976 to present.
	1928	6	1.95	1976 to present.
	1619	6	1.47	1976 to present.
	1744	6	4.96	1976 to present. Additional exposure in homopolymers.
	1426	6	4.52	10/77 to present. Additional exposure in homopolymers.
	889	6	4.14	12/76 to present. Additional exposure in homopolymers.
Dispersion				
[redacted]	4329	4	1.31	6/78 to present.
RESEARCH				
Research Chemists				
[redacted]	W/S		0.43	
	W/S		0.45	

( ) Previous blood samples taken in June.

Redacted - Privacy

NAME	P.R. NO.	ZONE	ORGANIC FLUORIDE PPM	COMMENTS
Semiworks Laboratorians				
[redacted]	870	6	0.44	5/70 to present.
[redacted]	3793	6	1.50	8/77 to present. Finishing operator 9/68 to 11/69, service operator 5/72 to 12/72, homopoly service operator 12/72 to 7/74, 8/75 to 11/7
[redacted]	3904	6F	0.24	4/77 to present.
[redacted]	911	6	0.70	2/75 to present.
[redacted]	560	6 (0.46)	0.26	4/77 to present.
[redacted]	3133	6	0.30	7/69 to 10/72, 5/79 to present.
[redacted]	3690	6F	0.24	8/77 to present. Service operator 2/75 to 9/75.
[redacted]	1592	6 (0.72)	0.59	10/72 to present. Teflon exposure 9/59-4/62, service operator 3/63-2/6
MONOMER OPERATORS WITH PAST FINE POWDER/DISP. POLYMERIZATION EXPOSURE				
[redacted]	939	7	6.66	Polymerization 1/62 to 10/78 Monomer operator 11 months.
[redacted]	3044	7	5.29	Exposure 5/62 to 5/77. Monomer operator 28 months.
[redacted]	1633	7	5.64	Exposure 9/62 to 11/77. Monomer operator 22 months.
			$\bar{X}$ = 5.8	
FOREMAN VOLUNTEER				
[redacted]	W/S		0.69	Various jobs with C-8 10/56 to 3/63. Monomer operator 3/63 to 2/69. Foreman 2/69 to present.

Total 12

0 - 1 8
1-5 1
5-10 3
10-15
15-20

( ) Previous blood samples taken in June.

JFDoughty:mps
10/10/79

Redacted - Privacy

AR226_3469

6pp

RECYCLED

AR226-3469

CHAMBERS WORKS

FLUOROCHEMICALS IN BLOOD STUDY

(1) RESULTS OF STUDY - LEVELS OF FLUORINE IN THE BLOOD OF CHAMBERS WORKS EMPLOYEES. (INORGANIC AND LOW VOLATILITY ORGANIC FLUORINE)

(2) INDUSTRIAL HYGIENE SURVEY

- MANUFACTURE OF [redacted]
- MANUFACTURE OF [redacted]

R. D. RICHARDSON/AMB
18 MAY 1979

Company Sanitized. Does not contain TSCA CBI

ORGANIC FLUORINE IN BLOOD

GROUP (SAMPLE SIZE)	PPM ORGANIC FLUORINE*
3M DATA	
GENERAL POPULATION (106)	0.002 TO 0.13 [0.02]**
PLANT OFFICE WORKER	0.01 TO 0.06
PLANT WORKER – GENERAL	0.13 TO 1.18
PLANT WORKER – LONG SERVICE IN F/C AREA	
NEWER PLANT	0.9 TO 9.1
OLDER PLANT	5.9 TO 71
DU PONT DATA	
WILMINGTON CONTROL GROUP (25)	(23 OF 25) 0 – 0.38 *** [0.094]
CHAMBERS WORKS GROUP (55)	(54 OF 55) 0 – 0.37 **** [0.15]

CONCLUSIONS

- CHAMBERS WORKS EMPLOYEES DO NOT HAVE ELEVATED LEVELS OF ORGANIC FLUORINE IN THEIR BLOOD AS WAS REPORTED FOR 3M WORKERS.
- THE MEAN VALUE FOR CHAMBERS WORKS EMPLOYEES WAS SLIGHTLY HIGHER THAN THE WILMINGTON CONTROL GROUP [0.15 VERSUS 0.094], BUT ALL VALUES ARE CONSIDERED TO BE "NORMAL" (<1 PPM) EXCEPT ONE VALUE IN THE WILMINGTON CONTROL GROUP (10.6 PPM).

* BY DIFFERENCE BETWEEN TOTAL AND INORGANIC FLUORINE

** [MEDIAN VALUES]

*** EXCEPT 2 VALUES 10.6; 0.78

**** EXCEPT 1 VALUE 0.89 PPM

CHAMBERS WORKS FLUOROCHEMICALS COHORT

- CHAMBERS WORKS EMPLOYEES WERE IDENTIFIED WHO
  - (1) HAVE HAD JOB ASSIGNMENTS WITH POTENTIAL FOR EXPOSURE
  - (2) ARE STILL ACTIVE OR ARE READILY AVAILABLE ON SITE
- BLOOD SAMPLES TAKEN AT REGULARLY SCHEDULED PHYSICAL EXAMINATION

JOB ASSIGNMENT	LOCATION	NUMBER IDENTIFIED	NUMBER CHECKED TO DATE	(%)
R & D	JACKSON LAB. TECHNICAL LAB.	50	18	(36)
DEVELOPMENT MANUFACTURING	SPEC. CHEM. WEST	36	6	(17)
MANUFACTURING	SPEC. CHEM. EAST	84	26	(31)
	OTHER	29	5	(17)
		199	55	(28)

- INFORMAL CHECK WITH SUPERVISION INDICATED THAT GROUP (55) SAMPLED WAS REPRESENTATIVE OF COHORT (199).

CONCLUSIONS - INDUSTRIAL HYGIENE SURVEY

A) [redacted]

1) ENVIRONMENTAL MONITORING DATA SUGGESTED CONDITIONS IN THE MANUFACTURING FACILITIES TO BE NORMALLY <5 MG/M^3 [redacted] (8 HRS.). HOWEVER, EXCURSIONS TO RAISE THIS LEVEL TO 30 TO 40 MG/M^3 [redacted] (8 HRS.) HAVE BEEN OBSERVED ON MULTIPLE OCCASIONS.

2) ADDITIONAL ENVIRONMENTAL MONITORING REQUIRED TO IDENTIFY EXPOSURE SOURCES AND DEFINE POTENTIAL EXPOSURE LEVELS. (IN PROGRESS)

3) MOST PROBABLE EXPOSURE SOURCES ARE DRUMMING ~~AND DEDRUMMING~~ FACILITIES, AND TO A LESSER EXTENT SAMPLING EQUIPMENT AND PROCEDURES.

4) DRUMMING, ~~DEDRUMMING~~ AND SAMPLING FACILITIES ARE OF A LOW STANDARD FOR CONTAINMENT BY ENGINEERING CONTROLS. (NOT ENCLOSED, NO LOCAL VENTILATION)

5) A CONTRIBUTING FACTOR IS THAT THE FACILITIES ARE ENCLOSED IN A BUILDING. PROMPT ELIMINATION OF PROCESS LEAKS AND MAINTAINENCE OF VENTILATION IS ESSENTIAL.

B) [redacted] USE AREAS

LIMITED, AVAILABLE, ENVIRONMENTAL DATA SUGGEST THE POTENTIAL FOR EXPOSURE TO [redacted] TO BE LOW.

Company Sanitized. Does not contain TSCA CBI

RECOMMENDATIONS

1) DISCONTINUE PROGRAM TO DETERMINE FLUORINE IN BLOOD.

2) ADVISE EMPLOYEES THAT BLOOD ANALYSIS PROGRAM HAS BEEN DISCONTINUED DUE TO UNIFORMLY FAVORABLE RESULTS.

3) UPGRADE FACILITIES, IF REQUIRED, TO MEET HASKELL LABORATORY EXPOSURE LIMIT GUIDELINES WHEN THESE ISSUE.

18 MAY 1979

2 pp

AR226_3470

RECYCLED

From: Barbara J Dawson on 03/05/99 10:23 AM

To: Carol S Lyell/AE/DuPont@DuPont

cc:

Subject: 1978-79 Chambers Works Organic Fluorine in Blood Monitoring Program

At your request, I have reviewed and summarized the data contained in the Chambers Works Medical topical files concerning the study performed in 1978-79 on organic fluorine levels in the blood of Chambers Works employees.

Background

In 1978, prompted by a report by another company that elevated organic fluorine levels had been observed in the blood of their workers who had been exposed to certain fluorinated surfactants, DuPont initiated a study of the workers potentially exposed to DuPont fluorosurfactants. Although CW did not handle the specific chemical manufactured by the other company and used a different manufacturing process for the fluorosurfactants manufactured at the site, DuPont performed this study which included an assessment of airborne concentrations of fluorosurfactants, measurement of fluorine levels in the blood and a review of medical files to determine if any adverse health effects could be associated with the exposure.

Overview

Personal and fixed station air monitoring was conducted to identify sources of exposure. Normal conditions within the manufacturing building showed an average 8-hour time-weighted average (TWA) concentration of <0.25 ppm with occasional excursions to an 8-hour TWA of 2 ppm. The air sampling suggested that the drumming operation was the most likely source of exposure.

Chambers Works employees were identified who had job assignments with potential for exposure to fluorochemicals. (see Table 1 for a breakdown by job assignment). A subset of these employees were selected for blood monitoring to be representative of the larger group. Blood samples were taken during their regularly scheduled physical exams and analyzed for total fluorine and inorganic fluorine. A control group of DuPont office workers stationed in Wilmington, DE was also tested. Results of the blood monitoring are summarized in Table 2. In addition to the blood monitoring, the medical staff reviewed the medical records of the larger group and found no adverse health effects attributable to exposure to fluorochemicals.

Table 1 Chambers Works Employee Cohort

Assignment	Number Identified	Number Tested
R&D	50	18
Semi-works	36	6
Manufacturing	84	26
Historical*	29	5
Total	199	55

* Employees who previously held one of the other identified assignments

Table 2 Blood Testing Data

Wilmington Control Group

Number of samples 25

Samples in analysis 23

Range 0 to 0.38 ppm organic fluorine* (minus two outliers - 10.6 ppm and 0.78 ppm)

Median 0.094 ppm

3pp

AR226-3471

RECYCLED

AR 226 - 3471

Susan S Mileti
03/21/2000 05:09 PM

To: Gerald L Kennedy/AE/DuPont@DuPont, Stephen H Korzeniowski/DuPont@DuPont
cc: [redacted]

Subject: CW blood monitoring C-8 & total F

Gerry & Steve, below is the summary of the CW and 3M Employee blood data. CW 1999 data similar to 1979 & Wilmington Controls.

1979 CW workers were from "fluorochemical/ fluorosurfactant operations from Jackson & Tech Labs & small and full scale manufacturing operations. A review of the medical records of 200 potentially exposed employees did not suggest any adverse health effects attributable to exposure to fluorochemicals. Group of 55 sampled was representative of 199 cohort." Reported as organic fluorine.

1981, July -August, CW workers from Polymer Products employees using 3M [redacted] (C-8) which had moved to CW. Samples taken to reevaluate exposure controls fo[redacted] after 3-M announced preliminary results of birth defects when FC-143 was fed to pregnant rats. [redacted] analyzed by GC, reported as ppm Fluorine.

1999 CW workers in fluorochemical area, baseline before new project. 1999 total fluorine analysis detection level higher, 0.2 ppm, C-8 as 0.01 ppm detection level by GC/EC.

I can put this into Excel if you prefer.

Sue

EMPLOYEE BLOOD SAMPLES

	1979 DATA Organic fluorine ppm*	1981 DATA ppm	1999 DATA ppm	ppm
C-8 total GROUP (sample size) Fluorine	Organic Fluorine, (Median value)	C-8 as F, (mean)	as F, (mean)	(mean)
3M DATA				
General population (106)	0.002 - 0.3 (0.02)			
plant office workers	0.01 - 0.06			
plant worker - general	0.13 - 1.18			
plant worker - long service in F/C area				
Newer plant	0.09 -9.1			
Older plant	5.9 - 71			

Company Sanitized. Does not contain TSCA CBI

DUPONT DATA

Wilmington Control group (25) 0 - 0.38*** (0.094)***

***except two Wilm. Controls 10.6 & 0.78 ppm

Chambers Works group (55) 0 - 0.37** (0.15**)

0 - 0.37
(median or mean)
(0.21)
** except one value 0.89 ppm

0 - 0.25 (0.049) 33 samples

0 -0.061 (0.018) 42 samples

Detection level 0.01 0.01 0.2

RECYCLED

Background

DuPont has manufactured fluorotelomer-based products at its Chambers Works manufacturing plant for over thirty-five years. The Chambers Works is located in Deepwater, New Jersey.

1978-1979 Study

In 1978, prompted by another company informing DuPont that elevated organic fluorine levels had been observed in the blood of their workers who had been exposed to certain fluorinated surfactants, DuPont initiated a study of their Chambers Works workers potentially exposed to DuPont fluorotelomer-based fluorosurfactants. Although the Chambers Works workers did not handle the specific chemicals manufactured by the other company and used a different manufacturing process for the fluorosurfactants manufactured on site, DuPont performed a study which included measurement of total organic fluorine (TOF) levels in the blood of workers and a review of medical files to determine if any adverse health effects could be associated with potential exposure.

Overview
Chambers Works employees were identified who had job assignments with potential for exposure. A subset were selected for blood monitoring representative of the larger worker group. These included employees in research, semi-works, and manufacturing operations. A control group of DuPont office workers in Wilmington, Delaware was also tested. Blood samples were taken during regularly scheduled physical exams and analyzed for total organic fluorine (TOF). The results of the tests were reported to the employees.

Results
The other company reported that 0.002 to 0.3 ppm TOF was present in the blood of the general population; 0.01 to 0.06 ppm TOF in their plant office workers; 0.13 to 1.18 ppm, TOF in their general plant workers; and 0.09 to 71 ppm in plant worker in their fluorinated surfactants production area.

DuPont results showed none detected to 0.38 ppm TOF in the Wilmington office workers control group and none detected to 0.37 ppm TOF in the Chambers Works workers group. DuPont concluded that the Chambers Works employees did not have elevated levels of TOF in their blood as compared to the DuPont Wilmington office worker control group. Nor did the worker group show elevated TOF levels as was reported for workers of the other company. In addition, a health and morbidity study of the worker group who had potential for exposure was no different than the overall plant control group and did not suggest any adverse health effect attributable to exposure to fluorotelomer-based chemicals. It was concluded that no further employee blood monitoring would be continued.

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1999-2000 Study

In Fall 1999, DuPont planned to start-up a new product operation at the DuPont Chambers Works where there was potential employee exposure to fluorinated chemicals. Employees in job assignments with potential for exposure which included [research, semi-works, and manufacturing] workers had blood samples taken for total organic fluorine analysis to establish a baseline. The analysis results showed none detected to 0.37 ppm TOF in the workers blood. These results were in the same range as was observed when a determination was made in ~1979 and within the range reported to be present in the general population.

Summary

DuPont has tested our workers' blood (1979-1999) and sees no elevation of organic fluorine in blood versus background control populations, and no increase versus 1979.

Based upon our testing, blood monitoring programs, and the general experience of our plant-based medical staff and health insurance claims, we have no reason to believe that there are any health concerns associated with proper manufacture, handling or use (i.e. when applied to textiles) of our fluorotelomer-based products

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000720

AR 226-7472

4PP

AR226 – 3473

DATA SUMMARY

Chemical: PFOA

Site: Chambers Works

Date of Monitoring: 2004

Matrix: Human Blood Serum

Operation: Telomers

Job Title	Number Sampled	Minimum Concentration	Mean	Median	Maximum Concentration	Standard Deviation
Entire Cohort	38	10.6	135.82	82.85	720	158.13
Males	36	10.6	123.67	82.85	720	131.70
Females	2	25	354.5	354.5	684	465.98
Operators	18	34.80	179.37	150.75	720	161.16
Males	18	34.80	179.37	150.75	720	161.16
Females	0	-	-	-	-	-
Mechanics	11	13.3	85.95	78.8	193	60.35
Males	11	13.3	85.95	78.8	193	60.35
Females	0	-	-	-	-	-
Laboratorians	0	-	-	-	-	-
Males	0	-	-	-	-	-
Females	0	-	-	-	-	-
Supervision	9	10.6	109.66	25	684	217.82
Males	7	10.6	39.71	17.5	111	37.11
Females	2	25	354.5	354.5	684	465.98

Comments:

- Analysis by Exygen
- Where duplicate samples were run, averages of two were used for statistical analysis
- Descriptive statistics calculated using Microsoft Excel

Prepared by: Barbara J. Dawson, CIH, CSP
Date of Preparation: December 9, 2004

000722

AR226-3473

DuPont Company
PFOA in Blood
Chambers Works
2004 Telomers

	Operators	Mechanics	Supervision	
	Male	Male	Male	Female
	158	49.1	111	25
	140.5	35.1	50.85	684
	185	13.3	14.3	
	720	78.8	10.6	
	400	141	59.8	
	224	134	13.9	
	141	193	17.5	
	266	38.9		
	153.5	79		
	50	28.3		
	163	155		
	85.5			
	44.25			
	159			
	148			
	34.8			
	75.9			
	80.2			
Count	18	11	7	2
Min	34.80	13.30	10.60	25.00
Avg	179.37	85.95	39.71	354.50
Median	150.75	78.80	17.50	354.50
Max	720.00	193.00	111.00	684.00
Std Dev	161.16	60.35	37.11	465.98

Prepared December 9, 2004
Barbara J. Dawson, CIH, CSP

DuPont Company
PFOA in Blood
Chambers Works
2004 Telomers Summary

	All	All Male	All Sup
	158	158	25
	140.5	140.5	684
	185	185	111
	720	720	50.85
	400	400	14.3
	224	224	10.6
	141	141	59.8
	266	266	13.9
	153.5	153.5	17.5
	50	50	
	163	163	
	85.5	85.5	
	44.25	44.25	
	159	159	
	148	148	
	34.8	34.8	
	75.9	75.9	
	80.2	80.2	
	49.1	49.1	
	35.1	35.1	
	13.3	13.3	
	78.8	78.8	
	141	141	
	134	134	
	193	193	
	38.9	38.9	
	79	79	
	28.3	28.3	
	155	155	
	111	111	
	50.85	50.85	
	14.3	14.3	
	10.6	10.6	
	59.8	59.8	
	13.9	13.9	
	17.5	17.5	
	25		
	684		
Count	38	36	9
Min	10.60	10.60	10.60
Avg	135.82	123.67	109.66
Median	82.85	82.85	25.00
Max	720.00	720.00	684.00
Std Dev	158.13	131.70	217.82

Prepared December 9, 2004
Barbara J. Dawson, CIH, CSP

3pp

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AR226_3474

First Chemical Company
Pascagoula, MS
Baseline Monitoring
December 2003

Sample Number	Result (ppb)	Comment
FCC001	5.67	
FCC001	5.45	Duplicate
FCC002	9.37	
FCC003	6.86	
FCC004	10.6	
FCC005	7.38	
FCC006	8.74	
FCC007	4.36	
FCC008	6.91	
FCC009	5.31	
FCC010	5.71	
FCC011	3.75	
FCC012	7.3	
FCC013	9.9	
FCC014	9.89	
FCC015	4.04	
FCC016	5.94	
FCC017	0.989	
FCC018	4.95	
FCC019	6.25	
FCC020	6.18	
FCC021	8.11	
FCC022	3.94	
FCC022	4.44	Duplicate
FCC023	6.11	
FCC024	5.81	
FCC025	4.57	
FCC026	7.09	
FCC027	11.1	
FCC028	3.85	
FCC029	8.67	
FCC030	9.62	
FCC031	7.87	
FCC032	6.39	
FCC033	4.41	
FCC034	5.25	
FCC035	6.17	
FCC036	7.74	
FCC037	4.1	
FCC038	9.12	
FCC039	2.98	
FCC040	6.64	
FCC041	6.42	
FCC042	4.29	
FCC042	4	Duplicate

Prepared December 7, 2004
Barbara J. Dawson, CIH, CSP

First Chemical Company
Pascagoula, MS
Baseline Monitoring
December 2003

Sample Number	Result (ppb)	Comment
FCC043	12.1	
FCC044	4.7	
FCC045	8.33	
FCC046	4.66	
FCC047	7.09	
FCC048	3.83	
FCC049	2.99	
FCC050	3.79	
FCC051	5.55	
FCC052	6.71	
FCC053	8.61	
FCC054	2.87	
FCC055	6.73	
FCC056	10.2	
FCC058	4.02	
FCC059	5.09	
FCC060	5.81	
FCC061	4.86	
FCC062	4.76	
FCC063	4.12	
FCC063	4.89	Duplicate
FCC064	5.19	
FCC065	5.28	
FCC066	2.08	
FCC067	2.47	
FCC068	2.24	
FCC069	3.07	
FCC070	5.81	
FCC071	3.87	
FCC072	5.61	
FCC073	4.22	
FCC074	4.57	
Count	77	
Average	5.85	
Std Dev	2.27	
Median	5.55	
Min	0.989	
Max	12.1	

Prepared December 7, 2004
Barbara J. Dawson, CIH, CSP

1311

AR226_3475

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AR226_3475

Télomères fluorés
Dosages sanguins

- Usines de Jarrie, Pierre Bénite, Villers Saint Paul
- EOH8, PFNA, PFOA, PFOS
- Prélèvements effectués en décembre 2001, janvier et février 2002
- Laboratoire Shiwara (Bremen, D)

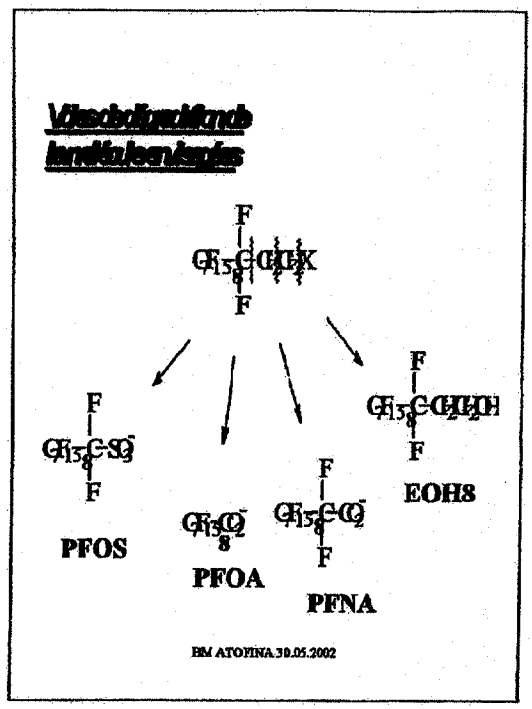
EM ATOFINA 30.05.2002

000729

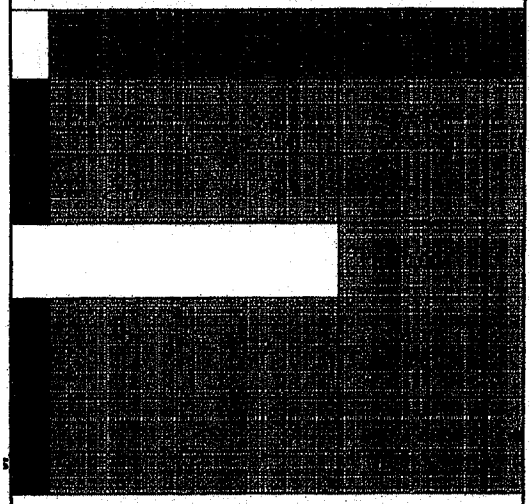
Produits dosés:

- EOH8 perfluorooctylethanol $C_8F_{17}CH_2CH_2OH$
- PFNA perfluorononanoic acid $C_8F_{17}COO$
- PFOA perfluorooctanoic acid $C_7F_{15}COO$
- PFOS perfluorooctylsulfonate $C_8F_{17}SO_3$

BM ATOFINA 30.05.2002


PFOS
PFOA
PFNA
EOH8
BM ATOFINA 30.05.2002

OYENNES ± ECART TYPE (Mini-Médian-Maxi) µg/l = ppb



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exposés et les témoins diffèrent
ificativement pour le PFOA (taux 5 fois
érieur, mais plus de 30 fois inférieur au niv
en le plus bas dosé chez les opérateurs des
es 3M et 200 fois inférieur à la valeur limi
le publiée par 3M qui est 5000 ppb) ;
te différence n'est pas significative pour le
S, et probablement pas non plus pour le PFI
che de la limite de quantification) ;
H8 n'a pas été détecté.
r PFOA, les témoins sont au niveau populatio
érale USA ; pour PFOS ce sont à la fois les
oins et les exposés qui se situent à ce niveo

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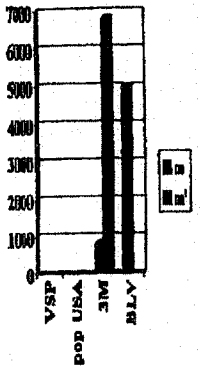
PFOA Comparaisons des niveaux

- VSP 25 ppb (5-52)
- *Population générale USA* 3 à 17 ppb (1-56)
- usines 3M 840 à 6800
- Valeur limite 3M (BLV) 5000 ppb
- 1000 ppb = 1000 µg = 1ppm = 1 mg



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PFOA sources d'informations:

- Evaluation des risques US EPA *février 02*
- Synthèse S. tox. Atofina N. Drouot *avril 02*
- Document BLV 3M (5 ppm) *mars 2000*
- Etudes épidémiologiques 3M *1993+1997* (mortalité) *1998* (hormones).

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PFOA

données d 'expérimentation animale

- Nocif par ingestion **DL50/rat= 450 mg/kg**
- Toxique par inhalation **CL50/4h/rat= 1mg/l**
- Faible nocivité par contact avec la peau **DL50/rat= 6959 mg/kg**
- Irritant pour les yeux et la peau
- Non sensibilisant

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PFOA

données d'expérimentation animale

- Toxicité long terme (3 à 6 mois): organe cible le foie, dose sans effet : 10 mg/kg/jour (singe); perturbations hormonales.
- Cancérogénèse: augmentation de l'incidence des tumeurs du foie et des testicules (mécanisme spécifique non extrapolable à l'homme), ainsi que du pancréas (mécanisme d'action non connu); dose sans effet 1.5 mg/kg/jour (rat).
- Non tératogène

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PFOA
données chez l 'homme:

- **Pas d'effets toxiques rapportés** (notamment sur le foie)
- **pas d'augmentation de l'incidence des différentes causes de mortalité** (association PFOA et cancer de la prostate soupçonnée, mais non confirmée lors d'une étude complémentaire et en l'absence d'effets hormonaux)
- **persistant** : demie vie d'élimination de l'ordre de 1 à 3 ans

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PFOA

autres données:

- VME (USA) : 0.01 mg/m3, pénétration cutanée possible
- cancérogène pour l'animal A3 (ACGIH)
- présence dans l'environnement (*persistant, bioaccumulable*): aliments (0.5 à 2 ppb), eau potable (0.1 à 0.8 ppb), espèces animales sauvages (4 à 12 ppb)

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Premières conclusions VSP:

- **Les distributions des valeurs suivent la loi normale**, pour PFOA (exposés) et PFOS (exposés et témoins); la population exposée est homogène (GHE).
- **Les exposés diffèrent significativement des témoins uniquement pour le PFOA, qui serait l'un des métabolites des télomères Atofina.**
- **Les taux de PFOA des exposés (indicateur d'exposition) sont compris dans l'intervalle mini-maxi de la population générale USA et très faibles par rapport au personnel de 3M (coefficient de sécurité de 200 / BLV 3M).**

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AR226-3476

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AR226-3476

Jim E Pesek
03/27/2003 05:47 PM

To: Stephen H Korzeniowski/DuPont@DuPont, Robert W Rickard/AE/DuPont@DuPont, Ann K Masse/HO/DuPont@DuPont
cc: [redacted]
Subject: Blood Monitoring at Villers St. Paul

Folks—

For info.

Jim

Forwarded by Jim E Pesek/AE/DuPont on 03/27/2003 05:46 PM

From: Barbara J Dawson on 03/27/2003 10:56 AM
To: Rozemarijn Laureyssens/EUR/DuPont@DuPont
cc: [redacted]
Subject: Blood Monitoring at Villers St. Paul

Rozemarijn,
I enjoyed speaking with you this morning. I appreciate your willingness to assist us in getting some more information about the PFOA blood monitoring at our former Atofina telomers manufacturing site. Attached is a note from the Atofina Medical Director, Dr. Mery, to Daniel Bechadergue, our plant manager, relative to the upcoming monitoring campaign which they have planned. We would like more information before we agree to participate.

As I mentioned, our analytical chemists have made contact with the laboratory [redacted]. They are discussing the analytical method (PFOA is gas chromatography/mass spec/mass spec) and its detection/quantiation limits. The lab suggested that they can also analyze the samples by LC/MS/MS if PFOS is analyzed concurrently. Their preliminary discussions with the lab have found that the the detection limit of the method is 3 ug/l and the limit of quantitation is 10 ug/l. If you have any information about this laboratory in terms of reputation or quality assurance, that would be helpful. After I spoke to you, I learned that our chemists will be attending a meeting in Germany during the last week of April and are trying to make arrangements to visit the lab on April 29.

Here is the information we have received to date about the first round of sampling.

Company Sanitized. Does not contain TSCA CBI

MOYENNES ± ECART TYPE (Mini-Médian-Maxi) µg/l = ppb

VSP	[illegible]	PFNA	PFOA	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

We'd like to know:

- what job assignments were represented by the initial monitoring? (both the exposed and the non-exposed group)
- number of years each worker has been in job
- calibration range of the analytical method (the lab told us the limit of quantitation is 10 yet it appears that they have reported a result of 5)
- if possible, actual results (without names, by job assignment if possible) for the workers sampled
- by what date would they need a decision from us about whether to particpate in the next campaign

We'd appreciate your guidance on whether or not we should participate in the next sampling campaign? Thanks!
Barbara

Forwarded by Daniel J Bechadergue/EUR/DuPont on 03/03/2003 19:22

"Bernard MERY" <bernard.mery@atofina.com> on 27/02/2003 12:05:43

To: Daniel J Bechadergue/EUR/DuPont@DuPont
cc: [redacted]
Subject: Biomonitoring EOH8, PFNA, PFOA, PFOS

La campagne 2003 est en cours chez Atofina, pr_l_vements en mars et exp_dition des _chantillons de sang semaine 14 en ce qui concerne Villers St Paul (personnel de l'UPF et de maintenance intervenant pour vous).
L'objectif de r_aliser cette campagne pour le personnel DUPONT avant le 30/06/2003 me semble raisonnable. Qu'en pensez-vous ?
Cordialement.
MERY

Dr B.

Company Sanitized. Does not contain TSCA CBI

Ps. la reprise d'un protocole _quivalent _ celui mis en place chez Atofina implique l'envoi d'un courrier _ chaque salari_ concern_ (mod_le 2001 joint) et surtout l'"agr_ment" du laboratoire Schiwara pour effectuer les analyses (contact: info@schiwara.de www.schiwara.de) selon les modalit_s actuelles (mat_riel de pr_l_vement, centrifugation et cong_lation avant exp_dition, transport isotherme par DHL: d_tails _ votre disposition).

C.htm

- information prise de sang DFF.doc