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FYI-0505-01495

May 13, 2005

Via Federal Express Delivery

J.I. Palmer, Jr., Regional Administrator
U.S. EPA, Region 4
Sam Nunn Atlanta Federal Center
61 Forsyth Street, SW
Atlanta, GA 30303

Via Federal Express Delivery

Tom Skinner
Acting Assistant Administrator for the EPA
Office of Enforcement and Compliance Assurance
1200 Pennsylvania Avenue, N.W.
Washington, DC 20460

Re: **REQUEST FOR IMMEDIATE ENFORCEMENT ACTION**
E.I. DuPont de Nemours and Company's Pass Christian/Delisle, Harrison County,
Mississippi Titanium Dioxide Plant.

Dear Mr. Palmer and Mr. Skinner:

It has come to our attention that, in the recent past, the EPA has filed two complaints against E.I. DuPont de Nemours and Company ("DuPont") regarding its Washington Works Facility located in Washington, Wood County, West Virginia for failing to disclose information in violation of TSCA § 8(e), 15 U.S.C. § 2607 (e). Specifically, the first complaint addresses Dupont's failure to submit data to the EPA from 1981 to 2001 concerning human blood sampling of pregnant employees confirming transplacental movement of PFOA blood levels in humans, and DuPont's failure to submit data concerning PFOA contamination in public drinking water in and around the facility.¹ The second complaint addresses DuPont's failure to submit to the EPA data concerning human serum sampling of twelve members of the

¹In the Matter of: E.I. du Pont de Nemours and Company, Docket No. TSCA-HQ-2004-0016,
Docket No. RCRA-HQ-2004-0016

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general population living near the Washington Works Facility.²

We believe that Dupont continues to violate TSCA § 8(e), 15 U.S.C. § 2607 (e) regarding disclosure of information at its other plants, which presents a substantial risk of health. Specifically, DuPont owns and operates a titanium dioxide plant in Pass Christian/Delisle, Harrison County, Mississippi. Dupont's DeLisle plant is the second largest producer of dioxin in the United States according to U.S. EPA TRI reports. Dupont has been aware of elevated blood dioxin levels in members of the community residing in the same zip code as Dupont's DeLisle, Mississippi plant since September, 2004. The human serum samples were obtained during the course of currently pending litigation relating to community exposure to DeLisle's plant emissions. We doubt that Dupont has reported these tests to the EPA. A copy of the serum sampling results along with the report of Richard Clapp, D.Sc., M.P.H. is attached. (See Attachment 1).

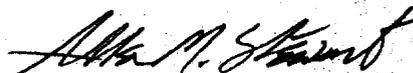
Further, Dupont has also known since September, 2004 that dioxin in house dust levels in the area surrounding its DeLisle plant are elevated. This data was also obtained during the course of the pending litigation. A copy of the Delisle house dust results is attached. (See Attachment 2). Also attached is the report of Rod O'Connor, Ph.D. (See Attachment 3). Comparing Attachment 2 and 3 shows that Delisle dioxin house dust levels are 500% higher than background dioxin house dust levels in rural Mississippi. Dr. O'Connor's rural Mississippi background dioxin house dust study has been accepted for publication in a peer reviewed journal and is scheduled for publication in September of 2005.

Finally, Dupont has known since November, 2004 that oysters and sediment in St. Louis Bay are contaminated with elevated amounts of heavy metals emanating from Dupont's Delisle facility. DuPont's DeLisle plant is located on the edge of St. Louis Bay and DuPont has an outfall that drains directly into the bay. The testing results were recently published in the Journal of Shellfish Research. A copy of the publication is enclosed for your convenience. (See Attachment 4).

Unless Dupont has previously reported this data to the EPA, we believe that Dupont's DeLisle, Mississippi plant is knowingly violating TSCA § 8(e), 15 U.S.C. § 2607 (e) and TSCA § 15(3)(B), 15 U.S.C. § 2614(3)(B), which makes it unlawful "to fail or refuse to submit reports, notices, or other information" required by TSCA. The human serum sampling results, house dust levels, and oyster and sediments data is information that reasonably supports the conclusion that dioxins and heavy metals emanating from DuPont's DeLisle plant present a substantial risk of injury to human health. As such, DuPont is required under TSCA § 8(e) to immediately report the information to the EPA Administrator. If DuPont has indeed failed or refused to submit this data to the EPA, we believe the EPA should take the appropriate enforcement action against DuPont.

Thank you for your attention to this matter.

Sincerely,
BARON & BUDD, P.C.



Allen M. Stewart

²In the Matter of: E.I. du Pont de Nemours and Company, Docket No. TSCA-HQ-2005-5001.

Exhibit 1

Exhibit 1-(a)

**A COMPARISON OF BLOOD DIOXIN LEVELS AMONG PERSONS IN PASS
CHRISTIAN, MS AND TWO LOUISIANA PARISHES**

Richard Clapp (1) and Sara Donahue (2)

(1) B.U. School of Public Health, and (2) University of Massachusetts – Lowell

Introduction

Pass Christian, MS is the location of the Dupont chemical company's DeLisle titanium dioxide plant for many years. The plant used the chloride-ilmenite process and heated the ore in a coke-fired oven in order to produce the product. Because of design and operations characteristics (Powell, 1968), this plant has released dioxins and furans into the surrounding community and water bodies, leading to concerns about human health effects including cancer. In one report (2000) of EPA Toxic Release Inventory information, this plant was the second leading emitter of dioxins and dioxin-like compounds in the U.S.

As a result of a petition by a community member in 2001, the Agency for Toxic Substances and Disease Registry conducted a health consultation (ATSDR, 2004). This consultation included an assessment of sources of dioxin and dioxin-like compounds from the DuPont DeLisle plant, potential routes of exposure including air dispersion and food chain contamination, including consumption of fish and shellfish from a bay (St. Louis Bay) adjacent to the plant. The draft report concluded that current air emissions

and fish consumption pose no apparent public health hazard, but recommend further testing of crab in St. Louis Bay and further testing of surface soil on the plant grounds. This report failed to consider other routes of exposure and accumulation of dioxin and related compounds in house dust or other environmental media.

During the past two years, residents near the DeLisle plant have sought legal representation and filed a lawsuit. The clients in this lawsuit include 494 individuals who lived in Zip Code 39571, where the DeLisle plant is located, for at least five years and were between the ages of 15 and 59. From these, 45 were selected randomly and agreed to have their blood drawn and analyzed for dioxin and dioxin-like compounds. These results were compared to other recently published results in the same age groups in two communities in Louisiana, Calcasieu and Lafayette, one of whose residents were also potentially exposed to airborne dioxin emissions (Millette, et al., 2003). The age groups and selection criteria for the comparison communities in Louisiana were the same as in this study.

Methods

This comparison consisted of drawing a stratified random sample of 45 participants from a database of clients in a lawsuit who resided in Zip Code 39571 for at least five years. The sampling was done in order to select 15 individuals in three age groups: 15-29, 30-44, and 45-59. The blood samples were analyzed at a commercial laboratory meeting all relevant quality assurance criteria (ERGO Lab, Hamburg, Germany) and presented as both lipid based congener specific concentrations and WHO Toxic Equivalent values

(TEQ). The methods used by the laboratory have been described elsewhere (Papke O, and Herrmann T, 2002).

The mean and 95% confidence intervals for the Dioxin TEQ values of the three age groups in Pass Christian participants were calculated, along with the 95th percentiles of the distributions and their attendant confidence intervals.

Results and Discussion

The results of the equivalent WHO TEQ analyses for Pass Christian and the two Louisiana communities are presented in the Table. The results indicate that Pass Christian participants mean dioxin levels were higher than both comparison communities in all age groups. In particular, the older Pass Christian residents had significantly higher mean dioxin levels in their blood than those in the older age groups in both Calcasieu and Lafayette, Louisiana.

Furthermore, the specific congeners in the blood of Pass Christian participants were a mixture of dioxins, furans and other dioxin-like compounds. The percentage of the TEQ contributed by furans varied between 12% and 20% in the three age groups, with the largest percent contribution from furans in those aged 30-44 (data not shown). This is a higher percentage than in the Calcasieu participants (Orloff, et al., 2001) and is consistent with exposure from a high temperature production process (Schechter and Gasiewicz, 2003).

These results suggest an unusual exposure to dioxin and dioxin-like compounds in long-term residents of Zip Code 39571, Pass Christian, MS. Further studies are underway to determine whether there are unusual patterns of cancer and other adverse health effects in this population.

| Dioxin TEQ in Pass Christian, Calcasieu and Lafayette | | | | |
|---|----------------|----|-----------------------------|-----------------------------|
| Age Group | Parish | N | Arithmetic Mean (95% CI) | 95th Percentile (95% CI) |
| 45-59 | Pass Christian | 15 | 29.8 (23.5 - 36.0) | 50.0 (43.8 - 56.2) |
| | Calcasieu | 79 | 19.1 (16.9 - 21.3) | 35.2 (30.5 - 55.4) |
| | Lafayette | 31 | 19.1 (15.3 - 22.8) | 32.4 (29.4 - 46.4) |
| 30-44 | Pass Christian | 15 | 16.2 (12.2 - 20.8) | 32.9 (28.6 - 37.3) |
| | Calcasieu | 70 | 11.6 (9.6 - 13.6) | 24.5 (21.1 - 50.4) |
| | Lafayette | 31 | 13.6 (10.8 - 16.4) | 30.4 (21.0 - 32.0) |
| 15-29 | Pass Christian | 15 | 9.5 (7.1 - 11.9) | 19.0 (16.5 - 21.4) |
| | Calcasieu | 75 | 5.9 (4.4 - 7.4) | 14.0 (10.9 - 53.9) |
| | Lafayette | 26 | 5.8 (4.3 - 7.3) | 11.7 (10.1 - 12.2) |

Dioxin TEQ in Pass Christian, Calcasieu and Lafayette

| Age Group | Parish | N | Arithmetic Mean (95% CI) | 95th Percentile (95% CI) |
|-----------|----------------|----|--------------------------|--------------------------|
| 45-59 | Pass Christian | 15 | 29.8 (23.5 - 36.0) | 50.0 (43.8 - 56.2) |
| | Calcasieu | 79 | 19.1 (16.9 - 21.3) | 35.2 (30.5 - 55.4) |
| | Lafayette | 31 | 19.1 (15.3 - 22.8) | 32.4 (29.4 - 46.4) |
| 30-44 | Pass Christian | 15 | 16.2 (12.2 - 20.8) | 32.9 (28.6 - 37.3) |
| | Calcasieu | 70 | 11.6 (9.6 - 13.6) | 24.5 (21.1 - 50.4) |
| | Lafayette | 31 | 13.6 (10.8 - 16.4) | 30.4 (21.0 - 32.0) |
| 15-29 | Pass Christian | 15 | 9.5 (7.1 - 11.9) | 19.0 (16.5 - 21.4) |
| | Calcasieu | 75 | 5.9 (4.4 - 7.4) | 14.0 (10.9 - 53.9) |
| | Lafayette | 26 | 5.8 (4.3 - 7.3) | 11.7 (10.1 - 12.2) |

| Number | lastname | middlename | firstname | current city-state-zip | DOB | Age at Time of Blood Draw | TEQ (WHO) | |
|---------------------------|----------|------------|-----------|--------------------------|-----|---------------------------|-----------|------|
| 1 | | | | Pass Christian MS 39571 | '51 | 52 | 17.674 | |
| 2 | | | | Pass Christian, MS 39571 | '59 | 44 | 21.938 | |
| 3 | | | | Pass Christian 39571 | '50 | 53 | 49.930 | |
| 4 | | | | Pass Christian I 39571 | '50 | 53 | 36.125 | |
| 5 | | | | Pass Christian, MS 39571 | '57 | 46 | 24.843 | |
| 6 | | | | Pass Christian, MS 39571 | '53 | 50 | 25.459 | |
| 7 | | | | Pass Christian, MS 39571 | '55 | 49 | 42.782 | |
| 8 | | | | Pass Christian, MS 39571 | '58 | 46 | 6.695 | |
| 9 | | | | Pass Christian, MS 39571 | '54 | 49 | 18.875 | |
| 10 | | | | Pass Christian, MS 39571 | '46 | 57 | 50.176 | |
| 11 | | | | Pass Christian, MS 39571 | '51 | 52 | 26.353 | |
| 12 | | | | Pass Christian MS 39571 | '50 | 54 | 36.533 | |
| 13 | | | | Pass Christian, MS 39571 | '52 | 51 | 26.530 | |
| 14 | | | | Pass Christian, MS 39571 | '51 | 52 | 23.702 | |
| 15 | | | | Pass Christian, MS 39571 | '46 | 57 | 39.115 | |
| Mean | | | | | | | 29.8 | |
| St Dev | | | | | | | 12.3 | |
| 95% confidence interval | | | | | | | 6.2 | |
| Mean +/- CI | | | | | | 23.5 | 29.8 | 36.0 |
| Calcasieu | | | | | | | | |
| Mean +/- CI | | | | | | 16.9 | 19.1 | 21.3 |
| Lafayette | | | | | | | | |
| Mean +/- CI | | | | | | 15.3 | 19.1 | 22.8 |
| 95% Percentile Population | | | | | | | 50.0 | |
| St. Dev | | | | | | | 12.3 | |
| 95% Confidence Interval | | | | | | | 6.2 | |
| 95% Percentile +/- CI | | | | | | 43.8 | 50.0 | 56.2 |
| Calcasieu | | | | | | 30.5 | 35.2 | 55.4 |
| Lafayette | | | | | | 29.4 | 32.4 | 46.4 |

| Number | lastname | middlename | firstname | current city- state-zip | DOB | Age at Time of Blood Draw | TEQ (WHO) | |
|------------------------|----------|------------|-----------|-----------------------------|-----|---------------------------------|-------------|------|
| 1 | | | | Pass Christian MS 39571 | 60 | 44 | 9.440 | |
| 2 | | | | Pass Christian, MS 39571 | 70 | 34 | 5.080 | |
| 3 | | | | Pass Christian MS 39571 | 71 | 32 | 9.351 | |
| 4 | | | | Pass Christian, MS 39571 | 63 | 40 | 12.606 | |
| 5 | | | | Pass Christian, MS 39571 | 64 | 39 | 10.691 | |
| 6 | | | | Pass Christian MS 39571 | 71 | 32 | 19.331 | |
| 7 | | | | Pass Christian MS 39571 | 71 | 32 | 11.877 | |
| 8 | | | | Pass Christian, MS 39571 | 59 | 35 | 14.396 | |
| 9 | | | | Pass Christian MS 39571 | 64 | 39 | 16.486 | |
| 10 | | | | Pass Christian, MS 39571 | 65 | 38 | 17.125 | |
| 11 | | | | Pass Christian, MS 39571 | 59 | 44 | 20.628 | |
| 12 | | | | Pass Christian MS 39571 | 62 | 41 | 20.655 | |
| 13 | | | | Pass Christian, MS 39571 | 73 | 31 | 11.592 | |
| 14 | | | | Pass Christian, MS 39571 | 60 | 43 | 37.561 | |
| 15 | | | | Pass Christian MS 39571 | 66 | 38 | 30.943 | |
| Mean | | | | | | | 16.5 | |
| St Dev | | | | | | | 8.6 | |
| 95% CI | | | | | | | 4.3 | |
| Mean +/- CI | | | | | | 12.2 | 16.5 | 20.8 |
| Calcasieu | | | | | | | | |
| Mean +/- CI | | | | | | 9.6 | 11.6 | 13.6 |
| Lafayette | | | | | | | | |
| | | | | | | 10.8 | 13.6 | 16.4 |
| 95th percentile | | | | | | | | |
| St Dev | | | | | | | 8.6 | |
| 95% CI | | | | | | | 4.3 | |
| 95th +/- CI | | | | | | 28.6 | 32.9 | 37.3 |
| Calcasieu | | | | | | | | |
| | | | | | | 21.1 | 24.5 | 50.4 |
| Lafayette | | | | | | | | |
| | | | | | | 21.0 | 30.4 | 32.0 |

| Number | lastname | middlename | firstname | current city- state-zip | DOB | Age at Time of Blood Draw | TEQ (WHO) | | | |
|-----------------|----------|------------|-----------|--|-----|---------------------------------|-----------|-------|--|--|
| 1 | | | | Pass Christian, MS 39571 | 87 | 16 | 10.530 | | | |
| 2 | | | | Pass Christian, MS 39571 | 77 | 26 | 19.748 | | | |
| 3 | | | | Pass Christian, MS 39571 | 76 | 27 | 11.053 | | | |
| 4 | | | | Pass Christian, MS 39571 | 84 | 19 | 18.617 | | | |
| 5 | | | | Pass Christian, MS 39571 | 87 | 16 | 2.946 | | | |
| 6 | | | | Pass Christian MS 39571 | 87 | 17 | 5.952 | | | |
| 7 | | | | Pass Christian, MS 39571 | 76 | 28 | 11.180 | | | |
| 8 | | | | Pass Christian MS 39571 | 86 | 17 | 8.215 | | | |
| 9 | | | | Pass Christian MS 39571 | 88 | 15 | 9.663 | | | |
| 10 | | | | Pass Christian, MS 39571 | 87 | 16 | 7.751 | | | |
| 11 | | | | Pass Christian, MS 39571 | 76 | 27 | 9.771 | | | |
| 12 | | | | Pass Christian, MS 39571 | 76 | 28 | 3.524 | | | |
| 13 | | | | Deisle -Pass Christian, MS 39571 | 75 | 29 | 10.972 | | | |
| 14 | | | | Pass Christian, MS 39571 | 79 | 24 | 7.208 | | | |
| 15 | | | | Pass Christian MS 39571 | 87 | 17 | 5.169 | | | |
| Mean | | | | | | | 9.5 | | | |
| St Dev | | | | | | | 4.8 | | | |
| 95% CI | | | | | | | 2.4 | | | |
| Mean +/- CI | | | | | | 7.08 | 9.49 | 11.89 | | |
| Calcasieu | | | | | | | | | | |
| Mean +/- CI | | | | | | 4.4 | 5.9 | 7.4 | | |
| Lafayette | | | | | | | | | | |
| | | | | | | 4.3 | 5.8 | 7.3 | | |
| 95th percentile | | | | | | | 19.0 | | | |
| St Dev | | | | | | | 4.8 | | | |
| 95% CI | | | | | | | 2.4 | | | |
| 95th +/- CI | | | | | | 16.5 | 19.0 | 21.4 | | |
| Calcasieu | | | | | | 10.9 | 14.0 | 53.9 | | |
| Lafayette | | | | | | 10.1 | 11.7 | 12.2 | | |

Exhibit 1-(b)

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Page 1 of 26

ERGO Forschungsgesellschaft mbH, Geierstr. 1, 22305 Hamburg, Germany

Baron & Budd, P.C.
Att.: Mr. Jim Piel
3102 Oak Lawn Avenue, Suite 1100
Dallas 75219
USA

Report 2004-0498cc

1 Order

The order was given in writing on 21.05.2004 by the client mentioned above.
The order has the following internal project code: A-0507-04-400.

2 Sampling

The sampling was done by the customer.

3 Description of sample

| Sample Code | Client Code | Matrix | Receipt of sample | Date of the test performance |
|--------------|---|--------------|-------------------|------------------------------|
| H-04-06-0082 | 09 Date: 5/21/04, approximately 30 ml | Serum/Plasma | 04.06.2004 | 15.06.2004 - 29.06.2004 |
| H-04-06-0083 | 11 Date: 5/18/04, approximately 30 ml | Serum/Plasma | 04.06.2004 | 15.06.2004 - 29.06.2004 |



Testing Laboratory accredited by the DAP Deutsches Akkreditierungssystem Prüfwesen GmbH according to DIN EN ISO/IEC 17025. The Accreditation applies for the Testing Methods mentioned in the List attached to the Certificate.

Accreditation by the German Authorities (Notification) related to §§ 26, 28 BImSchG, Emission- and Ambient Air Measurement, Olfactometry and Function Test.

Laboratory for Dioxin Testing in Feeding Stuff listed by the European Commission (DG IV).

Board members: Dr. Michael Ball, Olaf Pöpke
Geierstraße 1, D-22305 Hamburg, Tel: +49 40 69 70 96-0, Fax: +49 40 69 70 98 99
Bank account: Commerzbank Hamburg - BLZ 200 400 00 - Account-No 2707826
Local court Hamburg HRB 22799 - FA Hamburg-Barmbek-Uhlenhorst - Tax-No 71 856 01913

ERGO.000046

| Sample Code | Client Code | Matrix | Receipt of sample | Date of the test performance |
|--------------|---|--------------|-------------------|------------------------------|
| H-04-06-0084 | 21 Date: 5/20/04, approximately 20 ml | Serum/Plasma | 04.06.2004 | 15.06.2004 - 29.06.2004 |
| H-04-06-0085 | 22 Date: 5/20/04, approximately 20 ml | Serum/Plasma | 04.06.2004 | 15.06.2004 - 29.06.2004 |
| H-04-06-0086 | 28 Date: 5/18/04, approximately 30 ml | Serum/Plasma | 04.06.2004 | 15.06.2004 - 29.06.2004 |
| H-04-06-0087 | 32 Date: 5/22/04, approximately 30 ml | Serum/Plasma | 04.06.2004 | 15.06.2004 - 29.06.2004 |
| H-04-06-0088 | 33 Date: 5/17/04, approximately 20 ml | Serum/Plasma | 04.06.2004 | 15.06.2004 - 29.06.2004 |
| H-04-06-0089 | 34 Date: 5/20/04, approximately 20 ml | Serum/Plasma | 04.06.2004 | 15.06.2004 - 29.06.2004 |
| H-04-06-0090 | 36 Date: 5/6/04, approximately 30 ml | Serum/Plasma | 04.06.2004 | 15.06.2004 - 29.06.2004 |
| H-04-06-0091 | 40 Date: 5/18/04, approximately 30 ml | Serum/Plasma | 04.06.2004 | 15.06.2004 - 29.06.2004 |
| H-04-06-0092 | 41 Date: 5/25/04, approximately 15 ml | Serum/Plasma | 04.06.2004 | 15.06.2004 - 29.06.2004 |

| Sample Code | Client Code | Matrix | Receipt of sample | Date of the test performance |
|--------------|---|--------------|-------------------|------------------------------|
| H-04-06-0093 | 46 Date: 5/22/04, approximately 30 ml | Serum/Plasma | 04.06.2004 | 15.06.2004 - 29.06.2004 |
| H-04-06-0094 | 49 Date: 5/26/04, approximately 20 ml | Serum/Plasma | 04.06.2004 | 15.06.2004 - 29.06.2004 |
| H-04-06-0095 | 50 Date: 5/27/04, approximately 15 ml | Serum/Plasma | 04.06.2004 | 15.06.2004 - 29.06.2004 |
| H-04-06-0096 | 51 Date: 5/28/04, approximately 15 ml | Serum/Plasma | 04.06.2004 | 15.06.2004 - 29.06.2004 |
| H-04-06-0097 | 52 Date: 5/26/04, approximately 10 ml | Serum/Plasma | 04.06.2004 | 15.06.2004 - 29.06.2004 |
| H-04-06-0098 | 23 Date: 6/1/04, approximately 20 ml | Serum/Plasma | 04.06.2004 | 15.06.2004 - 29.06.2004 |

4 Analytical methods

4.1 PCDDs/PCDFs in blood

In the following the analytical procedures for the analysis of human blood is shown. We would like to mention, that the measurements are done by *high resolution mass spectrometry (HRMS)*, which guarantees high specificity and high sensitivity.

Prior the extraction following ^{13}C -UL-labeled internal standards are added to the sample:

| Internal standards (^{13}C -UL), PCDDs/PCDFs | | | |
|--|------------|-----------------|------------|
| PCDDs | | PCDFs | |
| 2,3,7,8 | -Tetra-CDD | 2,3,7,8 | -Tetra-CDF |
| 1,2,3,7,8 | -Penta-CDD | 1,2,3,7,8 | -Penta-CDF |
| | | 2,3,4,7,8 | -Penta-CDF |
| 1,2,3,4,7,8 | -Hexa-CDD | 1,2,3,4,7,8 | -Hexa-CDF |
| 1,2,3,6,7,8 | -Hexa-CDD | 1,2,3,6,7,8 | -Hexa-CDF |
| 1,2,3,7,8,9 | -Hexa-CDD | 1,2,3,7,8,9 | -Hexa-CDF |
| | | 2,3,4,6,7,8 | -Hexa-CDF |
| 1,2,3,4,6,7,8 | -Hepta-CDD | 1,2,3,4,6,7,8 | -Hepta-CDF |
| | | 1,2,3,4,7,8,9 | -Hepta-CDF |
| 1,2,3,4,6,7,8,9 | -Octa-CDD | 1,2,3,4,6,7,8,9 | -Octa-CDF |

After the spiking, the samples are extracted with hexane for ultratrace-analyses (e.g. nanograde) by using a liquid/liquid extraction.

After performing the gravimetric lipid determination, the clean up is done on a multicolumn system (involving carbon-on-glasfibre or carbon-on-celite for PCDDs/PCDFs). The measurement is done by means of high resolution gaschromatography and high resolution mass spectrometry (HRGC/HRMS) with VG-AutoSpec and/or Finnigan MAT 95 XL using DB-5 capillary columns.

For each component 2 isotope masses are measured. The quantification is carried out by the use of internal/external standard mixtures (isotope dilution method). Following PCDDs/PCDFs are determined and reported.

| PCDDs/PCDFs | | | |
|-----------------|------------|-----------------|------------|
| PCDDs | | PCDFs | |
| 2,3,7,8 | -Tetra-CDD | 2,3,7,8 | -Tetra-CDF |
| 1,2,3,7,8 | -Penta-CDD | 1,2,3,7,8 | -Penta-CDF |
| | | 2,3,4,7,8 | -Penta-CDF |
| 1,2,3,4,7,8 | -Hexa-CDD | 1,2,3,4,7,8 | -Hexa-CDF |
| 1,2,3,6,7,8 | -Hexa-CDD | 1,2,3,6,7,8 | -Hexa-CDF |
| 1,2,3,7,8,9 | -Hexa-CDD | 1,2,3,7,8,9 | -Hexa-CDF |
| | | 2,3,4,6,7,8 | -Hexa-CDF |
| 1,2,3,4,6,7,8 | -Hepta-CDD | 1,2,3,4,6,7,8 | -Hepta-CDF |
| | | 1,2,3,4,7,8,9 | -Hepta-CDF |
| 1,2,3,4,6,7,8,9 | -Octa-CDD | 1,2,3,4,6,7,8,9 | -Octa-CDF |

In addition to the single results, calculations of the toxicity equivalents (TEQ) according to the WHO-system are carried out.

4.2 WHO-PCBs in blood

In the following the analytical procedures for the analysis of human blood is shown. We would like to mention, that the measurements are done by *high resolution mass spectrometry (HRMS)*, which guarantees high specificity and high sensitivity.

Prior the extraction following ^{13}C -UL-labeled internal standards are added to the sample:

| | | Internal standards (^{13}C -UL), PCBs | |
|-----------------|------------------|---|------------|
| | | Compound | IUPAC Code |
| Non-ortho PCBs | 3,3',4,4' | -Tetra-CB | PCB 77 |
| | 3,4,4',5 | -Tetra-CB | PCB 81 |
| | 3,3',4,4',5 | -Penta-CB | PCB 126 |
| | 3,3',4,4',5,5' | -Hexa-CB | PCB 169 |
| Mono-ortho PCBs | 2,3,3',4,4' | -Penta-CB | PCB 105 |
| | 2,3,4,4',5 | -Penta-CB | PCB 114 |
| | 2,3',4,4',5 | -Penta-CB | PCB 118 |
| | 2',3,4,4',5 | -Penta-CB | PCB 123 |
| | 2,3,3',4,4',5 | -Hexa-CB | PCB 156 |
| | 2,3,3',4,4',5' | -Hexa-CB | PCB 157 |
| | 2,3',4,4',5,5' | -Hexa-CB | PCB 167 |
| | 2,3,3',4,4',5,5' | -Hepta-CB | PCB 189 |

After the spiking, the samples are extracted with hexane for ultratrace-analyses (e.g. nanograde) by using a liquid/liquid extraction.

After performing the gravimetric lipid determination, the clean up is done on a multicolumn system (involving carbon-on-glasfibre or carbon-on-celite for PCBs). The measurement is done by means of high resolution gaschromatography and high resolution mass spectrometry (HRGC/HRMS) with VG-AutoSpec and/or Finnigan MAT 95 XL using DB-5 capillary columns.

For each component 2 isotope masses are measured. The quantification is carried out by the use of internal/external standard mixtures (isotope dilution method). Following PCBs are determined and reported.

| | PCBs | | |
|------------------|------------------|-----------|------------|
| | Compound | | IUPAC Code |
| Non-ortho PCBs | 3,3',4,4' | -Tetra-CB | PCB 77 |
| | 3,4,4',5 | -Tetra-CB | PCB 81 |
| | 3,3',4,4',5 | -Penta-CB | PCB 126 |
| | 3,3',4,4',5,5' | -Hexa-CB | PCB 169 |
| Mono-ortho PCBs | 2,3,3',4,4' | -Penta-CB | PCB 105 |
| | 2,3,4,4',5 | -Penta-CB | PCB 114 |
| | 2,3',4,4',5 | -Penta-CB | PCB 118 |
| | 2',3,4,4',5 | -Penta-CB | PCB 123 |
| | 2,3,3',4,4',5 | -Hexa-CB | PCB 156 |
| | 2,3,3',4,4',5,5' | -Hexa-CB | PCB 157 |
| | 2,3',4,4',5,5' | -Hexa-CB | PCB 167 |
| 2,3,3',4,4',5,5' | -Hepta-CB | PCB 189 | |

In addition to the single results, calculations of the toxicity equivalents (TEQ) according to the WHO-system are carried out.

5 General information about PCDDs/PCDFs

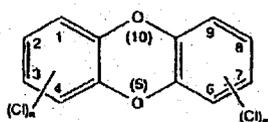
Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) are unwanted by-products in a variety of industrial and thermal processes. However, their levels in the environment increased significantly with the beginning of the industrial chlorine industry in this century. Because of their many sources, PCDDs and PCDFs are ubiquitously distributed. The degree of chlorination of the tricyclic components varies between 1 and 8 atoms per molecule. The overall number of dioxins and furans is 75 and 135, respectively.

In humans, only the isomers with 2,3,7,8-substitution are found, totaling seven dioxins and 10 furans. Humans may become contaminated with PCDD/PCDF through environmental (background), occupational, or accidental exposure.

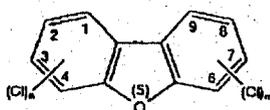
It is generally agreed that for the normal population, food represents the main route of environmental exposure to PCDD/s/PCDFs. Usually more than 90% of the total daily intake of these contaminants derives from food.

In contrast, exposure via other routes, such as inhalation and ingestion of particles from air, ingestion of contaminated soil, and dermal absorption, normally contributes less than 10% of daily intake. Because humans are the high end of the food chain, it becomes obvious that human tissue may contain relatively high amounts of xenobiotics such as PCDDs/PCDFs. Because of the lipophilic nature of these two classes of environmental contaminants, food-stuffs of animal origin are of special importance.

The following figure shows the general structure of polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs):

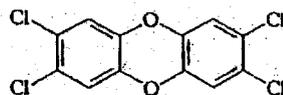


Polychlorinated dibenzo-p-dioxins
(PCDDs)



Polychlorinated dibenzofurans
(PCDFs)

The following figure shows the formula of 2,3,7,8-Tetrachlorodibenzo-p-dioxin, the most toxic compound of PCDDs/PCDFs.



2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN

Certain PCBs were found to have "dioxin-like" properties and were given a TEF (toxic equivalent factor) by WHO as well:

International TEFs for human beings and mammals

| PCDDs (dioxins) | TEF | PCBs with no chlorine at ortho positions ('coplanar' PCBs) | TEF |
|-----------------------|--------|--|--------|
| 2,3,7,8-TCDD (TCDD) | 1 | 3,3',4,4'-TCB | 0.0001 |
| 1,2,3,7,8-PeCDD | 1 | 3,4,4',5-TCB | 0.0001 |
| 1,2,3,4,7,8-HxCDD | 0.1 | 3,3',4,4',5-PeCB | 0.1 |
| 1,2,3,7,8,9-HxCDD | 0.1 | 3,3',4,4',5,5'-HxCB | 0.01 |
| 1,2,3,6,7,8-HxCDD | 0.1 | | |
| 1,2,3,4,6,7,8-HpCDD | 0.01 | | |
| OCDD | 0.0001 | | |
| | | PCBs with one chlorine atom at ortho position | |
| PCDFs (furans) | | 2,3,3',4,4'-PeCDF | 0.0001 |
| 2,3,7,8-TCDF | 0.1 | 2,3,4,4',5-PeCB | 0.0005 |
| 1,2,3,7,8-PeCDF | 0.05 | 2,3,4,4',5-PeCB | 0.0001 |
| 2,3,4,7,8-PeCDF | 0.5 | 2,3,3',4,4',5-HxCB | 0.0005 |
| 1,2,3,4,7,8-HxCDF | 0.1 | 2,3,3',4,4',5-HxCB | 0.0005 |
| 1,2,3,7,8,9-HxCDF | 0.1 | 2,3,4,4',5,5'-HxCB | 0.0001 |
| 1,2,3,6,7,8-HxCDF | 0.1 | 2,3,3',4,4',5,5'-HpCB | 0.0001 |
| 2,3,4,6,7,9-HxCDF | 0.1 | | |
| 1,2,3,4,6,7,8-HpCDF | 0.01 | | |
| 1,2,3,4,7,8,9-HpCDF | 0.01 | | |
| OCDF | 0.0001 | | |

T = tetra (4 chlorine atoms)
Pe = penta (5 chlorine atoms)
Hex = hexa (6 chlorine atoms)
Hp = hepta (7 chlorine atoms)
O = octa (8 chlorine atoms)

Source: *Persistent Organic Pollutants*, Monitor 16, 2000, Swedish Environmental Protection Agency

| PCDD/PCDF and PCB in Serum | | | | |
|--------------------------------------|---------------------------------|---------------|------------------------------------|----------------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-06-0082 | | 09 | Date: 5/21/04, approximately 30 ml | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2,3,7,8-Tetra-CDD | 1,5 | 1,000 | 1,457 |
| | 1,2,3,7,8-Penta-CDD | 6,4 | 1,000 | 6,445 |
| | 1,2,3,4,7,8-Hexa-CDD | 5,9 | 0,100 | 0,592 |
| | 1,2,3,6,7,8-Hexa-CDD | 31,1 | 0,100 | 3,113 |
| | 1,2,3,7,8,9-Hexa-CDD | 9,8 | 0,100 | 0,979 |
| | 1,2,3,4,6,7,8-Hepta-CDD OCDD | 45,0 394,7 | 0,010 0,0001 | 0,450 0,039 |
| PCDF | 2,3,7,8-Tetra-CDF | 1,9 | 0,100 | 0,187 |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - (1,0) |
| | 2,3,4,7,8-Penta-CDF | 3,8 | 0,500 | 1,914 |
| | 1,2,3,4,7,8-Hexa-CDF | 8,2 | 0,100 | 0,822 |
| | 1,2,3,6,7,8-Hexa-CDF | 5,8 | 0,100 | 0,576 |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (1,0) |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - (1,8) |
| | 1,2,3,4,6,7,8-Hepta-CDF | 15,4 | 0,010 | 0,154 |
| | 1,2,3,4,7,8,9-Hepta-CDF OCDF | n.d. n.d. | 0,010 0,0001 | - - (1,2) |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (32) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (3) |
| | 3,3',4,4',5-PeCB (126) | 15 | 0,1000 | 1,455 |
| | 3,3',4,4',5,5'-HxCB (169) | 8 | 0,0100 | 0,082 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 987 | 0,0001 | 0,099 |
| | 2,3,4,4',5-PeCB (114) | 202 | 0,0005 | 0,101 |
| | 2,3',4,4',5-PeCB (118) | 5113 | 0,0001 | 0,511 |
| | 2',3,4,4',5-PeCB (123) | 90 | 0,0001 | 0,009 |
| | 2,3,3',4,4',5-HxCB (156) | 1205 | 0,0005 | 0,603 |
| | 2,3,3',4,4',5'-HxCB (157) | 288 | 0,0005 | 0,144 |
| | 2,3',4,4',5,5'-HxCB (167) | 465 | 0,00001 | 0,005 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 110 | 0,0001 | 0,011 |
| Total PCDD/PCDF | | 529,5 | | |
| Total non-ortho-PCB | | 23 | | |
| Total mono-ortho-PCB | | 8460 | | |
| TEQ (WHO) based on PCDD/F | | | 16,728 | |
| TEQ (WHO) based on PCB | | | 3,020 | |
| TEQ (WHO) | | | 19,748 | |

TEQ, TEF (WHO) = Toxic equivalent /-faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (). n.a. = not analysed, Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computer roundings

| PCDD/PCDF and PCB in Serum | | | | |
|--|-----------------------------|-----------|-----------|-----------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-06-0083 | | | | |
| 11 Date: 5/18/04, approximately 30 ml | | | | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2,3,7,8-Tetra-CDD | 2,7 | 1,000 | 2,659 |
| | 1,2,3,7,8-Penta-CDD | 5,8 | 1,000 | 5,772 |
| | 1,2,3,4,7,8-Hexa-CDD | 3,4 | 0,100 | 0,335 |
| | 1,2,3,6,7,8-Hexa-CDD | 32,8 | 0,100 | 3,281 |
| | 1,2,3,7,8,9-Hexa-CDD | 6,9 | 0,100 | 0,693 |
| | 1,2,3,4,6,7,8-Hepta-CDD | 11,6 | 0,010 | 0,116 |
| | OCDD | 166,0 | 0,0001 | 0,017 |
| PCDF | 2,3,7,8-Tetra-CDF | n.d. | 0,100 | - (1,0) |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - (1,0) |
| | 2,3,4,7,8-Penta-CDF | 2,3 | 0,500 | 1,141 |
| | 1,2,3,4,7,8-Hexa-CDF | 3,5 | 0,100 | 0,348 |
| | 1,2,3,6,7,8-Hexa-CDF | 1,9 | 0,100 | 0,191 |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (1,0) |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - (1,1) |
| | 1,2,3,4,6,7,8-Hepta-CDF | 2,8 | 0,010 | 0,028 |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (1,0) |
| OCDF | n.d. | 0,0001 | - (1,4) | |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (23) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (2) |
| | 3,3',4,4',5-PeCB (126) | 14 | 0,1000 | 1,442 |
| | 3,3',4,4',5,5'-HxCB (169) | 15 | 0,0100 | 0,149 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 1858 | 0,0001 | 0,186 |
| | 2,3,4,4',5-PeCB (114) | 1006 | 0,0005 | 0,503 |
| | 2,3',4,4',5-PeCB (118) | 11199 | 0,0001 | 1,120 |
| | 2',3,4,4',5-PeCB (123) | 79 | 0,0001 | 0,008 |
| | 2,3,3',4,4',5-HxCB (156) | 6300 | 0,0005 | 3,150 |
| | 2,3,3',4,4',5'-HxCB (157) | 1488 | 0,0005 | 0,744 |
| | 2,3',4,4',5,5'-HxCB (167) | 1625 | 0,00001 | 0,016 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 406 | 0,0001 | 0,041 |
| | Total PCDD/PCDF | 239,7 | | |
| Total non-ortho-PCB | 29 | | | |
| Total mono-ortho-PCB | 23960 | | | |
| TEQ (WHO) based on PCDD/F | | | 14,581 | |
| TEQ (WHO) based on PCB | | | 7,358 | |
| TEQ (WHO) | | | 21,938 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (), n.a. = not analysed, Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computerroundings

| PCDD/PCDF and PCB in Serum | | | | |
|--------------------------------------|-----------------------------|-----------|------------------------------------|-----------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-06-0084 | | 21 | Date: 5/20/04, approximately 20 ml | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2,3,7,8-Tetra-CDD | n.d. | 1,000 | - (1,0) |
| | 1,2,3,7,8-Penta-CDD | 2,8 | 1,000 | 2,786 |
| | 1,2,3,4,7,8-Hexa-CDD | 2,1 | 0,100 | 0,211 |
| | 1,2,3,6,7,8-Hexa-CDD | 19,2 | 0,100 | 1,925 |
| | 1,2,3,7,8,9-Hexa-CDD | 3,1 | 0,100 | 0,313 |
| | 1,2,3,4,6,7,8-Hepta-CDD | 14,5 | 0,010 | 0,145 |
| | OCDD | 185,5 | 0,0001 | 0,019 |
| PCDF | 2,3,7,8-Tetra-CDF | 1,9 | 0,100 | 0,193 |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - (1,0) |
| | 2,3,4,7,8-Penta-CDF | 1,8 | 0,500 | 0,909 |
| | 1,2,3,4,7,8-Hexa-CDF | 3,6 | 0,100 | 0,358 |
| | 1,2,3,6,7,8-Hexa-CDF | 2,1 | 0,100 | 0,212 |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (1,0) |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - (1,1) |
| | 1,2,3,4,6,7,8-Hepta-CDF | 3,2 | 0,010 | 0,032 |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (1,0) |
| OCDF | n.d. | 0,0001 | - (1,3) | |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (33) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (5) |
| | 3,3',4,4',5-PeCB (126) | 8 | 0,1000 | 0,809 |
| | 3,3',4,4',5,5'-HxCB (169) | 9 | 0,0100 | 0,087 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 682 | 0,0001 | 0,068 |
| | 2,3,4,4',5-PeCB (114) | 367 | 0,0005 | 0,183 |
| | 2,3',4,4',5-PeCB (118) | 3498 | 0,0001 | 0,350 |
| | 2',3,4,4',5-PeCB (123) | 61 | 0,0001 | 0,006 |
| | 2,3,3',4,4',5-HxCB (156) | 3343 | 0,0005 | 1,671 |
| | 2,3,3',4,4',5'-HxCB (157) | 770 | 0,0005 | 0,385 |
| | 2,3',4,4',5,5'-HxCB (167) | 594 | 0,00001 | 0,006 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 238 | 0,0001 | 0,024 |
| Total PCDD/PCDF | | 240,0 | | |
| Total non-ortho-PCB | | 17 | | |
| Total mono-ortho-PCB | | 9552 | | |
| TEQ (WHO) based on PCDD/F | | | 7,103 | |
| TEQ (WHO) based on PCB | | | 3,589 | |
| TEQ (WHO) | | | 10,691 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals

n.d. = not detected, limit of detection (LOD) in (), n.a. = not analysed, Values with < contribute with 50%

(M) = maximum value, contains possible outside contamination

Small differences on totals result from computerroundings

| PCDD/PCDF and PCB in Serum | | | | | |
|-----------------------------------|-----------------------------|-----------|------------------------------------|---------|---------|
| Values in pg/g (ppt), lipid based | | | | | |
| Analysis-No. H-04-06-0085 | | 22 | Date: 5/20/04, approximately 20 ml | | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD | |
| PCDD | 2,3,7,8-Tetra-CDD | n.d. | 1,000 | - | (1,0) |
| | 1,2,3,7,8-Penta-CDD | 4,1 | 1,000 | 4,075 | |
| | 1,2,3,4,7,8-Hexa-CDD | 2,4 | 0,100 | 0,241 | |
| | 1,2,3,6,7,8-Hexa-CDD | 27,0 | 0,100 | 2,701 | |
| | 1,2,3,7,8,9-Hexa-CDD | 5,4 | 0,100 | 0,537 | |
| | 1,2,3,4,6,7,8-Hepta-CDD | 19,1 | 0,010 | 0,191 | |
| | OCDD | 301,7 | 0,0001 | 0,030 | |
| PCDF | 2,3,7,8-Tetra-CDF | 1,3 | 0,100 | 0,130 | |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - | (1,0) |
| | 2,3,4,7,8-Penta-CDF | 2,5 | 0,500 | 1,233 | |
| | 1,2,3,4,7,8-Hexa-CDF | 3,4 | 0,100 | 0,344 | |
| | 1,2,3,6,7,8-Hexa-CDF | 3,3 | 0,100 | 0,331 | |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - | (1,0) |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - | (1,4) |
| | 1,2,3,4,6,7,8-Hepta-CDF | 5,8 | 0,010 | 0,058 | |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - | (1,0) |
| OCDF | n.d. | 0,0001 | - | (1,5) | |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - | (24) |
| | 3,4,4',5'-TCB (81) | n.d. | 0,0001 | - | (3) |
| | 3,3',4,4',5'-PeCB (126) | 6 | 0,1000 | 0,596 | |
| | 3,3',4,4',5,5'-HxCB (169) | 11 | 0,0100 | 0,110 | |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 470 | 0,0001 | 0,047 | |
| | 2,3,4,4',5'-PeCB (114) | 254 | 0,0005 | 0,127 | |
| | 2,3',4,4',5'-PeCB (118) | 2611 | 0,0001 | 0,261 | |
| | 2',3,4,4',5'-PeCB (123) | 39 | 0,0001 | 0,004 | |
| | 2,3,3',4,4',5'-HxCB (156) | 2588 | 0,0005 | 1,294 | |
| | 2,3,3',4,4',5'-HxCB (157) | 538 | 0,0005 | 0,269 | |
| | 2,3',4,4',5,5'-HxCB (167) | 397 | 0,00001 | 0,004 | |
| | 2,3,3',4,4',5,5'-HpCB (189) | 225 | 0,0001 | 0,022 | |
| Total PCDD/PCDF | | 376,0 | | | |
| Total non-ortho-PCB | | 17 | | | |
| Total mono-ortho-PCB | | 7124 | | | |
| TEQ (WHO) based on PCDD/F | | | 9,871 | | |
| TEQ (WHO) based on PCB | | | 2,735 | | |
| TEQ (WHO) | | | 12,606 | | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals

n.d. = not detected, limit of detection (LOD) in (), n.a. = not analysed, Values with < contribute with 50%

(M) = maximum value, contains possible outside contamination

Small differences on totals result from computer roundings

| PCDD/PCDF and PCB in Serum | | | | | |
|--------------------------------------|-----------------------------|-----------|---------------|------------------------------------|---------|
| Values in pg/g (ppt), lipid based | | | | | |
| Analysis-No. H-04-06-0086 | | | 28 | Date: 5/18/04, approximately 30 ml | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD | |
| PCDD | 2,3,7,8-Tetra-CDD | 1,5 | 1,000 | 1,504 | |
| | 1,2,3,7,8-Penta-CDD | 3,4 | 1,000 | 3,436 | |
| | 1,2,3,4,7,8-Hexa-CDD | 3,3 | 0,100 | 0,327 | |
| | 1,2,3,6,7,8-Hexa-CDD | 17,3 | 0,100 | 1,727 | |
| | 1,2,3,7,8,9-Hexa-CDD | 4,5 | 0,100 | 0,448 | |
| | 1,2,3,4,6,7,8-Hepta-CDD | 32,3 | 0,010 | 0,323 | |
| | OCDD | 234,6 | 0,0001 | 0,023 | |
| PCDF | 2,3,7,8-Tetra-CDF | n.d. | 0,100 | - | (1,0) |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - | (1,0) |
| | 2,3,4,7,8-Penta-CDF | 1,4 | 0,500 | 0,709 | |
| | 1,2,3,4,7,8-Hexa-CDF | 3,1 | 0,100 | 0,307 | |
| | 1,2,3,6,7,8-Hexa-CDF | 2,1 | 0,100 | 0,207 | |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - | (1,0) |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - | (2,1) |
| | 1,2,3,4,6,7,8-Hepta-CDF | 5,3 | 0,010 | 0,053 | |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - | (1,0) |
| OCDF | n.d. | 0,0001 | - | (1,6) | |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - | (29) |
| | 3,4,4',5'-TCB (81) | n.d. | 0,0001 | - | (2) |
| | 3,3',4,4',5'-PeCB (126) | 9 | 0,1000 | 0,867 | |
| | 3,3',4,4',5,5'-HxCB (169) | 6 | 0,0100 | 0,057 | |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 785 | 0,0001 | 0,079 | |
| | 2,3,4,4',5'-PeCB (114) | 313 | 0,0005 | 0,156 | |
| | 2,3',4,4',5'-PeCB (118) | 4070 | 0,0001 | 0,407 | |
| | 2',3,4,4',5'-PeCB (123) | 66 | 0,0001 | 0,007 | |
| | 2,3,3',4,4',5'-HxCB (156) | 2009 | 0,0005 | 1,004 | |
| | 2,3,3',4,4',5'-HxCB (157) | 435 | 0,0005 | 0,218 | |
| | 2,3',4,4',5,5'-HxCB (167) | 495 | 0,00001 | 0,005 | |
| | 2,3,3',4,4',5,5'-HpCB (189) | 136 | 0,0001 | 0,014 | |
| Total PCDD/PCDF | | 308,7 | | | |
| Total non-ortho-PCB | | 14 | | | |
| Total mono-ortho-PCB | | 8308 | | | |
| TEQ (WHO) based on PCDD/F | | | 9,064 | | |
| TEQ (WHO) based on PCB | | | 2,813 | | |
| TEQ (WHO) | | | 11,877 | | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (), n.a. = not analysed, Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computerroundings

| PCDD/PCDF and PCB in Serum | | | | |
|--------------------------------------|-----------------------------|-----------|------------------------------------|-----------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-06-0087 | | 32 | Date: 5/22/04, approximately 30 ml | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2,3,7,8-Tetra-CDD | n.d. | 1,000 | - (1,0) |
| | 1,2,3,7,8-Penta-CDD | 1,9 | 1,000 | 1,928 |
| | 1,2,3,4,7,8-Hexa-CDD | 1,7 | 0,100 | 0,172 |
| | 1,2,3,6,7,8-Hexa-CDD | 12,9 | 0,100 | 1,285 |
| | 1,2,3,7,8,9-Hexa-CDD | 1,3 | 0,100 | 0,127 |
| | 1,2,3,4,6,7,8-Hepta-CDD | 9,2 | 0,010 | 0,092 |
| | OCDD | 60,8 | 0,0001 | 0,006 |
| PCDF | 2,3,7,8-Tetra-CDF | n.d. | 0,100 | - (1,0) |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - (1,0) |
| | 2,3,4,7,8-Penta-CDF | 1,1 | 0,500 | 0,549 |
| | 1,2,3,4,7,8-Hexa-CDF | 1,2 | 0,100 | 0,116 |
| | 1,2,3,6,7,8-Hexa-CDF | 1,6 | 0,100 | 0,157 |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (1,0) |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - (1,1) |
| | 1,2,3,4,6,7,8-Hepta-CDF | 2,8 | 0,010 | 0,028 |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (1,1) |
| | OCDF | n.d. | 0,0001 | - (1,9) |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (26) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (3) |
| | 3,3',4,4',5-PeCB (126) | n.d. | 0,1000 | - (10) |
| | 3,3',4,4',5,5'-HxCB (169) | 9 | 0,0100 | 0,088 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 92 | 0,0001 | 0,009 |
| | 2,3,4,4',5-PeCB (114) | 224 | 0,0005 | 0,112 |
| | 2,3',4,4',5-PeCB (118) | 828 | 0,0001 | 0,083 |
| | 2',3,4,4',5-PeCB (123) | 22 | 0,0001 | 0,002 |
| | 2,3,3',4,4',5-HxCB (156) | 3147 | 0,0005 | 1,574 |
| | 2,3,3',4,4',5-HxCB (167) | 670 | 0,0005 | 0,335 |
| | 2,3',4,4',5,5'-HxCB (167) | 215 | 0,00001 | 0,002 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 302 | 0,0001 | 0,030 |
| Total PCDD/PCDF | | 94,4 | | |
| Total non-ortho-PCB | | 9 | | |
| Total mono-ortho-PCB | | 5499 | | |
| TEQ (WHO) based on PCDD/F | | | 4,460 | |
| TEQ (WHO) based on PCB | | | 2,235 | |
| TEQ (WHO) | | | 6,695 | |

TEQ, TEF (WHO) = Toxic equivalent / faktor by WHO for humans & mammals

n.d. = not detected, limit of detection (LOD) in (). n.a. = not analysed, Values with * contribute with 50%

(M) = maximum value, contains possible outside contamination

Small differences on totals result from computerroundings

| PCDD/PCDF and PCB in Serum | | | | |
|--------------------------------------|-----------------------------|-----------|------------------------------------|-----------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-06-0088 | | 33 | Date: 5/17/04, approximately 20 ml | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2,3,7,8-Tetra-CDD | 1,3 | 1,000 | 1,338 |
| | 1,2,3,7,8-Penta-CDD | 5,6 | 1,000 | 5,621 |
| | 1,2,3,4,7,8-Hexa-CDD | 2,4 | 0,100 | 0,238 |
| | 1,2,3,6,7,8-Hexa-CDD | 24,7 | 0,100 | 2,473 |
| | 1,2,3,7,8,9-Hexa-CDD | 2,4 | 0,100 | 0,240 |
| | 1,2,3,4,6,7,8-Hepta-CDD | 10,3 | 0,010 | 0,103 |
| | OCDD | 140,6 | 0,0001 | 0,014 |
| PCDF | 2,3,7,8-Tetra-CDF | n.d. | 0,100 | - (1,0) |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - (1,0) |
| | 2,3,4,7,8-Penta-CDF | 2,6 | 0,500 | 1,279 |
| | 1,2,3,4,7,8-Hexa-CDF | 3,0 | 0,100 | 0,300 |
| | 1,2,3,6,7,8-Hexa-CDF | 2,5 | 0,100 | 0,253 |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (1,1) |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - (1,3) |
| | 1,2,3,4,6,7,8-Hepta-CDF | 3,9 | 0,010 | 0,039 |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (1,4) |
| OCDF | n.d. | 0,0001 | - (2,6) | |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (34) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (2) |
| | 3,3',4,4',5-PeCB (126) | n.d. | 0,1000 | - (11) |
| | 3,3',4,4',5,5'-HxCB (169) | 27 | 0,0100 | 0,266 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 227 | 0,0001 | 0,023 |
| | 2,3,4,4',5-PeCB (114) | 420 | 0,0005 | 0,210 |
| | 2,3',4,4',5-PeCB (118) | 1380 | 0,0001 | 0,138 |
| | 2',3,4,4',5-PeCB (123) | 31 | 0,0001 | 0,003 |
| | 2,3,3',4,4',5-HxCB (156) | 10422 | 0,0005 | 5,211 |
| | 2,3,3',4,4',5'-HxCB (157) | 2034 | 0,0005 | 1,017 |
| | 2,3',4,4',5,5'-HxCB (167) | 390 | 0,00001 | 0,004 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 1051 | 0,0001 | 0,105 |
| Total PCDD/PCDF | | 199,4 | | |
| Total non-ortho-PCB | | 27 | | |
| Total mono-ortho-PCB | | 15954 | | |
| TEQ (WHO) based on PCDD/F | | | 11,899 | |
| TEQ (WHO) based on PCB | | | 6,976 | |
| TEQ (WHO) | | | 18,875 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (), n.a. = not analysed, Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computer roundings

| PCDD/PCDF and PCB in Serum | | | | |
|--------------------------------------|-----------------------------|-----------|--------------|------------------------------------|
| Values in pg/g (ppt), lipid based | | | | |
| Arfalysis-No. H-04-06-0089 | | | 34 | Date: 5/20/04, approximately 20 ml |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2.3.7.8-Tetra-CDD | 1,5 | 1,000 | 1,519 |
| | 1.2.3.7.8-Penta-CDD | 3,4 | 1,000 | 3,355 |
| | 1.2.3.4.7.8-Hexa-CDD | 3,1 | 0,100 | 0,305 |
| | 1.2.3.6.7.8-Hexa-CDD | 16,2 | 0,100 | 1,625 |
| | 1.2.3.7.8.9-Hexa-CDD | 4,6 | 0,100 | 0,461 |
| | 1.2.3.4.6.7.8-Hepta-CDD | 37,8 | 0,010 | 0,378 |
| | OCDD | 213,4 | 0,0001 | 0,021 |
| PCDF | 2.3.7.8-Tetra-CDF | n.d. | 0,100 | - (1,0) |
| | 1.2.3.7.8-Penta-CDF | n.d. | 0,050 | - (1,0) |
| | 2.3.4.7.8-Penta-CDF | 1,2 | 0,500 | 0,589 |
| | 1.2.3.4.7.8-Hexa-CDF | 2,8 | 0,100 | 0,281 |
| | 1.2.3.6.7.8-Hexa-CDF | 2,0 | 0,100 | 0,199 |
| | 1.2.3.7.8.9-Hexa-CDF | n.d. | 0,100 | - (1,3) |
| | 2.3.4.6.7.8-Hexa-CDF | n.d. | 0,100 | - (1,7) |
| | 1.2.3.4.6.7.8-Hepta-CDF | 8,0 | 0,010 | 0,080 |
| | 1.2.3.4.7.8.9-Hepta-CDF | n.d. | 0,010 | - (1,7) |
| OCDF | n.d. | 0,0001 | - (2,8) | |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (34) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (4) |
| | 3,3',4,4',5-PeCB (126) | n.d. | 0,1000 | - (16) |
| | 3,3',4,4',5,5'-HxCB (169) | 4 | 0,0100 | 0,038 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 628 | 0,0001 | 0,063 |
| | 2,3,4,4',5-PeCB (114) | 134 | 0,0005 | 0,067 |
| | 2,3',4,4',5-PeCB (118) | 2866 | 0,0001 | 0,287 |
| | 2',3,4,4',5-PeCB (123) | 62 | 0,0001 | 0,006 |
| | 2,3,3',4,4',5-HxCB (156) | 786 | 0,0005 | 0,393 |
| | 2,3,3',4,4',5'-HxCB (157) | 187 | 0,0005 | 0,094 |
| | 2,3',4,4',5,5'-HxCB (167) | 291 | 0,00001 | 0,003 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 73 | 0,0001 | 0,007 |
| Total PCDD/PCDF | | 294,0 | | |
| Total non-ortho-PCB | | 4 | | |
| Total mono-ortho-PCB | | 5027 | | |
| TEQ (WHO) based on PCDD/F | | | 8,814 | |
| TEQ (WHO) based on PCB | | | 0,958 | |
| TEQ (WHO) | | | 9,771 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals

n.d. = not detected, limit of detection (LOD) in (); n.a. = not analysed, Values with < contribute with 50%

(M) = maximum value, contains possible outside contamination

Small differences on totals result from computer roundings

| PCDD/PCDF and PCB in Serum | | | | |
|--------------------------------------|-----------------------------|-----------|---------------|-----------------------------------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-06-0090 | | | 36 | Date: 5/6/04, approximately 30 ml |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2,3,7,8-Tetra-CDD | 5,4 | 1,000 | 5,443 |
| | 1,2,3,7,8-Penta-CDD | 13,5 | 1,000 | 13,511 |
| | 1,2,3,4,7,8-Hexa-CDD | 20,0 | 0,100 | 1,997 |
| | 1,2,3,6,7,8-Hexa-CDD | 69,8 | 0,100 | 6,976 |
| | 1,2,3,7,8,9-Hexa-CDD | 16,8 | 0,100 | 1,685 |
| | 1,2,3,4,6,7,8-Hepta-CDD | 154,8 | 0,010 | 1,548 |
| | OCDD | 1142,0 | 0,0001 | 0,114 |
| PCDF | 2,3,7,8-Tetra-CDF | 2,1 | 0,100 | 0,213 |
| | 1,2,3,7,8-Penta-CDF | 1,6 | 0,050 | 0,082 |
| | 2,3,4,7,8-Penta-CDF | 7,0 | 0,500 | 3,513 |
| | 1,2,3,4,7,8-Hexa-CDF | 13,3 | 0,100 | 1,332 |
| | 1,2,3,6,7,8-Hexa-CDF | 10,9 | 0,100 | 1,087 |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (1,0) |
| | 2,3,4,6,7,8-Hexa-CDF | 2,5 | 0,100 | 0,255 |
| | 1,2,3,4,6,7,8-Hepta-CDF | 9,6 | 0,010 | 0,096 |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (1,0) |
| OCDF | n.d. | 0,0001 | - (1,0) | |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (14) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (2) |
| | 3,3',4,4',5-PeCB (126) | 50 | 0,1000 | 5,049 |
| | 3,3',4,4',5,5'-HxCB (169) | 24 | 0,0100 | 0,240 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 2771 | 0,0001 | 0,277 |
| | 2,3,4,4',5-PeCB (114) | 1375 | 0,0005 | 0,688 |
| | 2,3',4,4',5-PeCB (118) | 18281 | 0,0001 | 1,828 |
| | 2',3,4,4',5-PeCB (123) | 373 | 0,0001 | 0,037 |
| | 2,3,3',4,4',5-HxCB (156) | 6744 | 0,0005 | 3,372 |
| | 2,3,3',4,4',5'-HxCB (157) | 1511 | 0,0005 | 0,755 |
| | 2,3',4,4',5,5'-HxCB (167) | 2194 | 0,00001 | 0,022 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 573 | 0,0001 | 0,057 |
| Total PCDD/PCDF | | 1469,4 | | |
| Total non-ortho-PCB | | 74 | | |
| Total mono-ortho-PCB | | 33823 | | |
| TEQ (WHO) based on PCDD/F | | | 37,851 | |
| TEQ (WHO) based on PCB | | | 12,325 | |
| TEQ (WHO) | | | 50,176 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals

n.d. = not detected, limit of detection (LOD) in (), n.a. = not analysed, Values with < contribute with 50%

(M) = maximum value, contains possible outside contamination

Small differences on totals result from computerroundings

| PCDD/PCDF and PCB in Serum | | | | |
|--------------------------------------|-----------------------------|---|--------------|-----------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-06-0091 | | 40. Date: 5/18/04, approximately 30 ml | | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2,3,7,8-Tetra-CDD | n.d. | 1,000 | - (1,0) |
| | 1,2,3,7,8-Penta-CDD | 1,4 | 1,000 | 1,386 |
| | 1,2,3,4,7,8-Hexa-CDD | 1,2 | 0,100 | 0,121 |
| | 1,2,3,6,7,8-Hexa-CDD | 7,6 | 0,100 | 0,759 |
| | 1,2,3,7,8,9-Hexa-CDD | 1,9 | 0,100 | 0,185 |
| | 1,2,3,4,6,7,8-Hepta-CDD | 18,6 | 0,010 | 0,186 |
| | OCDD | 120,8 | 0,0001 | 0,012 |
| PCDF | 2,3,7,8-Tetra-CDF | n.d. | 0,100 | - (1,0) |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - (1,0) |
| | 2,3,4,7,8-Penta-CDF | n.d. | 0,500 | - (1,0) |
| | 1,2,3,4,7,8-Hexa-CDF | 1,7 | 0,100 | 0,174 |
| | 1,2,3,6,7,8-Hexa-CDF | 1,4 | 0,100 | 0,136 |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (1,0) |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - (1,9) |
| | 1,2,3,4,6,7,8-Hepta-CDF | 2,3 | 0,010 | 0,023 |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (1,0) |
| OCDF | n.d. | 0,0001 | - (1,0) | |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (21) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (2) |
| | 3,3',4,4',5-PeCB (126) | n.d. | 0,1000 | - (9) |
| | 3,3',4,4',5,5'-HxCB (169) | 3 | 0,0100 | 0,029 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 315 | 0,0001 | 0,032 |
| | 2,3,4,4',5-PeCB (114) | 79 | 0,0005 | 0,039 |
| | 2,3',4,4',5-PeCB (118) | 1617 | 0,0001 | 0,162 |
| | 2',3,4,4',5-PeCB (123) | 45 | 0,0001 | 0,005 |
| | 2,3,3',4,4',5-HxCB (156) | 453 | 0,0005 | 0,227 |
| | 2,3,3',4,4',5'-HxCB (157) | 88 | 0,0005 | 0,044 |
| | 2,3',4,4',5,5'-HxCB (167) | 117 | 0,00001 | 0,001 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 33 | 0,0001 | 0,003 |
| Total PCDD/PCDF | | 156,8 | | |
| Total non-ortho-PCB | | 3 | | |
| Total mono-ortho-PCB | | 2746 | | |
| TEQ (WHO) based on PCDD/F | | | 2,983 | |
| TEQ (WHO) based on PCB | | | 0,541 | |
| TEQ (WHO) | | | 3,524 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (); n.a. = not analysed, Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computerroundings

| PCDD/PCDF and PCB in Human Blood | | | | |
|--------------------------------------|-----------------------------|-----------|------------------------------------|-----------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-06-0092 | | 41 | Date: 5/25/04, approximately 15 ml | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2,3,7,8-Tetra-CDD | 1,4 | 1,000 | 1,362 |
| | 1,2,3,7,8-Penta-CDD | 3,5 | 1,000 | 3,470 |
| | 1,2,3,4,7,8-Hexa-CDD | 2,2 | 0,100 | 0,215 |
| | 1,2,3,6,7,8-Hexa-CDD | 17,7 | 0,100 | 1,770 |
| | 1,2,3,7,8,9-Hexa-CDD | 3,5 | 0,100 | 0,346 |
| | 1,2,3,4,6,7,8-Hepta-CDD | 21,7 | 0,010 | 0,217 |
| | OCDD | 162,5 | 0,0001 | 0,016 |
| PCDF | 2,3,7,8-Tetra-CDF | 1,0 | 0,100 | 0,098 |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - (1,0) |
| | 2,3,4,7,8-Penta-CDF | 1,7 | 0,500 | 0,859 |
| | 1,2,3,4,7,8-Hexa-CDF | 4,8 | 0,100 | 0,482 |
| | 1,2,3,6,7,8-Hexa-CDF | 3,2 | 0,100 | 0,317 |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (1,0) |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - (2,2) |
| | 1,2,3,4,6,7,8-Hepta-CDF | 9,5 | 0,010 | 0,095 |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (1,0) |
| OCDF | n.d. | 0,0001 | - (1,7) | |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (37) |
| | 3,4,4',5'-TCB (81) | n.d. | 0,0001 | - (3) |
| | 3,3',4,4',5'-PeCB (126) | n.d. | 0,1000 | - (13) |
| | 3,3',4,4',5,5'-HxCB (169) | 7 | 0,0100 | 0,068 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 1470 | 0,0001 | 0,147 |
| | 2,3,4,4',5'-PeCB (114) | 336 | 0,0005 | 0,168 |
| | 2,3',4,4',5'-PeCB (118) | 6379 | 0,0001 | 0,638 |
| | 2',3,4,4',5'-PeCB (123) | 146 | 0,0001 | 0,015 |
| | 2,3,3',4,4',5'-HxCB (156) | 1103 | 0,0005 | 0,551 |
| | 2,3,3',4,4',5'-HxCB (157) | 252 | 0,0005 | 0,126 |
| | 2,3',4,4',5,5'-HxCB (167) | 387 | 0,00001 | 0,004 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 74 | 0,0001 | 0,007 |
| | Total PCDD/PCDF | 232,5 | | |
| Total non-ortho-PCB | 7 | | | |
| Total mono-ortho-PCB | 10147 | | | |
| TEQ (WHO) based on PCDD/F | | | 9,248 | |
| TEQ (WHO) based on PCB | | | 1,724 | |
| TEQ (WHO) | | | 10,972 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (), n.a. = not analysed, Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computer roundings

| PCDD/PCDF and PCB in Human Blood | | | | |
|--------------------------------------|-----------------------------|-----------|--------------------------------------|-----------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-06-0093 | | 46, |) Date: 5/22/04, approximately 30 ml | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2.3.7.8-Tetra-CDD | 1,0 | 1,000 | 1,000 |
| | 1.2.3.7.8-Penta-CDD | 1,5 | 1,000 | 1,459 |
| | 1.2.3.4.7.8-Hexa-CDD | 1,0 | 0,100 | 0,103 |
| | 1.2.3.6.7.8-Hexa-CDD | 6,1 | 0,100 | 0,609 |
| | 1.2.3.7.8.9-Hexa-CDD | 2,0 | 0,100 | 0,205 |
| | 1.2.3.4.6.7.8-Hepta-CDD | 12,0 | 0,010 | 0,120 |
| | OCDD | 98,3 | 0,0001 | 0,010 |
| PCDF | 2.3.7.8-Tetra-CDF | 1,3 | 0,100 | 0,130 |
| | 1.2.3.7.8-Penta-CDF | n.d. | 0,050 | - (1,0) |
| | 2.3.4.7.8-Penta-CDF | 1,1 | 0,500 | 0,558 |
| | 1.2.3.4.7.8-Hexa-CDF | 2,5 | 0,100 | 0,249 |
| | 1.2.3.6.7.8-Hexa-CDF | 1,5 | 0,100 | 0,145 |
| | 1.2.3.7.8.9-Hexa-CDF | n.d. | 0,100 | - (1,0) |
| | 2.3.4.6.7.8-Hexa-CDF | n.d. | 0,100 | - (2,3) |
| | 1.2.3.4.6.7.8-Hepta-CDF | 2,4 | 0,010 | 0,024 |
| | 1.2.3.4.7.8.9-Hepta-CDF | n.d. | 0,010 | - (1,0) |
| | OCDF | n.d. | 0,0001 | - (1,6) |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (36) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (4) |
| | 3,3',4,4',5-PeCB (126) | n.d. | 0,1000 | - (12) |
| | 3,3',4,4',5,5'-HxCB (169) | 4 | 0,0100 | 0,039 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 430 | 0,0001 | 0,043 |
| | 2,3,4,4',5-PeCB (114) | 64 | 0,0005 | 0,032 |
| | 2,3',4,4',5-PeCB (118) | 2222 | 0,0001 | 0,222 |
| | 2',3,4,4',5-PeCB (123) | 40 | 0,0001 | 0,004 |
| | 2,3,3',4,4',5-HxCB (156) | 336 | 0,0005 | 0,168 |
| | 2,3,3',4,4',5'-HxCB (157) | 89 | 0,0005 | 0,045 |
| | 2,3',4,4',5,5'-HxCB (167) | 214 | 0,00001 | 0,002 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 28 | 0,0001 | 0,003 |
| | Total PCDD/PCDF | 130,7 | | |
| Total non-ortho-PCB | 4 | | | |
| Total mono-ortho-PCB | 3423 | | | |
| TEQ (WHO) based on PCDD/F | | | 4,612 | |
| TEQ (WHO) based on PCB | | | 0,558 | |
| TEQ (WHO) | | | 5,169 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals

n.d. = not detected, limit of detection (LOD) in (); n.a. = not analysed, Values with < contribute with 50%

(M) = maximum value, contains possible outside contamination

Small differences on totals result from computer roundings

| PCDD/PCDF and PCB in Human Blood | | | | |
|--------------------------------------|-----------------------------|-----------|------------------------------|-----------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-06-0094 | | 49. | 5/26/04, approximately 20 ml | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2,3,7,8-Tetra-CDD | 1,2 | 1,000 | 1,200 |
| | 1,2,3,7,8-Penta-CDD | 3,2 | 1,000 | 3,196 |
| | 1,2,3,4,7,8-Hexa-CDD | 3,2 | 0,100 | 0,319 |
| | 1,2,3,6,7,8-Hexa-CDD | 15,5 | 0,100 | 1,551 |
| | 1,2,3,7,8,9-Hexa-CDD | 4,9 | 0,100 | 0,487 |
| | 1,2,3,4,6,7,8-Hepta-CDD | 30,2 | 0,010 | 0,302 |
| | OCDD | 187,3 | 0,0001 | 0,019 |
| PCDF | 2,3,7,8-Tetra-CDF | n.d. | 0,100 | - (1,0) |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - (1,0) |
| | 2,3,4,7,8-Penta-CDF | 1,9 | 0,500 | 0,934 |
| | 1,2,3,4,7,8-Hexa-CDF | 4,8 | 0,100 | 0,484 |
| | 1,2,3,6,7,8-Hexa-CDF | 2,4 | 0,100 | 0,239 |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (1,0) |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - (1,8) |
| | 1,2,3,4,6,7,8-Hepta-CDF | 5,1 | 0,010 | 0,051 |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (1,0) |
| OCDF | n.d. | 0,0001 | - (1,3) | |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (22) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (2) |
| | 3,3',4,4',5-PeCB (126) | 9 | 0,1000 | 0,886 |
| | 3,3',4,4',5,5'-HxCB (169) | 6 | 0,0100 | 0,059 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 546 | 0,0001 | 0,055 |
| | 2,3,4,4',5-PeCB (114) | 109 | 0,0005 | 0,055 |
| | 2,3',4,4',5-PeCB (118) | 2801 | 0,0001 | 0,280 |
| | 2',3,4,4',5-PeCB (123) | 51 | 0,0001 | 0,005 |
| | 2,3,3',4,4',5-HxCB (156) | 651 | 0,0005 | 0,325 |
| | 2,3,3',4,4',5'-HxCB (157) | 156 | 0,0005 | 0,078 |
| | 2,3',4,4',5,5'-HxCB (167) | 267 | 0,00001 | 0,003 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 36 | 0,0001 | 0,004 |
| | Total PCDD/PCDF | 259,7 | | |
| Total non-ortho-PCB | 15 | | | |
| Total mono-ortho-PCB | 4617 | | | |
| TEQ (WHO) based on PCDD/F | | | 8,782 | |
| TEQ (WHO) based on PCB | | | 1,749 | |
| TEQ (WHO) | | | 10,530 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals

n.d. = not detected, limit of detection (LOD) in (). n.a. = not analysed, Values with < contribute with 50%

(M) = maximum value, contains possible outside contamination

Small differences on totals result from computerroundings

| PCDD/PCDF and PCB in Human Blood | | | | |
|--------------------------------------|-----------------------------|-----------|------------------------------|-----------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-06-0095 | | 50 | 5/27/04, approximately 15 ml | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2,3,7,8-Tetra-CDD | n.d. | 1,000 | - (1,3) |
| | 1,2,3,7,8-Penta-CDD | 2,5 | 1,000 | 2,531 |
| | 1,2,3,4,7,8-Hexa-CDD | 2,0 | 0,100 | 0,198 |
| | 1,2,3,6,7,8-Hexa-CDD | 12,8 | 0,100 | 1,282 |
| | 1,2,3,7,8,9-Hexa-CDD | 3,6 | 0,100 | 0,357 |
| | 1,2,3,4,6,7,8-Hepta-CDD | 14,8 | 0,010 | 0,148 |
| | OCDD | 159,3 | 0,0001 | 0,016 |
| PCDF | 2,3,7,8-Tetra-CDF | 1,5 | 0,100 | 0,148 |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - (1,0) |
| | 2,3,4,7,8-Penta-CDF | 2,6 | 0,500 | 1,284 |
| | 1,2,3,4,7,8-Hexa-CDF | 3,5 | 0,100 | 0,348 |
| | 1,2,3,6,7,8-Hexa-CDF | 3,2 | 0,100 | 0,315 |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (1,3) |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - (4,2) |
| | 1,2,3,4,6,7,8-Hepta-CDF | 14,8 | 0,010 | 0,148 |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (1,5) |
| OCDF | n.d. | 0,0001 | - (3,7) | |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (59) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (3) |
| | 3,3',4,4',5-PeCB (126) | n.d. | 0,1000 | - (14) |
| | 3,3',4,4',5,5'-HxCB (169) | 8 | 0,0100 | 0,083 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 504 | 0,0001 | 0,050 |
| | 2,3,4,4',5-PeCB (114) | 148 | 0,0005 | 0,074 |
| | 2,3',4,4',5-PeCB (118) | 2740 | 0,0001 | 0,274 |
| | 2',3,4,4',5-PeCB (123) | 28 | 0,0001 | 0,003 |
| | 2,3,3',4,4',5-HxCB (156) | 783 | 0,0005 | 0,392 |
| | 2,3,3',4,4',5'-HxCB (157) | 184 | 0,0005 | 0,092 |
| | 2,3',4,4',5,5'-HxCB (167) | 201 | 0,00001 | 0,002 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 57 | 0,0001 | 0,006 |
| | Total PCDD/PCDF | 220,5 | | |
| Total non-ortho-PCB | 8 | | | |
| Total mono-ortho-PCB | 4645 | | | |
| TEQ (WHO) based on PCDD/F | | | 6,775 | |
| TEQ (WHO) based on PCB | | | 0,976 | |
| TEQ (WHO) | | | 7,751 | |

TEQ, TEF (WHO) = Toxic equivalent /-faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (), n.a. = not analysed, Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computer roundings

| PCDD/PCDF and PCB in Human Blood | | | | | |
|-----------------------------------|-----------------------------|-----------|-----------|------------------------------------|---------|
| Values in pg/g (ppt), lipid based | | | | | |
| Analysis-No. H-04-06-0096 | | | 51 | Date: 5/28/04, approximately 15 ml | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD | |
| PCDD | 2.3.7.8-Tetra-CDD | n.d. | 1,000 | - | (1,3) |
| | 1.2.3.7.8-Penta-CDD | 3,0 | 1,000 | 2,993 | |
| | 1.2.3.4.7.8-Hexa-CDD | 1,8 | 0,100 | 0,183 | |
| | 1.2.3.6.7.8-Hexa-CDD | 12,7 | 0,100 | 1,269 | |
| | 1.2.3.7.8.9-Hexa-CDD | 2,3 | 0,100 | 0,235 | |
| | 1.2.3.4.6.7.8-Hepta-CDD | 13,2 | 0,010 | 0,132 | |
| | OCDD | 160,9 | 0,0001 | 0,016 | |
| PCDF | 2.3.7.8-Tetra-CDF | 1,6 | 0,100 | 0,162 | |
| | 1.2.3.7.8-Penta-CDF | n.d. | 0,050 | - | (1,0) |
| | 2.3.4.7.8-Penta-CDF | 2,7 | 0,500 | 1,327 | |
| | 1.2.3.4.7.8-Hexa-CDF | 4,4 | 0,100 | 0,439 | |
| | 1.2.3.6.7.8-Hexa-CDF | 3,6 | 0,100 | 0,355 | |
| | 1.2.3.7.8.9-Hexa-CDF | n.d. | 0,100 | - | (1,3) |
| | 2.3.4.6.7.8-Hexa-CDF | n.d. | 0,100 | - | (3,4) |
| | 1.2.3.4.6.7.8-Hepta-CDF | 14,2 | 0,010 | 0,142 | |
| | 1.2.3.4.7.8.9-Hepta-CDF | n.d. | 0,010 | - | (1,5) |
| OCDF | n.d. | 0,0001 | - | (4,1) | |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - | (60) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - | (4) |
| | 3,3',4,4',5-PeCB (126) | n.d. | 0,1000 | - | (14) |
| | 3,3',4,4',5,5'-HxCB (169) | 9 | 0,0100 | 0,091 | |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 508 | 0,0001 | 0,051 | |
| | 2,3,4,4',5-PeCB (114) | 144 | 0,0005 | 0,072 | |
| | 2,3',4,4',5-PeCB (118) | 2400 | 0,0001 | 0,240 | |
| | 2',3,4,4',5-PeCB (123) | 29 | 0,0001 | 0,003 | |
| | 2,3,3',4,4',5-HxCB (156) | 814 | 0,0005 | 0,407 | |
| | 2,3,3',4,4',5'-HxCB (157) | 182 | 0,0005 | 0,091 | |
| | 2,3',4,4',5,5'-HxCB (167) | 216 | 0,00001 | 0,002 | |
| | 2,3,3',4,4',5,5'-HpCB (189) | 51 | 0,0001 | 0,005 | |
| | Total PCDD/PCDF | 220,4 | | | |
| Total non-ortho-PCB | 9 | | | | |
| Total mono-ortho-PCB | 4344 | | | | |
| TEQ (WHO) based on PCDD/F | | | 7,253 | | |
| TEQ (WHO) based on PCB | | | 0,962 | | |
| TEQ (WHO) | | | 8,215 | | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (). n.a. = not analysed; Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computaroundings

| PCDD/PCDF and PCB in Human Blood | | | | | |
|--------------------------------------|-----------------------------|-----------|------------------------------------|---------|---------|
| Values in pg/g (ppt), lipid based | | | | | |
| Analysis-No. H-04-06-0097 | | | 52 5/26/04, approximately 10 ml | | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD | |
| PCDD | 2,3,7,8-Tetra-CDD | 1,1 | 1,000 | 1,108 | |
| | 1,2,3,7,8-Penta-CDD | 2,4 | 1,000 | 2,399 | |
| | 1,2,3,4,7,8-Hexa-CDD | 2,1 | 0,100 | 0,208 | |
| | 1,2,3,6,7,8-Hexa-CDD | 9,9 | 0,100 | 0,990 | |
| | 1,2,3,7,8,9-Hexa-CDD | 2,5 | 0,100 | 0,245 | |
| | 1,2,3,4,6,7,8-Hepta-CDD | 18,6 | 0,010 | 0,186 | |
| | OCDD | 108,0 | 0,0001 | 0,011 | |
| PCDF | 2,3,7,8-Tetra-CDF | n.d. | 0,100 | - | (1,0) |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - | (1,0) |
| | 2,3,4,7,8-Penta-CDF | 1,2 | 0,500 | 0,613 | |
| | 1,2,3,4,7,8-Hexa-CDF | 2,9 | 0,100 | 0,287 | |
| | 1,2,3,6,7,8-Hexa-CDF | 1,6 | 0,100 | 0,160 | |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - | (1,0) |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - | (2,8) |
| | 1,2,3,4,6,7,8-Hepta-CDF | 3,1 | 0,010 | 0,031 | |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - | (1,0) |
| OCDF | n.d. | 0,0001 | - | (1,5) | |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - | (34) |
| | 3,4,4',5'-TCB (81) | n.d. | 0,0001 | - | (3) |
| | 3,3',4,4',5'-PeCB (126) | n.d. | 0,1000 | - | (13) |
| | 3,3',4,4',5,5'-HxCB (169) | 6 | 0,0100 | 0,063 | |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 632 | 0,0001 | 0,063 | |
| | 2,3,4,4',5'-PeCB (114) | 146 | 0,0005 | 0,073 | |
| | 2,3',4,4',5'-PeCB (118) | 3138 | 0,0001 | 0,314 | |
| | 2',3,4,4',5'-PeCB (123) | 41 | 0,0001 | 0,004 | |
| | 2,3,3',4,4',5-HxCB (156) | 726 | 0,0005 | 0,363 | |
| | 2,3,3',4,4',5'-HxCB (157) | 165 | 0,0005 | 0,082 | |
| | 2,3',4,4',5,5'-HxCB (167) | 278 | 0,00001 | 0,003 | |
| | 2,3,3',4,4',5,5'-HpCB (189) | 55 | 0,0001 | 0,005 | |
| Total PCDD/PCDF | | 153,3 | | | |
| Total non-ortho-PCB | | 6 | | | |
| Total mono-ortho-PCB | | 5181 | | | |
| TEQ (WHO) based on PCDD/F | | | 6,238 | | |
| TEQ (WHO) based on PCB | | | 0,971 | | |
| TEQ (WHO) | | | 7,208 | | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (), n.a. = not analysed, Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computerroundings

| PCDD/PCDF and PCB in SERUM | | | | |
|--------------------------------------|-----------------------------|-----------|-------------------------------------|-----------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-06-0098 | | 23 |) Date: 6/1/04, approximately 20 ml | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2,3,7,8-Tetra-CDD | 1,5 | 1,000 | 1,455 |
| | 1,2,3,7,8-Penta-CDD | 3,1 | 1,000 | 3,071 |
| | 1,2,3,4,7,8-Hexa-CDD | 3,0 | 0,100 | 0,303 |
| | 1,2,3,6,7,8-Hexa-CDD | 19,6 | 0,100 | 1,956 |
| | 1,2,3,7,8,9-Hexa-CDD | 2,4 | 0,100 | 0,243 |
| | 1,2,3,4,6,7,8-Hepta-CDD | 27,0 | 0,010 | 0,270 |
| | OCDD | 253,0 | 0,0001 | 0,025 |
| PCDF | 2,3,7,8-Tetra-CDF | n.d. | 0,100 | - (1,0) |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - (1,0) |
| | 2,3,4,7,8-Penta-CDF | 2,1 | 0,500 | 1,050 |
| | 1,2,3,4,7,8-Hexa-CDF | 4,0 | 0,100 | 0,396 |
| | 1,2,3,6,7,8-Hexa-CDF | 2,1 | 0,100 | 0,213 |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (1,0) |
| | 2,3,4,6,7,8-Hexa-CDF | 1,8 | 0,100 | 0,182 |
| | 1,2,3,4,6,7,8-Hepta-CDF | 2,6 | 0,010 | 0,026 |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (1,0) |
| OCDF | n.d. | 0,0001 | - (2,0) | |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (26) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (3) |
| | 3,3',4,4',5-PeCB (126) | n.d. | 0,1000 | - (11) |
| | 3,3',4,4',5,5'-HxCB (169) | 8 | 0,0100 | 0,081 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 657 | 0,0001 | 0,066 |
| | 2,3,4,4',5-PeCB (114) | 452 | 0,0005 | 0,226 |
| | 2,3',4,4',5-PeCB (118) | 4966 | 0,0001 | 0,497 |
| | 2',3,4,4',5-PeCB (123) | 80 | 0,0001 | 0,008 |
| | 2,3,3',4,4',5-HxCB (156) | 1772 | 0,0005 | 0,886 |
| | 2,3,3',4,4',5'-HxCB (157) | 415 | 0,0005 | 0,208 |
| | 2,3',4,4',5,5'-HxCB (167) | 545 | 0,00001 | 0,005 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 129 | 0,0001 | 0,013 |
| Total PCDD/PCDF | | 322,1 | | |
| Total non-ortho-PCB | | 8 | | |
| Total mono-ortho-PCB | | 9016 | | |
| TEQ (WHO) based on PCDD/F | | | 9,191 | |
| TEQ (WHO) based on PCB | | | 1,989 | |
| TEQ (WHO) | | | 11,180 | |

TEQ, TEF (WHO) = Toxic equivalent f-factor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (), n.a. = not analysed, Values with * contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computer roundings

- End of Report 2004-0498cc -

ERGO.000070

6 Results

The detailed results of all 2,3,7,8-substituted PCDD/PCDF as well as the results of the PCBs are shown on the data sheets enclosed (second column). The sheets also present the individual Toxic Equivalent Factor (according to WHO, third column), which is used for the calculation of the *single* individual Toxic Equivalents (fourth and fifth column). The *total* of these values is the TEQ (WHO) value, which is used for the quantitative evaluation of the overall PCDD/PCDF- and PCB-contamination of a sample.

The results are valid for the analyzed samples only.

7 Final Remarks

For duplicating the report in parts a written permission by ERGO Forschungsgesellschaft mbH is required. The samples are stored – on dependence of the test parameters – not longer than three months after the date of the report.

Hamburg, 30.06.2004

ERGO Forschungsgesellschaft mbH

Olaf Pöpke
board member

Claudia Collingro
(official certified food chemist)
project manager

Exhibit 1-(c)

510000

Report 2004-0413th
Page 1 of 37



PLAINTIFF'S EXHIBIT
PL-9

01 JUN -7 AM 11:11

ERGO Forschungsgesellschaft mbH, Geislerstr. 1, 22303 Hamburg, Germany

Attn. Mr. James Piel
Baron & Budd, P.C.
3102 Oak Lawn Avenue, Suite 1100
75219 Dallas, Texas
USA

Report 2004-0413th

1 Order

The order was given by the client mentioned above.
The order has the following internal project code: A-0426-04-400.

2 Sampling and shipment

The sampling was done resp. organized by the customer. The samples were sent in frozen state by a courier service. The samples arrived frozen in the ERGO laboratory and were stored at -18°C until the beginning of the analyses.



Testing Laboratory accredited by the DAP Deutsches Akkreditierungssystem Prüfwesen GmbH according to DIN EN ISO/IEC 17025. The Accreditation applies for the Testing Methods mentioned in the List attached to the Certificate.

Accreditation by the German Authorities (Notification) related to §§ 25, 28 BImSchG, Emission- and Ambient Air Measurement, Olfactometry and Foulness Test.

Laboratory for Dioxin Testing in Fielding Staff listed by the European Commission (DG IV).

Board members: Dr. Michael Ball, Otfried Pöppke
Geislerstraße 1, D-22303 Hamburg, Tel: +49 40 69 79 95 -0, Fax: +49 40 69 79 95 99
Bank account: Commerzbank Hamburg - BIC 250 400 00 - Account-No 2707826
Local court Hamburg HRB 22789 - FA Hamburg-Barmbek-Uhlenhorst - Tax-No 71 656 01613

ERGO.000164

3 Description of sample

| Sample code | Client code | Matrix | Receipt of sample | Date of the test performance |
|--------------|---|--------------|-------------------|------------------------------|
| H-04-05-0173 | 08 date: 4/27/04, approximately 20 ml | Serum/Plasma | 07.05.2004 | 14.05.2004 – 28.05.2004 |
| H-04-05-0174 | 10 Date: 4/27/04, approximately 20 ml | Serum/Plasma | 07.05.2004 | 14.05.2004 – 28.05.2004 |
| H-04-05-0175 | 12 Date: 4/17/04, approximately 20 ml | Serum/Plasma | 07.05.2004 | 14.05.2004 – 28.05.2004 |
| H-04-05-0176 | 13 Date: 4/15/04, approximately 20 ml | Serum/Plasma | 07.05.2004 | 14.05.2004 – 28.05.2004 |
| H-04-05-0177 | 14 Date: 4/19/04, approximately 30 ml | Serum/Plasma | 07.05.2004 | 14.05.2004 – 28.05.2004 |
| H-04-05-0178 | 15 Date: 4/18/04, approximately 20 ml | Serum/Plasma | 07.05.2004 | 14.05.2004 – 28.05.2004 |
| H-04-05-0179 | 16 Date: 4/27/04, approximately 20 ml | Serum/Plasma | 07.05.2004 | 14.05.2004 – 28.05.2004 |
| H-04-05-0180 | 17 Date: 4/27/04, approximately 15 ml | Serum/Plasma | 07.05.2004 | 14.05.2004 – 28.05.2004 |
| H-04-05-0181 | 18 Date: 4/23/04, approximately 30 ml | Serum/Plasma | 07.05.2004 | 14.05.2004 – 28.05.2004 |

199001



| Sample code | Client code | Matrix | Receipt of sample | Date of the test performance |
|--------------|---|--------------|-------------------|------------------------------|
| H-04-05-0192 | 37 Date: 5/1/04, approximately 20 ml | Serum/Plasma | 07.05.2004 | 18.05.2004 – 28.05.2004 |
| H-04-05-0193 | 38 Date: 5/4/04, approximately 20 ml | Serum/Plasma | 07.05.2004 | 18.05.2004 – 28.05.2004 |
| H-04-05-0194 | 38 Date: 4/20/04, approximately 30 ml | Serum/Plasma | 07.05.2004 | 18.05.2004 – 28.05.2004 |
| H-04-05-0195 | 42 Date: 4/20/04, approximately 40 ml | Serum/Plasma | 07.05.2004 | 18.05.2004 – 28.05.2004 |
| H-04-05-0196 | 43 Date: 4/18/04, approximately 30 ml | Serum/Plasma | 07.05.2004 | 18.05.2004 – 28.05.2004 |
| H-04-05-0197 | 44 Date: 4/21/04, approximately 20 ml | Serum/Plasma | 07.05.2004 | 18.05.2004 – 28.05.2004 |
| H-04-05-0198 | 45 Date: 4/28/04, approximately 20 ml | Serum/Plasma | 07.05.2004 | 18.05.2004 – 28.05.2004 |
| H-04-05-0199 | 47 Date: 4/29/04, approximately 15 ml | Serum/Plasma | 07.05.2004 | 18.05.2004 – 28.05.2004 |
| H-04-05-0200 | 48 Date: 4/14/04, approximately 30 ml | Serum/Plasma | 07.05.2004 | 18.05.2004 – 28.05.2004 |

4 Analytical methods

In the following the analytical procedures for the analysis of serum/plasma is shown. We would like to mention, that the measurements are done by *high resolution mass spectrometry (HRMS)*, which guarantees high specificity and high sensitivity.

Prior the extraction following ¹³C-UL-labeled Internal standards are added to the sample:

| Internal standards (¹³ C-UL), PCDDs/PCDFs | | | |
|---|------------|-----------------|------------|
| PCDDs | | PCDFs | |
| 2,3,7,8 | -Tetra-CDD | 2,3,7,8 | -Tetra-CDF |
| 1,2,3,7,8 | -Penta-CDD | 1,2,3,7,8 | -Penta-CDF |
| | | 2,3,4,7,8 | -Penta-CDF |
| 1,2,3,4,7,8 | -Hexa-CDD | 1,2,3,4,7,8 | -Hexa-CDF |
| 1,2,3,6,7,8 | -Hexa-CDD | 1,2,3,6,7,8 | -Hexa-CDF |
| 1,2,3,7,8,9 | -Hexa-CDD | 1,2,3,7,8,9 | -Hexa-CDF |
| | | 2,3,4,6,7,8 | -Hexa-CDF |
| 1,2,3,4,6,7,8 | -Hepta-CDD | 1,2,3,4,6,7,8 | -Hepta-CDF |
| | | 1,2,3,4,7,8,9 | -Hepta-CDF |
| 1,2,3,4,6,7,8,9 | -Octa-CDD | 1,2,3,4,6,7,8,9 | -Octa-CDF |

| Internal standards (¹³ C-UL), PCBs | | | |
|--|------------------|-----------|------------|
| | | Compound | IUPAC Code |
| Non-ortho PCBs | 3,3',4,4' | -Tetra-CB | PCB 77 |
| | 3,4,4',5 | -Tetra-CB | PCB 81 |
| | 3,3',4,4',5 | -Penta-CB | PCB 126 |
| | 3,3',4,4',5,5' | -Hexa-CB | PCB 169 |
| Mono-ortho PCBs | 2,3,3',4,4' | -Penta-CB | PCB 105 |
| | 2,3,4,4',5 | -Penta-CB | PCB 114 |
| | 2,3',4,4',5 | -Penta-CB | PCB 118 |
| | 2',3,4,4',5 | -Penta-CB | PCB 123 |
| | 2,3,3',4,4',5 | -Hexa-CB | PCB 156 |
| | 2,3,3',4,4',5' | -Hexa-CB | PCB 157 |
| | 2,3',4,4',5,5' | -Hexa-CB | PCB 167 |
| | 2,3,3',4,4',5,5' | -Hepta-CB | PCB 189 |

After the spiking, the samples are extracted with hexane for ultratrace-analyses (e.g. nano-grade) by using a liquid/liquid extraction.

After performing the gravimetric lipid determination, the clean up is done on a multistage system (involving carbon-on-glassfibre or carbon-on-celite for PCDDs/PCDFs and certain PCBs). The measurement is done by means of high resolution gas chromatography and high resolution mass spectrometry (HRGC/HRMS) with VG-AutoSpec and/or Finnigan MAT 95 XL using DB-5 capillary columns.

For each component 2 isotope masses are measured. The quantification is carried out by the use of internal/external standard mixtures (isotope dilution method). Following PCDDs/PCDFs and PCBs are determined and reported.

| PCDDs/PCDFs | | | |
|-----------------|------------|-----------------|------------|
| PCDDs | | PCDFs | |
| 2,3,7,8 | -Tetra-CDD | 2,3,7,8 | -Tetra-CDF |
| 1,2,3,7,8 | -Penta-CDD | 1,2,3,7,8 | -Penta-CDF |
| | | 2,3,4,7,8 | -Penta-CDF |
| 1,2,3,4,7,8 | -Hexa-CDD | 1,2,3,4,7,8 | -Hexa-CDF |
| 1,2,3,6,7,8 | -Hexa-CDD | 1,2,3,6,7,8 | -Hexa-CDF |
| 1,2,3,7,8,9 | -Hexa-CDD | 1,2,3,7,8,9 | -Hexa-CDF |
| | | 2,3,4,6,7,8 | -Hexa-CDF |
| 1,2,3,4,6,7,8 | -Hepta-CDD | 1,2,3,4,6,7,8 | -Hepta-CDF |
| | | 1,2,3,4,7,8,9 | -Hepta-CDF |
| 1,2,3,4,6,7,8,9 | -Octa-CDD | 1,2,3,4,6,7,8,9 | -Octa-CDF |

| PCBs | | | |
|-----------------|------------------|-----------|------------|
| | | Compound | IUPAC Code |
| Non-ortho PCBs | 3,3',4,4' | -Tetra-CB | PCB 77 |
| | 3,4,4',5 | -Tetra-CB | PCB 81 |
| | 3,3',4,4',5 | -Penta-CB | PCB 126 |
| | 3,3',4,4',5,5' | -Hexa-CB | PCB 169 |
| Mono-ortho PCBs | 2,3,3',4,4' | -Penta-CB | PCB 105 |
| | 2,3,4,4',5 | -Penta-CB | PCB 114 |
| | 2,3',4,4',5 | -Penta-CB | PCB 118 |
| | 2',3,4,4',5 | -Penta-CB | PCB 123 |
| | 2,3,3',4,4',5 | -Hexa-CB | PCB 156 |
| | 2,3,3',4,4',5' | -Hexa-CB | PCB 157 |
| | 2,3',4,4',5,5' | -Hexa-CB | PCB 167 |
| | 2,3,3',4,4',5,5' | -Hepta-CB | PCB 189 |

In addition to the single results, calculations of the toxicity equivalents (TEQ) according to the WHO-system are carried out.

The analytical method for WHO-PCBs is not part of the accreditation, but it is scheduled for accreditation in 2004.

5 General Information about PCDDs/PCDFs

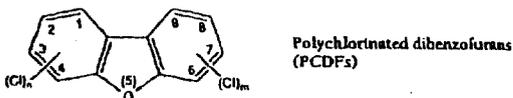
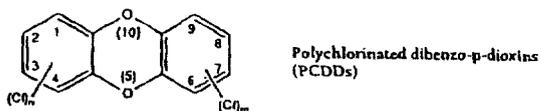
Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) are unwanted by-products in a variety of industrial and thermal processes. However, their levels in the environment increased significantly with the beginning of the industrial chlorine industry in this century. Because of their many sources, PCDDs and PCDFs are ubiquitously distributed. The degree of chlorination of the tricyclic components varies between 1 and 8 atoms per molecule. The overall number of dioxins and furans is 75 and 135, respectively.

In humans, only the isomers with 2,3,7,8-substitution are found, totaling seven dioxins and 10 furans. Humans may become contaminated with PCDD/PCDF through environmental (background), occupational, or accidental exposure.

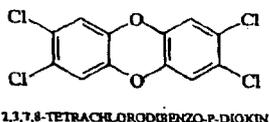
It is generally agreed that for the normal population, food represents the main route of environmental exposure to PCDD/s/PCDFs. Usually more than 90% of the total daily intake of these contaminants derives from food.

In contrast, exposure via other routes, such as inhalation and ingestion of particles from air, ingestion of contaminated soil, and dermal absorption, normally contributes less than 10% of daily intake. Because humans are the high end of the food chain, it becomes obvious that human tissue may contain relatively high amounts of xenobiotics such as PCDDs/PCDFs. Because of the lipophilic nature of these two classes of environmental contaminants, food-stuffs of animal origin are of special importance.

The following figure shows the general structure of polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs):



The following figure shows the formula of 2,3,7,8-Tetrachlorodibenzo-p-dioxin, the most toxic compound of PCDDs/PCDFs.



Certain PCBs were found to have "dioxin-like" properties and were given a TEF (toxic equivalent factor) by WHO as well:

International TEFs for human beings and mammals

| PCDDs (dioxins) | TEF | PCBs with no chlorine at ortho positions ('coplanar' PCBs) | TEF |
|-----------------------|--------|--|--------|
| 2,3,7,8-TCDD (TCDD) | 1 | | |
| 1,2,3,7,8-PeCDD | 1 | 3,3',4,4'-TCB | 0.0001 |
| 1,2,3,4,7,8-HxCDD | 0.1 | 3,4,4',5-TCB | 0.0001 |
| 1,2,3,7,8,9-HxCDD | 0.1 | 3,3',4,4',5-PeCB | 0.1 |
| 1,2,3,6,7,8-HxCDD | 0.1 | 3,3',4,4',5,5'-HxCB | 0.01 |
| 1,2,3,4,6,7,8-HpCDD | 0.01 | | |
| OCDD | 0.0001 | | |
| | | PCBs with one chlorine atom at ortho position | |
| PCDFs (furans) | | 2,3,3',4,4'-PeCB | 0.0001 |
| 2,3,7,8-TCDF | 0.1 | 2,3,4,4',5-PeCB | 0.0005 |
| 1,2,3,7,8-PeCDF | 0.05 | 2,3',4,4',5-PaCB | 0.0001 |
| 2,3,4,7,8-PeCDF | 0.5 | 2',3,4,4',5-PeCB | 0.0001 |
| 1,2,3,4,7,8-HxCDF | 0.1 | 2,3,3',4,4',5-HxCB | 0.0005 |
| 1,2,3,7,8,9-HxCDF | 0.1 | 2,3,3',4,4',5'-HxCB | 0.0005 |
| 1,2,3,6,7,8-HxCDF | 0.1 | 2,3',4,4',5,5'-HxCB | 0.0001 |
| 2,3,4,6,7,8-HxCDF | 0.1 | 2,3,3',4,4',5,5'-HpCB | 0.0001 |
| 1,2,3,4,6,7,8-HpCDF | 0.01 | | |
| 1,2,3,4,7,8,9-HpCDF | 0.01 | | |
| OCDF | 0.0001 | | |

T = tetra (4 chlorine atoms)
Pe = penta (5 chlorine atoms)
Hx = hexa (6 chlorine atoms)
Hp = hepta (7 chlorine atoms)
O = octa (8 chlorine atoms)

Source: *Persistent Organic Pollutants, Monitor 16, 2000, Swedish Environmental Protection Agency*



6 Results

The detailed results of all 2,3,7,8-substituted PCDD/PCDF as well as the results of the PCBs are shown on the data sheets enclosed (second column). The sheets also present the individual Toxic Equivalent Factor (according to WHO, third column), which is used for the calculation of the *single* individual Toxic Equivalents (fourth and fifth column). The *total* of these values is the TEQ (WHO) value, which is used for the quantitative evaluation of the overall PCDD/PCDF- and PCB-contamination of a sample.

The results are valid for the analyzed samples only.

7 Final Remarks

For duplicating the report in parts a written permission by ERGO Forschungsgesellschaft mbH is required.

The samples are stored – on dependence of the test parameters – not longer than three months after the date of the report.

Hamburg, 28.05.2004

ERGO Forschungsgesellschaft mbH

Thomas Herrmann (Dipl.-Ing.)
manager analytical service

Claudia Collingro
(official certified food analyst)
project manager

| PCDD/PCDF and PCB in Human Blood | | | | |
|-----------------------------------|-----------------------------|--|-----------|-----------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-05-0173 | | 08 Date: 4/27/04, approximately 20 ml | | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2,3,7,8-Tetra-CDD | 2,4 | 1,000 | 2,427 |
| | 1,2,3,7,8-Penta-CDD | 4,4 | 1,000 | 4,439 |
| | 1,2,3,4,7,8-Hexa-CDD | 3,5 | 0,100 | 0,347 |
| | 1,2,3,6,7,8-Hexa-CDD | 27,6 | 0,100 | 2,756 |
| | 1,2,3,7,8,9-Hexa-CDD | 5,0 | 0,100 | 0,500 |
| | 1,2,3,4,6,7,8-Hepta-CDD | 31,5 | 0,010 | 0,315 |
| | OCDD | 320,3 | 0,0001 | 0,032 |
| PCDF | 2,3,7,8-Tetra-CDF | n.d. | 0,100 | - (1,0) |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - (1,0) |
| | 2,3,4,7,8-Penta-CDF | 1,9 | 0,500 | 0,949 |
| | 1,2,3,4,7,8-Hexa-CDF | 3,0 | 0,100 | 0,297 |
| | 1,2,3,6,7,8-Hexa-CDF | 2,6 | 0,100 | 0,261 |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (1,7) |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - (1,2) |
| | 1,2,3,4,6,7,8-Hepta-CDF | 2,7 | 0,010 | 0,027 |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (2,7) |
| | OCDF | n.d. | 0,0001 | - (6,9) |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (14) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (2) |
| | 3,3',4,4',5-PeCB (126) | 8 | 0,1000 | 0,846 |
| | 3,3',4,4',5,5'-HxCB (169) | 17 | 0,0100 | 0,172 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 1562 | 0,0001 | 0,156 |
| | 2,3,4,4',5-PeCB (114) | 996 | 0,0005 | 0,498 |
| | 2,3',4,4',5-PeCB (118) | 9937 | 0,0001 | 0,994 |
| | 2',3,4,4',5-PeCB (123) | n.d. | 0,0001 | - (12) |
| | 2,3,3',4,4',5-HxCB (156) | 4368 | 0,0005 | 2,184 |
| | 2,3,3',4,4',5'-HxCB (157) | 849 | 0,0005 | 0,425 |
| | 2,3',4,4',5,5'-HxCB (167) | 1044 | 0,00001 | 0,010 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 396 | 0,0001 | 0,040 |
| Total PCDD/PCDF | | 404,9 | | |
| Total non-ortho-PCB | | 26 | | |
| Total mono-ortho-PCB | | 19152 | | |
| TEQ (WHO) based on PCDD/F | | | 12,350 | |
| TEQ (WHO) based on PCB | | | 5,324 | |
| TEQ (WHO) | | | 17,674 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
 n.d. = not detected, limit of detection (LOD) in (), n.a. = not analysed, Values with * contribute with 50%
 (M) = maximum value, contains possible outside contamination
 Small differences on totals result from computer roundings

| PCDD/PCDF and PCB in Human Blood | | | | |
|-----------------------------------|-----------------------------|-----------|------------------------------|-----------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-05-0174 | | 1G | 4/27/04, approximately 20 ml | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2,3,7,8-Tetra-CDD | 1,6 | 1,000 | 1,625 |
| | 1,2,3,7,8-Penta-CDD | 3,5 | 1,000 | 3,495 |
| | 1,2,3,4,7,8-Hexa-CDD | 3,8 | 0,100 | 0,383 |
| | 1,2,3,6,7,8-Hexa-CDD | 14,8 | 0,100 | 1,477 |
| | 1,2,3,7,8,9-Hexa-CDD | 3,0 | 0,100 | 0,298 |
| | 1,2,3,4,6,7,8-Hepta-CDD | 24,3 | 0,010 | 0,243 |
| | OCDD | 114,3 | 0,0001 | 0,011 |
| PCDF | 2,3,7,8-Tetra-CDF | n.d. | 0,100 | - (1,0) |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - (1,0) |
| | 2,3,4,7,8-Penta-CDF | 2,4 | 0,500 | 1,202 |
| | 1,2,3,4,7,8-Hexa-CDF | 2,4 | 0,100 | 0,244 |
| | 1,2,3,6,7,8-Hexa-CDF | 2,7 | 0,100 | 0,273 |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (1,5) |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - (1,3) |
| | 1,2,3,4,6,7,8-Hepta-CDF | 6,3 | 0,010 | 0,063 |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (2,4) |
| | OCDF | n.d. | 0,0001 | - (6,8) |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (20) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (1) |
| | 3,3',4,4',5-PeCB (126) | 6 | 0,1000 | 0,636 |
| | 3,3',4,4',5,5'-HxCB (169) | 6 | 0,0100 | 0,056 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 431 | 0,0001 | 0,043 |
| | 2,3,4,4',5-PeCB (114) | 164 | 0,0005 | 0,082 |
| | 2,3',4,4',5-PeCB (118) | 2180 | 0,0001 | 0,218 |
| | 2',3,4,4',5-PeCB (123) | 14 | 0,0001 | 0,001 |
| | 2,3,3',4,4',5-HxCB (156) | 1140 | 0,0005 | 0,570 |
| | 2,3,3',4,4',5'-HxCB (157) | 238 | 0,0005 | 0,119 |
| | 2,3',4,4',5,5'-HxCB (167) | 290 | 0,00001 | 0,003 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 103 | 0,0001 | 0,010 |
| Total PCDD/PCDF | | 179,1 | | |
| Total non-ortho-PCB | | 12 | | |
| Total mono-ortho-PCB | | 4559 | | |
| TEQ (WHO) based on PCDD/F | | | 9,315 | |
| TEQ (WHO) based on PCB | | | 1,738 | |
| TEQ (WHO) | | | 11,053 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (). n.a. = not analysed, Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computerroundings

| PCDD/PCDF and PCB in Human Blood | | | | |
|------------------------------------|-----------------------------|-----------|-----------|------------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-05-0175 | | | | |
| Date: 4/17/04, approximately 20 ml | | | | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2,3,7,8-Tetra-CDD | 2,5 | 1,000 | 2,456 |
| | 1,2,3,7,8-Penta-CDD | 5,4 | 1,000 | 5,365 |
| | 1,2,3,4,7,8-Hexa-CDD | 4,3 | 0,100 | 0,427 |
| | 1,2,3,6,7,8-Hexa-CDD | 21,8 | 0,100 | 2,180 |
| | 1,2,3,7,8,9-Hexa-CDD | 6,0 | 0,100 | 0,597 |
| | 1,2,3,4,6,7,8-Hepta-CDD | 66,3 | 0,010 | 0,663 |
| | OCDD | 484,4 | 0,0001 | 0,048 |
| PCDF | 2,3,7,8-Tetra-CDF | 4,0 | 0,100 | 0,399 |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - (1,2) |
| | 2,3,4,7,8-Penta-CDF | 4,4 | 0,500 | 2,187 |
| | 1,2,3,4,7,8-Hexa-CDF | 6,0 | 0,100 | 0,596 |
| | 1,2,3,6,7,8-Hexa-CDF | 6,8 | 0,100 | 0,679 |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (2,6) |
| | 2,3,4,6,7,8-Hexa-CDF | 2,2 | 0,100 | 0,221 |
| | 1,2,3,4,6,7,8-Hepta-CDF | 8,7 | 0,010 | 0,087 |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (4,1) |
| | OCDF | n.d. | 0,0001 | - (10,9) |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (29) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (1) |
| | 3,3',4,4',5-PeCB (126) | 18 | 0,1000 | 1,827 |
| | 3,3',4,4',5,5'-HxCB (169) | 3 | 0,0100 | 0,034 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 634 | 0,0001 | 0,063 |
| | 2,3,4,4',5-PeCB (114) | 120 | 0,0005 | 0,060 |
| | 2,3',4,4',5-PeCB (118) | 3230 | 0,0001 | 0,323 |
| | 2',3,4,4',5-PeCB (123) | 24 | 0,0001 | 0,002 |
| | 2,3,3',4,4',5-HxCB (156) | 636 | 0,0005 | 0,318 |
| | 2,3,3',4,4',5'-HxCB (157) | 150 | 0,0005 | 0,075 |
| | 2,3',4,4',5,5'-HxCB (167) | 304 | 0,00001 | 0,003 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 64 | 0,0001 | 0,006 |
| | Total PCDD/PCDF | 622,5 | | |
| Total non-ortho-PCB | 22 | | | |
| Total mono-ortho-PCB | 5162 | | | |
| TEQ (WHO) based on PCDD/F | | | 15,905 | |
| TEQ (WHO) based on PCB | | | 2,712 | |
| TEQ (WHO) | | | 18,617 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (), n.a. = not analysed, Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computer roundings

| PCDD/PCDF and PCB in Human Blood | | | | |
|-----------------------------------|-----------------------------|-----------------|------------------------------------|-----------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-05-0176 | | 13 | Date: 4/15/04, approximately 20 ml | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2,3,7,8-Tetra-CDD | 1,3 | 1,000 | 1,348 |
| | 1,2,3,7,8-Penta-CDD | 2,5 | 1,000 | 2,533 |
| | 1,2,3,4,7,8-Hexa-CDD | 2,1 | 0,100 | 0,206 |
| | 1,2,3,6,7,8-Hexa-CDD | 14,1 | 0,100 | 1,411 |
| | 1,2,3,7,8,9-Hexa-CDD | 2,3 | 0,100 | 0,233 |
| | 1,2,3,4,6,7,8-Hepta-CDD | 10,3 | 0,010 | 0,103 |
| | OCDD | 87,5 | 0,0001 | 0,009 |
| PCDF | 2,3,7,8-Tetra-CDF | n.d. | 0,100 | - (1,0) |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - (1,0) |
| | 2,3,4,7,8-Penta-CDF | 1,3 | 0,500 | 0,653 |
| | 1,2,3,4,7,8-Hexa-CDF | 1,8 | 0,100 | 0,177 |
| | 1,2,3,6,7,8-Hexa-CDF | 1,5 | 0,100 | 0,148 |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (1,3) |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - (1,6) |
| | 1,2,3,4,6,7,8-Hepta-CDF | 2,0 | 0,010 | 0,020 |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (2,3) |
| | OCDF | n.d. | 0,0001 | - (6,4) |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (19) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (1) |
| | 3,3',4,4',5-PeCB (126) | 5 | 0,1000 | 0,543 |
| | 3,3',4,4',5,5'-HxCB (169) | 9 | 0,0100 | 0,093 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 286 | 0,0001 | 0,029 |
| | 2,3,4,4',5-PeCB (114) | 235 | 0,0005 | 0,117 |
| | 2,3',4,4',5-PaCB (118) | 1723 | 0,0001 | 0,172 |
| | 2',3,4,4',5-PeCB (123) | 12 | 0,0001 | 0,001 |
| | 2,3,3',4,4',5-HxCB (156) | 2713 | 0,0005 | 1,356 |
| | 2,3,3',4,4',5'-HxCB (157) | 495 | 0,0005 | 0,247 |
| | 2,3',4,4',5,5'-HxCB (167) | 288 | 0,00001 | 0,003 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 363 | 0,0001 | 0,036 |
| | | Total PCDD/PCDF | 126,8 | |
| | Total non-ortho-PCB | 15 | | |
| | Total mono-ortho-PCB | 6115 | | |
| | TEQ (WHO) based on PCDD/F | | 6,841 | |
| | TEQ (WHO) based on PCB | | 2,599 | |
| | TEQ (WHO) | | 9,440 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (). n.a. = not analysed, Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computerroundings

| PCDD/PCDF and PCB in Human Blood | | | | |
|--------------------------------------|-----------------------------|-----------|--|-----------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-05-0177 | | | 14 l Date: 4/19/04, approximately 30 ml | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2,3,7,8-Tetra-CDD | n.d. | 1,000 | - (1,0) |
| | 1,2,3,7,8-Penta-CDD | 1,7 | 1,000 | 1,651 |
| | 1,2,3,4,7,8-Hexa-CDD | 2,1 | 0,100 | 0,205 |
| | 1,2,3,6,7,8-Hexa-CDD | 12,2 | 0,100 | 1,223 |
| | 1,2,3,7,8,9-Hexa-CDD | 2,0 | 0,100 | 0,204 |
| | 1,2,3,4,6,7,8-Hepta-CDD | 13,6 | 0,010 | 0,136 |
| | OCDD | 108,9 | 0,0001 | 0,011 |
| PCDF | 2,3,7,8-Tetra-CDF | 1,1 | 0,100 | 0,110 |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - (1,0) |
| | 2,3,4,7,8-Penta-CDF | n.d. | 0,500 | - (1,0) |
| | 1,2,3,4,7,8-Hexa-CDF | 1,7 | 0,100 | 0,166 |
| | 1,2,3,6,7,8-Hexa-CDF | 1,3 | 0,100 | 0,127 |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (1,0) |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - (1,2) |
| | 1,2,3,4,6,7,8-Hepta-CDF | 2,4 | 0,010 | 0,024 |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (1,6) |
| | OCDF | n.d. | 0,0001 | - (5,2) |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (14) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (1) |
| | 3,3',4,4',5-PeCB (126) | 4 | 0,1000 | 0,426 |
| | 3,3',4,4',5,5'-HxCB (169) | 4 | 0,0100 | 0,037 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 372 | 0,0001 | 0,037 |
| | 2,3,4,4',5-PeCB (114) | 146 | 0,0005 | 0,073 |
| | 2,3',4,4',5-PeCB (118) | 1839 | 0,0001 | 0,184 |
| | 2',3,4,4',5-PeCB (123) | 34 | 0,0001 | 0,003 |
| | 2,3,3',4,4',5-HxCB (156) | 745 | 0,0005 | 0,373 |
| | 2,3,3',4,4',5'-HxCB (157) | 166 | 0,0005 | 0,083 |
| | 2,3',4,4',5,5'-HxCB (167) | 196 | 0,00001 | 0,002 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 59 | 0,0001 | 0,006 |
| | Total PCDD/PCDF | 146,8 | | |
| Total non-ortho-PCB | 8 | | | |
| Total mono-ortho-PCB | 3556 | | | |
| TEQ (WHO) based on PCDD/F | | | 3,856 | |
| TEQ (WHO) based on PCB | | | 1,223 | |
| TEQ (WHO) | | | 5,080 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (), n.a. = not analysed, Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computerroundings

| PCDD/PCDF and PCB in Human Blood | | | | |
|------------------------------------|-----------------------------|-----------------|-----------|------------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-05-0179 | | | | |
| 16 | | | | |
| Date: 4/27/04, approximately 20 ml | | | | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2,3,7,8-Tetra-CDD | n.d. | 1,000 | - (1,7) |
| | 1,2,3,7,8-Penta-CDD | n.d. | 1,000 | - (2,0) |
| | 1,2,3,4,7,8-Hexa-CDD | n.d. | 0,100 | - (2,5) |
| | 1,2,3,6,7,8-Hexa-CDD | 10,4 | 0,100 | 1,044 |
| | 1,2,3,7,8,9-Hexa-CDD | 5,5 | 0,100 | 0,549 |
| | 1,2,3,4,6,7,8-Hepta-CDD | 29,2 | 0,010 | 0,292 |
| | OCDD | 271,0 | 0,0001 | 0,027 |
| PCDF | 2,3,7,8-Tetra-CDF | n.d. | 0,100 | - (1,3) |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - (1,1) |
| | 2,3,4,7,8-Penta-CDF | n.d. | 0,500 | - (1,1) |
| | 1,2,3,4,7,8-Hexa-CDF | 2,3 | 0,100 | 0,227 |
| | 1,2,3,6,7,8-Hexa-CDF | 1,8 | 0,100 | 0,177 |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (2,5) |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - (2,7) |
| | 1,2,3,4,6,7,8-Hepta-CDF | 7,8 | 0,010 | 0,078 |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (4,2) |
| | OCDF | n.d. | 0,0001 | - (12,8) |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (36) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (2) |
| | 3,3',4,4',5-PeCB (126) | n.d. | 0,1000 | - (13) |
| | 3,3',4,4',5,5'-HxCB (169) | n.d. | 0,0100 | - (7) |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 408 | 0,0001 | 0,041 |
| | 2,3,4,4',5-PeCB (114) | 87 | 0,0005 | 0,043 |
| | 2,3',4,4',5-PeCB (118) | 1900 | 0,0001 | 0,190 |
| | 2',3,4,4',5-PeCB (123) | 25 | 0,0001 | 0,002 |
| | 2,3,3',4,4',5-HxCB (156) | 439 | 0,0005 | 0,220 |
| | 2,3,3',4,4',5'-HxCB (157) | 103 | 0,0005 | 0,052 |
| | 2,3',4,4',5,5'-HxCB (167) | 185 | 0,00001 | 0,002 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 41 | 0,0001 | 0,004 |
| | | Total PCDD/PCDF | 327,9 | |
| | Total non-ortho-PCB | 0 | | |
| | Total mono-ortho-PCB | 3187 | | |
| | TEQ (WHO) based on PCDD/F | | 2,393 | |
| | TEQ (WHO) based on PCB | | 0,554 | |
| | TEQ (WHO) | | 2,946 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (). n.a. = not analyzed, Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computerroundings

| PCDD/PCDF and PCB in Human Blood | | | | |
|-----------------------------------|-----------------------------|-----------|------------------------------------|-----------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-05-0180 | | 17 | Date: 4/27/04, approximately 15 ml | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2,3,7,8-Tetra-CDD | 3,0 | 1,000 | 2,952 |
| | 1,2,3,7,8-Penta-CDD | 8,6 | 1,000 | 8,571 |
| | 1,2,3,4,7,8-Hexa-CDD | 6,2 | 0,100 | 0,618 |
| | 1,2,3,6,7,8-Hexa-CDD | 52,8 | 0,100 | 5,275 |
| | 1,2,3,7,8,9-Hexa-CDD | 8,1 | 0,100 | 0,812 |
| | 1,2,3,4,6,7,8-Hepta-CDD | 44,5 | 0,010 | 0,445 |
| | OCDD | 507,8 | 0,0001 | 0,051 |
| PCDF | 2,3,7,8-Tetra-CDF | 1,3 | 0,100 | 0,126 |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - (1,0) |
| | 2,3,4,7,8-Penta-CDF | 3,5 | 0,500 | 1,726 |
| | 1,2,3,4,7,8-Hexa-CDF | 8,5 | 0,100 | 0,848 |
| | 1,2,3,6,7,8-Hexa-CDF | 4,9 | 0,100 | 0,486 |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (1,9) |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - (1,7) |
| | 1,2,3,4,6,7,8-Hepta-CDF | 9,0 | 0,010 | 0,090 |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (3,5) |
| | OCDF | 16,3 | 0,0001 | 0,002 |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (32) |
| | 3,4,4',5-TCB (81) | 3 | 0,0001 | 0,000 |
| | 3,3',4,4',5-PeCB (126) | 42 | 0,1000 | 4,180 |
| | 3,3',4,4',5,5'-HxCB (169) | 26 | 0,0100 | 0,263 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 5374 | 0,0001 | 0,537 |
| | 2,3,4,4',5-PeCB (114) | 1564 | 0,0005 | 0,782 |
| | 2,3',4,4',5-PeCB (118) | 18220 | 0,0001 | 1,822 |
| | 2',3,4,4',5-PeCB (123) | 239 | 0,0001 | 0,024 |
| | 2,3,3',4,4',5-HxCB (156) | 10627 | 0,0005 | 5,313 |
| | 2,3,3',4,4',5'-HxCB (157) | 2195 | 0,0005 | 1,097 |
| | 2,3',4,4',5,5'-HxCB (167) | 2447 | 0,00001 | 0,024 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 792 | 0,0001 | 0,079 |
| | Total PCDD/PCDF | 674,2 | | |
| Total non-ortho-PCB | 72 | | | |
| Total mono-ortho-PCB | 41458 | | | |
| TEQ (WHO) based on PCDD/F | | | 22,002 | |
| TEQ (WHO) based on PCB | | | 14,124 | |
| TEQ (WHO) | | | 36,125 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
 n.d. = not detected, limit of detection (LOD) in (), n.a. = not analysed, Values with < contribute with 50%
 (M) = maximum value, contains possible outside contamination
 Small differences on totals result from computer roundings

| PCDD/PCDF and PCB In Human Blood | | | | |
|-----------------------------------|-----------------------------|-----------------|--|-----------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-05-0181 | | | 18 Date: 4/23/04, approximately 30 ml | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2.3.7.8-Tetra-CDD | 1,8 | 1,000 | 1,846 |
| | 1.2.3.7.8-Penta-CDD | 2,5 | 1,000 | 2,517 |
| | 1.2.3.4.7.8-Hexa-CDD | 2,2 | 0,100 | 0,216 |
| | 1.2.3.6.7.8-Hexa-CDD | 11,7 | 0,100 | 1,166 |
| | 1.2.3.7.8.9-Hexa-CDD | 3,8 | 0,100 | 0,377 |
| | 1.2.3.4.6.7.8-Hepta-CDD | 28,6 | 0,010 | 0,286 |
| | OCDD | 177,0 | 0,0001 | 0,018 |
| PCDF | 2.3.7.8-Tetra-CDF | n.d. | 0,100 | - (1,0) |
| | 1.2.3.7.8-Penta-CDF | n.d. | 0,050 | - (1,0) |
| | 2.3.4.7.8-Penta-CDF | 1,6 | 0,500 | 0,779 |
| | 1.2.3.4.7.8-Hexa-CDF | 2,7 | 0,100 | 0,275 |
| | 1.2.3.6.7.8-Hexa-CDF | 1,8 | 0,100 | 0,181 |
| | 1.2.3.7.8.9-Hexa-CDF | n.d. | 0,100 | - (1,0) |
| | 2.3.4.6.7.8-Hexa-CDF | n.d. | 0,100 | - (1,9) |
| | 1.2.3.4.6.7.8-Hepta-CDF | 3,1 | 0,010 | 0,031 |
| | 1.2.3.4.7.8.9-Hepta-CDF | n.d. | 0,010 | - (1,0) |
| | OCDF | 9,1 | 0,0001 | 0,001 |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (23) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (2) |
| | 3,3',4,4',5-PeCB (126) | 8 | 0,1000 | 0,800 |
| | 3,3',4,4',5,5'-HxCB (169) | n.d. | 0,0100 | - (6) |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 511 | 0,0001 | 0,051 |
| | 2,3,4,4',5-PeCB (114) | 163 | 0,0005 | 0,082 |
| | 2,3',4,4',5-PeCB (118) | 2548 | 0,0001 | 0,255 |
| | 2',3,4,4',5-PeCB (123) | 34 | 0,0001 | 0,003 |
| | 2,3,3',4,4',5-HxCB (156) | 760 | 0,0005 | 0,380 |
| | 2,3,3',4,4',5'-HxCB (157) | 161 | 0,0005 | 0,080 |
| | 2,3',4,4',5,5'-HxCB (167) | 253 | 0,00001 | 0,003 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 56 | 0,0001 | 0,006 |
| | | Total PCDD/PCDF | 245,9 | |
| | Total non-ortho-PCB | 8 | | |
| | Total mono-ortho-PCB | 4486 | | |
| | TEQ (WHO) based on PCDD/F | | 7,692 | |
| | TEQ (WHO) based on PCB | | 1,659 | |
| | TEQ (WHO) | | 9,351 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (). n.a. = not analysed, Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computerroundings

| PCDD/PCDF and PCB In Human Blood | | | | |
|-----------------------------------|-----------------------------|-----------------|------------------------------------|-----------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-05-0182 | | 19 | Date: 4/18/04, approximately 20 ml | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2,3,7,8-Tetra-CDD | 1,0 | 1,000 | 1,032 |
| | 1,2,3,7,8-Penta-CDD | 2,9 | 1,000 | 2,868 |
| | 1,2,3,4,7,8-Hexa-CDD | 2,1 | 0,100 | 0,207 |
| | 1,2,3,6,7,8-Hexa-CDD | 6,1 | 0,100 | 0,608 |
| | 1,2,3,7,8,9-Hexa-CDD | 2,6 | 0,100 | 0,258 |
| | 1,2,3,4,6,7,8-Hepta-CDD | 15,8 | 0,010 | 0,158 |
| | OCDD | 87,4 | 0,0001 | 0,009 |
| PCDF | 2,3,7,8-Tetra-CDF | 1,2 | 0,100 | 0,122 |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - (1,0) |
| | 2,3,4,7,8-Penta-CDF | n.d. | 0,500 | - (1,0) |
| | 1,2,3,4,7,8-Hexa-CDF | 2,2 | 0,100 | 0,217 |
| | 1,2,3,6,7,8-Hexa-CDF | 1,3 | 0,100 | 0,129 |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (1,4) |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - (1,6) |
| | 1,2,3,4,6,7,8-Hepta-CDF | 2,8 | 0,010 | 0,028 |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (2,2) |
| | | OCDF | n.d. | 0,0001 |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (21) |
| | 3,4,4',5'-TCB (81) | n.d. | 0,0001 | - (2) |
| | 3,3',4,4',5'-PeCB (126) | n.d. | 0,1000 | - (8) |
| | 3,3',4,4',5,5'-HxCB (169) | n.d. | 0,0100 | - (4) |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 226 | 0,0001 | 0,023 |
| | 2,3,4,4',5'-PeCB (114) | 47 | 0,0005 | 0,023 |
| | 2,3',4,4',5'-PeCB (118) | 1152 | 0,0001 | 0,115 |
| | 2',3,4,4',5'-PeCB (123) | 21 | 0,0001 | 0,002 |
| | 2,3,3',4,4',5'-HxCB (156) | 241 | 0,0005 | 0,121 |
| | 2,3,3',4,4',5'-HxCB (157) | 60 | 0,0005 | 0,030 |
| | 2,3',4,4',5,5'-HxCB (167) | 92 | 0,00001 | 0,001 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 20 | 0,0001 | 0,002 |
| | | Total PCDD/PCDF | 125,3 | |
| | Total non-ortho-PCB | 0 | | |
| | Total mono-ortho-PCB | 1858 | | |
| | TEQ (WHO) based on PCDD/F | | 5,635 | |
| | TEQ (WHO) based on PCB | | 0,317 | |
| | TEQ (WHO) | | 5,952 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (). n.a. = not analysed, Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computerroundings

| PCDD/PCDF and PCB in Human Serum | | | | |
|-----------------------------------|-----------------------------|-----------------|------------------------------------|-----------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-05-0183 | | 20 | Date: 4/18/04, approximately 40 ml | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2,3,7,8-Tetra-CDD | 2,7 | 1,000 | 2,741 |
| | 1,2,3,7,8-Penta-CDD | 7,0 | 1,000 | 7,046 |
| | 1,2,3,4,7,8-Hexa-CDD | 4,4 | 0,100 | 0,442 |
| | 1,2,3,6,7,8-Hexa-CDD | 42,4 | 0,100 | 4,243 |
| | 1,2,3,7,8,9-Hexa-CDD | 6,6 | 0,100 | 0,660 |
| | 1,2,3,4,6,7,8-Hepta-CDD | 29,5 | 0,010 | 0,295 |
| | OCDD | 235,0 | 0,0001 | 0,023 |
| PCDF | 2,3,7,8-Tetra-CDF | n.d. | 0,100 | - (1,5) |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - (1,0) |
| | 2,3,4,7,8-Penta-CDF | 2,9 | 0,500 | 1,445 |
| | 1,2,3,4,7,8-Hexa-CDF | 5,6 | 0,100 | 0,563 |
| | 1,2,3,6,7,8-Hexa-CDF | 2,5 | 0,100 | 0,248 |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (1,5) |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - (2,0) |
| | 1,2,3,4,6,7,8-Hepta-CDF | 5,4 | 0,010 | 0,054 |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (1,9) |
| | OCDF | n.d. | 0,0001 | - (6,4) |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (24) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (2) |
| | 3,3',4,4',5-PeCB (126) | 14 | 0,1000 | 1,363 |
| | 3,3',4,4',5,5'-HxCB (169) | 24 | 0,0100 | 0,239 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 570 | 0,0001 | 0,057 |
| | 2,3,4,4',5-PeCB (114) | 758 | 0,0005 | 0,379 |
| | 2,3',4,4',5-PeCB (118) | 4286 | 0,0001 | 0,429 |
| | 2',3,4,4',5-PeCB (123) | 32 | 0,0001 | 0,003 |
| | 2,3,3',4,4',5-HxCB (156) | 7400 | 0,0005 | 3,700 |
| | 2,3,3',4,4',5'-HxCB (157) | 1657 | 0,0005 | 0,828 |
| | 2,3',4,4',5,5'-HxCB (167) | 945 | 0,00001 | 0,009 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 720 | 0,0001 | 0,072 |
| | | Total PCDD/PCDF | 344,2 | |
| | Total non-ortho-PCB | 38 | | |
| | Total mono-ortho-PCB | 16369 | | |
| | TEQ (WHO) based on PCDD/F | | 17,763 | |
| | TEQ (WHO) based on PCB | | 7,080 | |
| | TEQ (WHO) | | 24,843 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (). n.a. = not analysed, Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computer roundings

| PCDD/PCDF and PCB in Human Serum | | | | | |
|-----------------------------------|-----------------------------|-----------|--|-------|---------|
| Values in pg/g (ppt), lipid based | | | | | |
| Analysis-No. H-04-05-0184 | | | 24 Date: 4/20/04, approximately 30 ml | | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD | |
| PCDD | 2,3,7,8-Tetra-CDD | 2,7 | 1,000 | 2,696 | |
| | 1,2,3,7,8-Penta-CDD | 4,9 | 1,000 | 4,949 | |
| | 1,2,3,4,7,8-Hexa-CDD | 7,2 | 0,100 | 0,718 | |
| | 1,2,3,6,7,8-Hexa-CDD | 34,8 | 0,100 | 3,480 | |
| | 1,2,3,7,8,9-Hexa-CDD | 7,8 | 0,100 | 0,776 | |
| | 1,2,3,4,6,7,8-Hepta-CDD | 72,9 | 0,010 | 0,729 | |
| | OCDD | 411,6 | 0,0001 | 0,041 | |
| PCDF | 2,3,7,8-Tetra-CDF | n.d. | 0,100 | - | (1,6) |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - | (1,0) |
| | 2,3,4,7,8-Penta-CDF | 2,6 | 0,500 | 1,306 | |
| | 1,2,3,4,7,8-Hexa-CDF | 5,2 | 0,100 | 0,525 | |
| | 1,2,3,6,7,8-Hexa-CDF | 3,7 | 0,100 | 0,375 | |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - | (1,0) |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - | (2,1) |
| | 1,2,3,4,6,7,8-Hepta-CDF | 5,5 | 0,010 | 0,055 | |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - | (1,2) |
| | OCDF | n.d. | 0,0001 | - | (4,6) |
| non-ortho PCB | 3,3',4,4'-TCB (77) | 19 | 0,0001 | 0,002 | |
| | 3,4,4',5-TCB (81) | 2 | 0,0001 | 0,000 | |
| | 3,3',4,4',5-PeCB (126) | 39 | 0,1000 | 3,945 | |
| | 3,3',4,4',5,5'-HxCB (169) | 17 | 0,0100 | 0,170 | |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 3097 | 0,0001 | 0,310 | |
| | 2,3,4,4',5-PeCB (114) | 1085 | 0,0005 | 0,542 | |
| | 2,3',4,4',5-PeCB (118) | 16361 | 0,0001 | 1,636 | |
| | 2',3,4,4',5-PeCB (123) | 402 | 0,0001 | 0,040 | |
| | 2,3,3',4,4',5-HxCB (156) | 5139 | 0,0005 | 2,570 | |
| | 2,3,3',4,4',5'-HxCB (157) | 1061 | 0,0005 | 0,531 | |
| | 2,3',4,4',5,5'-HxCB (167) | 1744 | 0,00001 | 0,017 | |
| | 2,3,3',4,4',5,5'-HpCB (189) | 460 | 0,0001 | 0,046 | |
| | Total PCDD/PCDF | 559,0 | | | |
| Total non-ortho-PCB | 77 | | | | |
| Total mono-ortho-PCB | 29349 | | | | |
| TEQ (WHO) based on PCDD/F | | | 15,650 | | |
| TEQ (WHO) based on PCB | | | 9,810 | | |
| TEQ (WHO) | | | 25,459 | | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (), n.a. = not analysed, Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computerroundings

| PCDD/PCDF and PCB in Human Serum | | | | |
|-----------------------------------|-----------------------------|-----------|------------------------------------|-------------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-05-0185 | | 25 | Date: 4/21/04, approximately 30 ml | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2,3,7,8-Tetra-CDD | n.d. | 1,000 | - (1,7) |
| | 1,2,3,7,8-Penta-CDD | 3,6 | 1,000 | 3,612 |
| | 1,2,3,4,7,8-Hexa-CDD | 3,4 | 0,100 | 0,345 |
| | 1,2,3,6,7,8-Hexa-CDD | 16,3 | 0,100 | 1,627 |
| | 1,2,3,7,8,9-Hexa-CDD | 6,4 | 0,100 | 0,636 |
| | 1,2,3,4,6,7,8-Hepta-CDD | 26,1 | 0,010 | 0,261 |
| | OCDD | 237,8 | 0,0001 | 0,024 |
| PCDF | 2,3,7,8-Tetra-CDF | n.d. | 0,100 | - (1,2) |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - (1,0) |
| | 2,3,4,7,8-Penta-CDF | 1,5 | 0,500 | 0,737 |
| | 1,2,3,4,7,8-Hexa-CDF | 3,3 | 0,100 | 0,333 |
| | 1,2,3,6,7,8-Hexa-CDF | 3,1 | 0,100 | 0,315 |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (1,8) |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - (3,1) |
| | 1,2,3,4,6,7,8-Hepta-CDF | 32,9 | 0,010 | 0,329 (M) |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (2,5) |
| | | OCDF | n.d. | 0,0001 |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (26) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (2) |
| | 3,3',4,4',5-PeCB (126) | 6 | 0,1000 | 0,589 |
| | 3,3',4,4',5,5'-HxCB (169) | 4 | 0,0100 | 0,041 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 547 | 0,0001 | 0,055 |
| | 2,3,4,4',5-PeCB (114) | 143 | 0,0005 | 0,071 |
| | 2,3',4,4',5-PeCB (118) | 2718 | 0,0001 | 0,272 |
| | 2',3,4,4',5-PeCB (123) | 44 | 0,0001 | 0,004 |
| | 2,3,3',4,4',5-HxCB (156) | 649 | 0,0005 | 0,324 |
| | 2,3,3',4,4',5-HxCB (157) | 163 | 0,0005 | 0,081 |
| | 2,3',4,4',5,5'-HxCB (167) | 253 | 0,00001 | 0,003 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 35 | 0,0001 | 0,004 |
| Total PCDD/PCDF | | 334,5 | | |
| Total non-ortho-PCB | | 10 | | |
| Total mono-ortho-PCB | | 4551 | | |
| TEQ (WHO), based on PCDD/F | | | 8,219 | |
| TEQ (WHO) based on PCB | | | 1,444 | |
| TEQ (WHO) | | | 9,663 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (), n.a. = not analysed, values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computer roundings

| PCDD/PCDF and PCB in Human Serum | | | | | |
|-----------------------------------|-----------------------------|---------------------|---------------------------------------|-----------|-----------|
| Values in pg/g (ppt), lipid based | | | | | |
| Analysis-No. H-04-05-0186 | | 26 |), Date: 4/29/04, approximately 20 ml | | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD | |
| PCDD | 2,3,7,8-Tetra-CDD | 2,1 | 1,000 | 2,085 | |
| | 1,2,3,7,8-Penta-CDD | 3,3 | 1,000 | 3,317 | |
| | 1,2,3,4,7,8-Hexa-CDD | 4,5 | 0,100 | 0,450 | |
| | 1,2,3,6,7,8-Hexa-CDD | 41,9 | 0,100 | 4,192 | |
| | 1,2,3,7,8,9-Hexa-CDD | 9,3 | 0,100 | 0,932 | |
| | 1,2,3,4,6,7,8-Hepta-CDD | 82,2 | 0,010 | 0,822 | |
| | OCDD | 446,0 | 0,0001 | 0,045 | |
| PCDF | 2,3,7,8-Tetra-CDF | n.d. | 0,100 | - (1,5) | |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - (1,0) | |
| | 2,3,4,7,8-Penta-CDF | 2,2 | 0,500 | 1,083 | |
| | 1,2,3,4,7,8-Hexa-CDF | 4,4 | 0,100 | 0,441 | |
| | 1,2,3,6,7,8-Hexa-CDF | 2,9 | 0,100 | 0,290 | |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (1,4) | |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - (2,3) | |
| | 1,2,3,4,6,7,8-Hepta-CDF | 6,0 | 0,010 | 0,060 | |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (1,7) | |
| | | OCDF | n.d. | 0,0001 | - (4,1) |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (24) | |
| | 3,4,4',5'-TCB (81) | n.d. | 0,0001 | - (2) | |
| | 3,3',4,4',5'-PeCB (126) | 12 | 0,1000 | 1,196 | |
| | 3,3',4,4',5,5'-HxCB (169) | 8 | 0,0100 | 0,079 | |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 780 | 0,0001 | 0,078 | |
| | 2,3,4,4',5'-PeCB (114) | 448 | 0,0005 | 0,224 | |
| | 2,3',4,4',5'-PeCB (118) | 4566 | 0,0001 | 0,457 | |
| | 2',3,4,4',5'-PeCB (123) | 98 | 0,0001 | 0,010 | |
| | 2,3,3',4,4',5'-HxCB (156) | 2168 | 0,0005 | 1,084 | |
| | 2,3,3',4,4',5'-HxCB (157) | 512 | 0,0005 | 0,256 | |
| | 2,3',4,4',5,5'-HxCB (167) | 621 | 0,00001 | 0,006 | |
| | 2,3,3',4,4',5,5'-HpCB (189) | 179 | 0,0001 | 0,018 | |
| | | Total PCDD/PCDF | 604,9 | | |
| | | Total non-ortho-PCB | 20 | | |
| | Total mono-ortho-PCB | 9372 | | | |
| | TEQ (WHO) based on PCDD/F | | 13,718 | | |
| | TEQ (WHO) based on PCB | | 3,407 | | |
| | TEQ (WHO) | | 17,125 | | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (). n.a. = not analysed, Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computeroundings

| PCDD/PCDF and PCB in Human Serum | | | | |
|-----------------------------------|-----------------------------|-----------------|------------------------------------|-----------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-05-0187 | | 27 | Date: 4/16/04, approximately 20 ml | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2,3,7,8-Tetra-CDD | 1,8 | 1,000 | 1,806 |
| | 1,2,3,7,8-Penta-CDD | 4,6 | 1,000 | 4,582 |
| | 1,2,3,4,7,8-Hexa-CDD | 4,9 | 0,100 | 0,491 |
| | 1,2,3,6,7,8-Hexa-CDD | 30,4 | 0,100 | 3,038 |
| | 1,2,3,7,8,9-Hexa-CDD | 6,8 | 0,100 | 0,679 |
| | 1,2,3,4,6,7,8-Hepta-CDD | 30,0 | 0,010 | 0,300 |
| | OCDD | 234,2 | 0,0001 | 0,023 |
| PCDF | 2,3,7,8-Tetra-CDF | n.d. | 0,100 | - (1,0) |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - (1,0) |
| | 2,3,4,7,8-Penta-CDF | 2,4 | 0,500 | 1,225 |
| | 1,2,3,4,7,8-Hexa-CDF | 5,0 | 0,100 | 0,499 |
| | 1,2,3,6,7,8-Hexa-CDF | 2,9 | 0,100 | 0,291 |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (1,0) |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - (1,5) |
| | 1,2,3,4,6,7,8-Hepta-CDF | 5,1 | 0,010 | 0,051 |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (1,4) |
| | | OCDF | n.d. | 0,0001 |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (19) |
| | 3,4,4',5'-TCB (81) | n.d. | 0,0001 | - (2) |
| | 3,3',4,4',5'-PeCB (126) | 12 | 0,1000 | 1,155 |
| | 3,3',4,4',5,5'-HxCB (169) | 6 | 0,0100 | 0,059 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 1093 | 0,0001 | 0,109 |
| | 2,3,4,4',5'-PeCB (114) | 418 | 0,0005 | 0,209 |
| | 2,3',4,4',5'-PeCB (118) | 5879 | 0,0001 | 0,588 |
| | 2',3,4,4',5'-PeCB (123) | 87 | 0,0001 | 0,009 |
| | 2,3,3',4,4',5'-HxCB (156) | 2224 | 0,0005 | 1,112 |
| | 2,3,3',4,4',5'-HxCB (157) | 481 | 0,0005 | 0,240 |
| | 2,3',4,4',5,5'-HxCB (167) | 607 | 0,00001 | 0,006 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 144 | 0,0001 | 0,014 |
| | | Total PCDD/PCDF | 328,1 | |
| | Total non-ortho-PCB | 17 | | |
| | Total mono-ortho-PCB | 10932 | | |
| | TEQ (WHO) based on PCDD/F | | 12,985 | |
| | TEQ (WHO) based on PCB | | 3,501 | |
| | TEQ (WHO) | | 16,486 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (). n.a. = not analysed, Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computerroundings

| PCDD/PCDF and PCB in Human Serum | | | | |
|-----------------------------------|-----------------------------|-----------|------------------------------------|-----------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-05-0188 | | 29 | Date: 4/18/04, approximately 30 ml | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2,3,7,8-Tetra-CDD | 1,6 | 1,000 | 1,554 |
| | 1,2,3,7,8-Penta-CDD | 4,7 | 1,000 | 4,719 |
| | 1,2,3,4,7,8-Hexa-CDD | 4,8 | 0,100 | 0,484 |
| | 1,2,3,6,7,8-Hexa-CDD | 21,2 | 0,100 | 2,116 |
| | 1,2,3,7,8,9-Hexa-CDD | 4,5 | 0,100 | 0,446 |
| | 1,2,3,4,6,7,8-Hepta-CDD | 58,9 | 0,010 | 0,589 |
| | OCDD | 221,1 | 0,0001 | 0,022 |
| PCDF | 2,3,7,8-Tetra-CDF | n.d. | 0,100 | - (1,0) |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - (1,0) |
| | 2,3,4,7,8-Penta-CDF | 2,4 | 0,500 | 1,203 |
| | 1,2,3,4,7,8-Hexa-CDF | 4,4 | 0,100 | 0,443 |
| | 1,2,3,6,7,8-Hexa-CDF | 3,9 | 0,100 | 0,386 |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (1,4) |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - (2,6) |
| | 1,2,3,4,6,7,8-Hepta-CDF | 7,5 | 0,010 | 0,075 |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (2,2) |
| | OCDF | n.d. | 0,0001 | - (5,8) |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (23) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (3) |
| | 3,3',4,4',5-PeCB (126) | 11 | 0,1000 | 1,127 |
| | 3,3',4,4',5,5'-HxCB (169) | 8 | 0,0100 | 0,075 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 360 | 0,0001 | 0,036 |
| | 2,3,4,4',5-PeCB (114) | 138 | 0,0005 | 0,069 |
| | 2,3',4,4',5-PeCB (118) | 2251 | 0,0001 | 0,225 |
| | 2',3,4,4',5-PeCB (123) | 24 | 0,0001 | 0,002 |
| | 2,3,3',4,4',5-HxCB (156) | 1304 | 0,0005 | 0,652 |
| | 2,3,3',4,4',5'-HxCB (157) | 307 | 0,0005 | 0,154 |
| | 2,3',4,4',5,5'-HxCB (167) | 284 | 0,00001 | 0,003 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 131 | 0,0001 | 0,013 |
| | Total PCDD/PCDF | 335,0 | | |
| | Total non-ortho-PCB | 19 | | |
| Total mono-ortho-PCB | 4799 | | | |
| TEQ (WHO) based on PCDD/F | | | 12,040 | |
| TEQ (WHO) based on PCB | | | 2,357 | |
| TEQ (WHO) | | | 14,396 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (), n.a. = not analysed, Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computerroundings

| PCDD/PCDF and PCB in Human Serum | | | | |
|-----------------------------------|-----------------------------|-----------|---------------------------------------|-----------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-05-0189 | | 30 |), Date: 4/20/04, approximately 20 ml | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2.3.7.8-Tetra-CDD | n.d. | 1,000 | - (1,0) |
| | 1.2.3.7.8-Penta-CDD | 5,1 | 1,000 | 5,108 |
| | 1.2.3.4.7.8-Hexa-CDD | 5,7 | 0,100 | 0,573 |
| | 1.2.3.6.7.8-Hexa-CDD | 31,5 | 0,100 | 3,147 |
| | 1.2.3.7.8.9-Hexa-CDD | 7,6 | 0,100 | 0,764 |
| | 1.2.3.4.6.7.8-Hepta-CDD | 64,1 | 0,010 | 0,641 |
| | OCDD | 300,4 | 0,0001 | 0,030 |
| PCDF | 2.3.7.8-Tetra-CDF | n.d. | 0,100 | - (1,0) |
| | 1.2.3.7.8-Penta-CDF | n.d. | 0,050 | - (1,0) |
| | 2.3.4.7.8-Penta-CDF | 6,0 | 0,500 | 2,999 |
| | 1.2.3.4.7.8-Hexa-CDF | 8,3 | 0,100 | 0,828 |
| | 1.2.3.6.7.8-Hexa-CDF | 6,7 | 0,100 | 0,669 |
| | 1.2.3.7.8.9-Hexa-CDF | n.d. | 0,100 | - (1,2) |
| | 2.3.4.6.7.8-Hexa-CDF | 4,0 | 0,100 | 0,405 |
| | 1.2.3.4.6.7.8-Hepta-CDF | 9,0 | 0,010 | 0,090 |
| | 1.2.3.4.7.8.9-Hepta-CDF | n.d. | 0,010 | - (1,5) |
| | OCDF | n.d. | 0,0001 | - (5,5) |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (21) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (2) |
| | 3,3',4,4',5-PeCB (126) | 24 | 0,1000 | 2,372 |
| | 3,3',4,4',5,5'-HxCB (169) | 9 | 0,0100 | 0,092 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 813 | 0,0001 | 0,081 |
| | 2,3,4,4',5-PeCB (114) | 212 | 0,0005 | 0,106 |
| | 2,3',4,4',5-PeCB (118) | 4685 | 0,0001 | 0,468 |
| | 2',3,4,4',5-PeCB (123) | 108 | 0,0001 | 0,011 |
| | 2,3,3',4,4',5-HxCB (156) | 1505 | 0,0005 | 0,753 |
| | 2,3,3',4,4',5'-HxCB (157) | 341 | 0,0005 | 0,171 |
| | 2,3',4,4',5,5'-HxCB (167) | 549 | 0,00001 | 0,005 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 166 | 0,0001 | 0,017 |
| | Total PCDD/PCDF | 448,4 | | |
| Total non-ortho-PCB | 33 | | | |
| Total mono-ortho-PCB | 8378 | | | |
| TEQ (WHO) based on PCDD/F | | | 15,255 | |
| TEQ (WHO) based on PCB | | | 4,076 | |
| TEQ (WHO) | | | 19,331 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (). n.a. = not analysed, Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computer roundings

| PCDD/PCDF and PCB in Human Serum | | | | |
|--------------------------------------|-----------------------------|-----------|---------------|------------------------------------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-05-0190 | | | 31 | Date: 4/18/04, approximately 20 ml |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2,3,7,8-Tetra-CDD | 3,6 | 1,000 | 3,598 |
| | 1,2,3,7,8-Penta-CDD | 8,5 | 1,000 | 8,454 |
| | 1,2,3,4,7,8-Hexa-CDD | 9,9 | 0,100 | 0,994 |
| | 1,2,3,6,7,8-Hexa-CDD | 75,4 | 0,100 | 7,541 |
| | 1,2,3,7,8,9-Hexa-CDD | 14,8 | 0,100 | 1,482 |
| | 1,2,3,4,6,7,8-Hepta-CDD | 45,7 | 0,010 | 0,457 |
| | OCDD | 833,4 | 0,0001 | 0,083 |
| PCDF | 2,3,7,8-Tetra-CDF | n.d. | 0,100 | - (1,0) |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - (1,0) |
| | 2,3,4,7,8-Penta-CDF | 5,9 | 0,500 | 2,964 |
| | 1,2,3,4,7,8-Hexa-CDF | 12,4 | 0,100 | 1,236 |
| | 1,2,3,6,7,8-Hexa-CDF | 7,2 | 0,100 | 0,723 |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (1,2) |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - (2,0) |
| | 1,2,3,4,6,7,8-Hepta-CDF | 5,9 | 0,010 | 0,059 |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (1,6) |
| | OCDF | n.d. | 0,0001 | - (4,2) |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (30) |
| | 3,4,4',5-TCB (81) | 3 | 0,0001 | 0,000 |
| | 3,3',4,4',5-PeCB (126) | 42 | 0,1000 | 4,207 |
| | 3,3',4,4',5,5'-HxCB (169) | 27 | 0,0100 | 0,270 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 3104 | 0,0001 | 0,310 |
| | 2,3,4,4',5-PeCB (114) | 1880 | 0,0005 | 0,940 |
| | 2,3',4,4',5-PeCB (118) | 24538 | 0,0001 | 2,454 |
| | 2',3,4,4',5-PeCB (123) | 237 | 0,0001 | 0,024 |
| | 2,3,3',4,4',5-HxCB (156) | 11360 | 0,0005 | 5,680 |
| | 2,3,3',4,4',5'-HxCB (157) | 2400 | 0,0005 | 1,200 |
| | 2,3',4,4',5,5'-HxCB (167) | 3317 | 0,00001 | 0,033 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 716 | 0,0001 | 0,072 |
| Total PCDD/PCDF | | 1022,7 | | |
| Total non-ortho-PCB | | 72 | | |
| Total mono-ortho-PCB | | 47552 | | |
| TEQ (WHO) based on PCDD/F | | | 27,592 | |
| TEQ (WHO) based on PCB | | | 15,190 | |
| TEQ (WHO) | | | 42,782 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (). n.a. = not analysed, Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computer roundings

| PCDD/PCDF and PCB in Human Serum | | | | | |
|-----------------------------------|-----------------------------|-----------|---------------|------------------------------------|---------|
| Values in pg/g (ppt), lipid based | | | | | |
| Analysis-No. H-04-05-0191 | | | 35 | Date: 4/29/04, approximately 20 ml | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD | |
| PCDD | 2,3,7,8-Tetra-CDD | 2,3 | 1,000 | 2,263 | |
| | 1,2,3,7,8-Penta-CDD | 5,1 | 1,000 | 5,135 | |
| | 1,2,3,4,7,8-Hexa-CDD | 4,9 | 0,100 | 0,489 | |
| | 1,2,3,6,7,8-Hexa-CDD | 38,5 | 0,100 | 3,853 | |
| | 1,2,3,7,8,9-Hexa-CDD | 5,1 | 0,100 | 0,513 | |
| | 1,2,3,4,6,7,8-Hepta-CDD | 33,2 | 0,010 | 0,332 | |
| | OCDD | 281,3 | 0,0001 | 0,028 | |
| PCDF | 2,3,7,8-Tetra-CDF | n.d. | 0,100 | - | (1,1) |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - | (1,1) |
| | 2,3,4,7,8-Penta-CDF | 2,9 | 0,500 | 1,464 | |
| | 1,2,3,4,7,8-Hexa-CDF | 4,7 | 0,100 | 0,467 | |
| | 1,2,3,6,7,8-Hexa-CDF | 4,0 | 0,100 | 0,404 | |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - | (1,8) |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - | (2,0) |
| | 1,2,3,4,6,7,8-Hepta-CDF | 6,8 | 0,010 | 0,068 | |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - | (2,5) |
| OCDF | n.d. | 0,0001 | - | (6,2) | |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - | (41) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - | (5) |
| | 3,3',4,4',5-PeCB (126) | 10 | 0,1000 | 1,015 | |
| | 3,3',4,4',5,5'-HxCB (169) | 22 | 0,0100 | 0,224 | |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 673 | 0,0001 | 0,067 | |
| | 2,3,4,4',5-PeCB (114) | 479 | 0,0005 | 0,240 | |
| | 2,3',4,4',5-PeCB (118) | 3943 | 0,0001 | 0,394 | |
| | 2',3,4,4',5-PeCB (123) | 74 | 0,0001 | 0,007 | |
| | 2,3,3',4,4',5-HxCB (156) | 5912 | 0,0005 | 2,956 | |
| | 2,3,3',4,4',5'-HxCB (157) | 1272 | 0,0005 | 0,636 | |
| | 2,3',4,4',5,5'-HxCB (167) | 655 | 0,00001 | 0,007 | |
| | 2,3,3',4,4',5,5'-HpCB (189) | 654 | 0,0001 | 0,065 | |
| | Total PCDD/PCDF | 388,9 | | | |
| Total non-ortho-PCB | 33 | | | | |
| Total mono-ortho-PCB | 13663 | | | | |
| TEQ (WHO) based on PCDD/F | | | 15,016 | | |
| TEQ (WHO) based on PCB | | | 5,612 | | |
| TEQ (WHO) | | | 20,628 | | |

TEQ, TEF (WHO) = Toxic equivalent f-factor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (), n.a. = not analysed, Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computer roundings

| PCDD/PCDF and PCB in Human Serum | | | | |
|-----------------------------------|-----------------------------|-----------|-----------------------------------|-----------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-05-0192 | | 37 | Date: 5/1/04, approximately 20 ml | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2,3,7,8-Tetra-CDD | 2,0 | 1,000 | 2,004 |
| | 1,2,3,7,8-Penta-CDD | 5,9 | 1,000 | 5,871 |
| | 1,2,3,4,7,8-Hexa-CDD | 3,6 | 0,100 | 0,363 |
| | 1,2,3,6,7,8-Hexa-CDD | 42,9 | 0,100 | 4,294 |
| | 1,2,3,7,8,9-Hexa-CDD | 7,0 | 0,100 | 0,696 |
| | 1,2,3,4,6,7,8-Hepta-CDD | 16,0 | 0,010 | 0,160 |
| | OCDD | 227,7 | 0,0001 | 0,023 |
| PCDF | 2,3,7,8-Tetra-CDF | n.d. | 0,100 | - (1,0) |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - (1,0) |
| | 2,3,4,7,8-Penta-CDF | 2,9 | 0,500 | 1,465 |
| | 1,2,3,4,7,8-Hexa-CDF | 4,2 | 0,100 | 0,424 |
| | 1,2,3,6,7,8-Hexa-CDF | 3,0 | 0,100 | 0,302 |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (1,6) |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - (1,9) |
| | 1,2,3,4,6,7,8-Hepta-CDF | 4,3 | 0,010 | 0,043 |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (1,9) |
| | OCDF | n.d. | 0,0001 | - (4,8) |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (30) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (4) |
| | 3,3',4,4',5-PeCB (126) | 7 | 0,1000 | 0,736 |
| | 3,3',4,4',5,5'-HxCB (169) | 13 | 0,0100 | 0,132 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 366 | 0,0001 | 0,037 |
| | 2,3,4,4',5-PeCB (114) | 539 | 0,0005 | 0,270 |
| | 2,3',4,4',5-PeCB (118) | 2496 | 0,0001 | 0,250 |
| | 2',3,4,4',5-PeCB (123) | 16 | 0,0001 | 0,002 |
| | 2,3,3',4,4',5-HxCB (156) | 5876 | 0,0005 | 2,938 |
| | 2,3,3',4,4',5'-HxCB (157) | 1185 | 0,0005 | 0,592 |
| | 2,3',4,4',5,5'-HxCB (167) | 605 | 0,00001 | 0,006 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 460 | 0,0001 | 0,046 |
| | Total PCDD/PCDF | 319,7 | | |
| Total non-ortho-PCB | 21 | | | |
| Total mono-ortho-PCB | 11544 | | | |
| TEQ (WHO) based on PCDD/F | | | 15,646 | |
| TEQ (WHO) based on PCB | | | 5,009 | |
| TEQ (WHO) | | | 20,655 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (). n.a. = not analysed, Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computer roundings

| PCDD/PCDF and PCB in Human Serum | | | | | |
|--------------------------------------|-----------------------------|-----------|-----------------------------------|-----------|-----------|
| Values in pg/g (ppt), lipid based | | | | | |
| Analysis-No. H-04-05-0193 | | 38 | Date: 5/4/04, approximately 20 ml | | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD | |
| PCDD | 2.3.7.8-Tetra-CDD | 3,1 | 1,000 | 3,105 | |
| | 1.2.3.7.8-Penta-CDD | 6,7 | 1,000 | 6,697 | |
| | 1.2.3.4.7.8-Hexa-CDD | 7,4 | 0,100 | 0,736 | |
| | 1.2.3.6.7.8-Hexa-CDD | 44,2 | 0,100 | 4,421 | |
| | 1.2.3.7.8.9-Hexa-CDD | 9,2 | 0,100 | 0,921 | |
| | 1.2.3.4.6.7.8-Hepta-CDD | 51,3 | 0,010 | 0,513 | |
| | OCDD | 395,5 | 0,0001 | 0,040 | |
| PCDF | 2.3.7.8-Tetra-CDF | 1,2 | 0,100 | 0,123 | |
| | 1.2.3.7.8-Penta-CDF | n.d. | 0,050 | - (1,0) | |
| | 2.3.4.7.8-Penta-CDF | 4,8 | 0,500 | 2,380 | |
| | 1.2.3.4.7.8-Hexa-CDF | 6,4 | 0,100 | 0,642 | |
| | 1.2.3.6.7.8-Hexa-CDF | 4,4 | 0,100 | 0,442 | |
| | 1.2.3.7.8.9-Hexa-CDF | n.d. | 0,100 | - (1,0) | |
| | 2.3.4.6.7.8-Hexa-CDF | n.d. | 0,100 | - (2,4) | |
| | 1.2.3.4.6.7.8-Hepta-CDF | 2,9 | 0,010 | 0,029 | |
| | 1.2.3.4.7.8.9-Hepta-CDF | n.d. | 0,010 | - (1,3) | |
| | | OCDF | n.d. | 0,0001 | - (3,7) |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (24) | |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (2) | |
| | 3,3',4,4',5-PeCB (126) | 16 | 0,1000 | 1,646 | |
| | 3,3',4,4',5,5'-HxCB (169) | 17 | 0,0100 | 0,174 | |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 2723 | 0,0001 | 0,272 | |
| | 2,3,4,4',5-PeCB (114) | 754 | 0,0005 | 0,377 | |
| | 2,3',4,4',5-PeCB (118) | 11067 | 0,0001 | 1,107 | |
| | 2',3,4,4',5-PeCB (123) | 100 | 0,0001 | 0,010 | |
| | 2,3,3',4,4',5-HxCB (156) | 4394 | 0,0005 | 2,197 | |
| | 2,3,3',4,4',5'-HxCB (157) | 946 | 0,0005 | 0,473 | |
| | 2,3',4,4',5,5'-HxCB (167) | 1150 | 0,00001 | 0,012 | |
| | 2,3,3',4,4',5,5'-HpCB (189) | 365 | 0,0001 | 0,036 | |
| | Total PCDD/PCDF | | 537,1 | | |
| | Total non-ortho-PCB | | 34 | | |
| Total mono-ortho-PCB | | 21498 | | | |
| TEQ (WHO) based on PCDD/F | | | 20,049 | | |
| TEQ (WHO) based on PCB | | | 6,304 | | |
| TEQ (WHO) | | | 26,353 | | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (), n.a. = not analysed, Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computerroundings

| PCDD/PCDF and PCB In Human Serum | | | | |
|-----------------------------------|-----------------------------|-----------|------------------------------------|-----------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-05-0194 | | 39 | Date: 4/20/04, approximately 30 ml | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2,3,7,8-Tetra-CDD | 3,2 | 1,000 | 3,222 |
| | 1,2,3,7,8-Penta-CDD | 9,2 | 1,000 | 9,219 |
| | 1,2,3,4,7,8-Hexa-CDD | 15,9 | 0,100 | 1,589 |
| | 1,2,3,6,7,8-Hexa-CDD | 52,5 | 0,100 | 5,246 |
| | 1,2,3,7,8,9-Hexa-CDD | 11,8 | 0,100 | 1,177 |
| | 1,2,3,4,6,7,8-Hepta-CDD | 147,5 | 0,010 | 1,475 |
| | OCDD | 694,0 | 0,0001 | 0,069 |
| PCDF | 2,3,7,8-Tetra-CDF | n.d. | 0,100 | - (1,0) |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - (1,0) |
| | 2,3,4,7,8-Penta-CDF | 3,4 | 0,500 | 1,682 |
| | 1,2,3,4,7,8-Hexa-CDF | 12,8 | 0,100 | 1,279 |
| | 1,2,3,6,7,8-Hexa-CDF | 6,7 | 0,100 | 0,666 |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (1,0) |
| | 2,3,4,6,7,8-Hexa-CDF | 1,8 | 0,100 | 0,179 |
| | 1,2,3,4,6,7,8-Hepta-CDF | 7,7 | 0,010 | 0,077 |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (1,5) |
| OCDF | n.d. | 0,0001 | - (5,1) | |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (22) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (3) |
| | 3,3',4,4',5-PeCB (126) | 47 | 0,1000 | 4,696 |
| | 3,3',4,4',5,5'-HxCB (169) | 16 | 0,0100 | 0,155 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 3516 | 0,0001 | 0,352 |
| | 2,3,4,4',5-PeCB (114) | 1041 | 0,0005 | 0,521 |
| | 2,3',4,4',5-PeCB (118) | 17642 | 0,0001 | 1,764 |
| | 2',3,4,4',5-PeCB (123) | 236 | 0,0001 | 0,024 |
| | 2,3,3',4,4',5-HxCB (156) | 5077 | 0,0005 | 2,539 |
| | 2,3,3',4,4',5'-HxCB (157) | 1092 | 0,0005 | 0,546 |
| | 2,3',4,4',5,5'-HxCB (167) | 1783 | 0,00001 | 0,018 |
| | 2,3,3',4,4',5,5'-HxCB (189) | 374 | 0,0001 | 0,037 |
| | Total PCDD/PCDF | 966,4 | | |
| Total non-ortho-PCB | 62 | | | |
| Total mono-ortho-PCB | 30762 | | | |
| TEQ (WHO) based on PCDD/F | | | 25,882 | |
| TEQ (WHO) based on PCB | | | 10,651 | |
| TEQ (WHO) | | | 36,533 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (), n.a. = not analysed, Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computerroundings

| PCDD/PCDF and PCB in Human Serum | | | | |
|--------------------------------------|-----------------------------|-----------|------------------------------------|-----------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-05-0195 | | 42 | Date: 4/20/04, approximately 40 ml | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2,3,7,8-Tetra-CDD | 1,6 | 1,000 | 1,594 |
| | 1,2,3,7,8-Penta-CDD | 2,9 | 1,000 | 2,922 |
| | 1,2,3,4,7,8-Hexa-CDD | 2,8 | 0,100 | 0,282 |
| | 1,2,3,6,7,8-Hexa-CDD | 14,5 | 0,100 | 1,447 |
| | 1,2,3,7,8,9-Hexa-CDD | 3,3 | 0,100 | 0,335 |
| | 1,2,3,4,6,7,8-Hepta-CDD | 21,6 | 0,010 | 0,216 |
| | OCDD | 202,4 | 0,0001 | 0,020 |
| PCDF | 2,3,7,8-Tetra-CDF | 2,2 | 0,100 | 0,219 |
| | 1,2,3,7,8-Penta-CDF | 1,3 | 0,050 | 0,067 |
| | 2,3,4,7,8-Penta-CDF | 3,8 | 0,500 | 1,893 |
| | 1,2,3,4,7,8-Hexa-CDF | 5,4 | 0,100 | 0,536 |
| | 1,2,3,6,7,8-Hexa-CDF | 4,0 | 0,100 | 0,397 |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (1,0) |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - (1,7) |
| | 1,2,3,4,6,7,8-Hepta-CDF | 3,8 | 0,010 | 0,038 |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (1,0) |
| | OCDF | n.d. | 0,0001 | - (2,6) |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (17) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (2) |
| | 3,3',4,4',5-PeCB (126) | 6 | 0,1000 | 0,590 |
| | 3,3',4,4',5,5'-HxCB (169) | 4 | 0,0100 | 0,043 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 447 | 0,0001 | 0,045 |
| | 2,3,4,4',5-PeCB (114) | 194 | 0,0005 | 0,097 |
| | 2,3',4,4',5-PeCB (118) | 2417 | 0,0001 | 0,242 |
| | 2',3,4,4',5-PeCB (123) | 52 | 0,0001 | 0,005 |
| | 2,3,3',4,4',5-HxCB (156) | 978 | 0,0005 | 0,489 |
| | 2,3,3',4,4',5'-HxCB (157) | 212 | 0,0005 | 0,106 |
| | 2,3',4,4',5,5'-HxCB (167) | 282 | 0,00001 | 0,003 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 71 | 0,0001 | 0,007 |
| | Total PCDD/PCDF | 269,6 | | |
| | Total non-ortho-PCB | 10 | | |
| Total mono-ortho-PCB | 4653 | | | |
| TEQ (WHO) based on PCDD/F | | | 9,966 | |
| TEQ (WHO) based on PCB | | | 1,626 | |
| TEQ (WHO) | | | 11,592 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (), n.a. = not analysed, Values with < contributes with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computerroundings

| PCDD/PCDF and PCB in Human Serum | | | | |
|--------------------------------------|-----------------------------|-----------|------------------------------------|-----------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-05-0196 | | 43 | Date: 4/18/04, approximately 30 ml | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2,3,7,8-Tetra-CDD | 2,7 | 1,000 | 2,673 |
| | 1,2,3,7,8-Penta-CDD | 6,9 | 1,000 | 6,877 |
| | 1,2,3,4,7,8-Hexa-CDD | 5,8 | 0,100 | 0,579 |
| | 1,2,3,6,7,8-Hexa-CDD | 37,9 | 0,100 | 3,790 |
| | 1,2,3,7,8,9-Hexa-CDD | 6,6 | 0,100 | 0,658 |
| | 1,2,3,4,6,7,8-Hepta-CDD | 45,5 | 0,010 | 0,455 |
| | OCDD | 393,8 | 0,0001 | 0,039 |
| PCDF | 2,3,7,8-Tetra-CDF | n.d. | 0,100 | - (1,0) |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - (1,0) |
| | 2,3,4,7,8-Penta-CDF | 2,8 | 0,500 | 1,399 |
| | 1,2,3,4,7,8-Hexa-CDF | 5,5 | 0,100 | 0,552 |
| | 1,2,3,6,7,8-Hexa-CDF | 3,1 | 0,100 | 0,307 |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (1,0) |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - (1,5) |
| | 1,2,3,4,6,7,8-Hepta-CDF | 3,0 | 0,010 | 0,030 |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (1,0) |
| | OCDF | n.d. | 0,0001 | - (2,4) |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (16) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (2) |
| | 3,3',4,4',5-PeCB (126) | 34 | 0,1000 | 3,355 |
| | 3,3',4,4',5,5'-HxCB (169) | 14 | 0,0100 | 0,137 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 3476 | 0,0001 | 0,348 |
| | 2,3,4,4',5-PeCB (114) | 834 | 0,0005 | 0,417 |
| | 2,3',4,4',5-PeCB (118) | 17806 | 0,0001 | 1,781 |
| | 2',3,4,4',5-PeCB (123) | 190 | 0,0001 | 0,019 |
| | 2,3,3',4,4',5'-HxCB (156) | 5036 | 0,0005 | 2,518 |
| | 2,3,3',4,4',5'-HxCB (157) | 1068 | 0,0005 | 0,534 |
| | 2,3',4,4',5,5'-HxCB (167) | 1625 | 0,00001 | 0,016 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 454 | 0,0001 | 0,045 |
| | Total PCDD/PCDF | 513,6 | | |
| Total non-ortho-PCB | 47 | | | |
| Total mono-ortho-PCB | 30489 | | | |
| TEQ (WHO) based on PCDD/F | | | 17,360 | |
| TEQ (WHO) based on PCB | | | 9,170 | |
| TEQ (WHO) | | | 26,530 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (). n.a. = not analysed. Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computerroundings

| PCDD/PCDF and PCB in Human Serum | | | | | |
|-----------------------------------|-----------------------------|--|-----------|-----------|-----------|
| Values in pg/g (ppt), lipid based | | | | | |
| Analysis-No. H-04-05-0197 | | 44 Date: 4/21/04, approximately 20 ml | | | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD | |
| PCDD | 2.3.7.8-Tetra-CDD | 3,2 | 1,000 | 3,158 | |
| | 1.2.3.7.8-Penta-CDD | 7,4 | 1,000 | 7,378 | |
| | 1.2.3.4.7.8-Hexa-CDD | 9,1 | 0,100 | 0,905 | |
| | 1.2.3.6.7.8-Hexa-CDD | 49,0 | 0,100 | 4,903 | |
| | 1.2.3.7.8.9-Hexa-CDD | 10,3 | 0,100 | 1,029 | |
| | 1.2.3.4.6.7.8-Hepta-CDD | 90,1 | 0,010 | 0,901 | |
| | OCDD | 334,0 | 0,0001 | 0,033 | |
| PCDF | 2.3.7.8-Tetra-CDF | 6,8 | 0,100 | 0,675 | |
| | 1.2.3.7.8-Penta-CDF | 7,5 | 0,050 | 0,376 | |
| | 2.3.4.7.8-Penta-CDF | 12,3 | 0,500 | 6,164 | |
| | 1.2.3.4.7.8-Hexa-CDF | 21,8 | 0,100 | 2,176 | |
| | 1.2.3.6.7.8-Hexa-CDF | 16,3 | 0,100 | 1,634 | |
| | 1.2.3.7.8.9-Hexa-CDF | n.d. | 0,100 | - (1,6) | |
| | 2.3.4.6.7.8-Hexa-CDF | 7,6 | 0,100 | 0,765 | |
| | 1.2.3.4.6.7.8-Hepta-CDF | 16,9 | 0,010 | 0,169 | |
| | 1.2.3.4.7.8.9-Hepta-CDF | n.d. | 0,010 | - (2,4) | |
| | | OCDF | n.d. | 0,0001 | - (2,7) |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (25) | |
| | 3,4,4',5-TCB (81) | 3 | 0,0001 | 0,000 | |
| | 3,3',4,4',5-PeCB (126) | 32 | 0,1000 | 3,192 | |
| | 3,3',4,4',5,5'-HxCB (169) | 23 | 0,0100 | 0,225 | |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 1216 | 0,0001 | 0,122 | |
| | 2,3,4,4',5-PeCB (114) | 597 | 0,0005 | 0,299 | |
| | 2,3',4,4',5-PeCB (118) | 7975 | 0,0001 | 0,797 | |
| | 2',3,4,4',5-PeCB (123) | 92 | 0,0001 | 0,009 | |
| | 2,3,3',4,4',5-HxCB (156) | 4289 | 0,0005 | 2,145 | |
| | 2,3,3',4,4',5'-HxCB (157) | 895 | 0,0005 | 0,447 | |
| | 2,3',4,4',5,5'-HxCB (167) | 1085 | 0,00001 | 0,011 | |
| | 2,3,3',4,4',5,5'-HpCB (189) | 476 | 0,0001 | 0,048 | |
| | | Total PCDD/PCDF | 592,3 | | |
| | Total non-ortho-PCB | 57 | | | |
| | Total mono-ortho-PCB | 16624 | | | |
| | TEQ (WHO) based on PCDD/F | | | 30,266 | |
| | TEQ (WHO) based on PCB | | | 7,295 | |
| | TEQ (WHO) | | | 37,561 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (). n.a. = not analysed, Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computer roundings



| PCDD/PCDF and PCB in Human Serum | | | | | |
|-----------------------------------|-----------------------------|-----------|--|-----------|--|
| Values in pg/g (ppt), lipid based | | | | | |
| Analysis-No. H-04-05-0198 | | | 45 Date: 4/28/04, approximately 20 ml | | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD | |
| PCDD | 2,3,7,8-Tetra-CDD | 2,1 | 1,000 | 2,062 | |
| | 1,2,3,7,8-Penta-CDD | 5,5 | 1,000 | 5,541 | |
| | 1,2,3,4,7,8-Hexa-CDD | 4,8 | 0,100 | 0,477 | |
| | 1,2,3,6,7,8-Hexa-CDD | 54,0 | 0,100 | 5,398 | |
| | 1,2,3,7,8,9-Hexa-CDD | 5,6 | 0,100 | 0,558 | |
| | 1,2,3,4,6,7,8-Hepta-CDD | 29,6 | 0,010 | 0,296 | |
| | OCDD | 242,9 | 0,0001 | 0,024 | |
| PCDF | 2,3,7,8-Tetra-CDF | n.d. | 0,100 | - (1,0) | |
| | 1,2,3,7,8-Penta-CDF | n.d. | 0,050 | - (1,0) | |
| | 2,3,4,7,8-Penta-CDF | 3,3 | 0,500 | 1,668 | |
| | 1,2,3,4,7,8-Hexa-CDF | 6,4 | 0,100 | 0,644 | |
| | 1,2,3,6,7,8-Hexa-CDF | 4,7 | 0,100 | 0,471 | |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (1,2) | |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - (2,4) | |
| | 1,2,3,4,6,7,8-Hepta-CDF | 2,4 | 0,010 | 0,024 | |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (1,7) | |
| OCDF | n.d. | 0,0001 | - (5,0) | | |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (29) | |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (4) | |
| | 3,3',4,4',5-PeCB (126) | 13 | 0,1000 | 1,348 | |
| | 3,3',4,4',5,5'-HxCB (169) | 22 | 0,0100 | 0,221 | |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 1053 | 0,0001 | 0,105 | |
| | 2,3,4,4',5-PeCB (114) | 931 | 0,0005 | 0,466 | |
| | 2,3',4,4',5-PeCB (118) | 5325 | 0,0001 | 0,532 | |
| | 2',3,4,4',5-PeCB (123) | 117 | 0,0001 | 0,012 | |
| | 2,3,3',4,4',5-HxCB (156) | 6226 | 0,0005 | 3,113 | |
| | 2,3,3',4,4',5'-HxCB (157) | 1349 | 0,0005 | 0,675 | |
| | 2,3',4,4',5,5'-HxCB (167) | 814 | 0,00001 | 0,008 | |
| | 2,3,3',4,4',5,5'-HpCB (189) | 589 | 0,0001 | 0,059 | |
| | Total PCDD/PCDF | 361,4 | | | |
| Total non-ortho-PCB | 36 | | | | |
| Total mono-ortho-PCB | 16404 | | | | |
| TEQ (WHO) based on PCDD/F | | | 17,163 | | |
| TEQ (WHO) based on PCB | | | 6,539 | | |
| TEQ (WHO) | | | 23,702 | | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (), n.e. = not analysed, Values with - contribute with 60%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computerroundings

| PCDD/PCDF and PCB in Human Serum | | | | |
|--------------------------------------|-----------------------------|--|---------------|-----------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-05-0199 | | 47 Date: 4/29/04, approximately 15 ml | | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2,3,7,8-Tetra-CDD | 3,2 | 1,000 | 3,233 |
| | 1,2,3,7,8-Penta-CDD | 5,9 | 1,000 | 5,853 |
| | 1,2,3,4,7,8-Hexa-CDD | 8,6 | 0,100 | 0,857 |
| | 1,2,3,6,7,8-Hexa-CDD | 25,1 | 0,100 | 2,509 |
| | 1,2,3,7,8,9-Hexa-CDD | 9,5 | 0,100 | 0,954 |
| | 1,2,3,4,6,7,8-Hepta-CDD | 90,7 | 0,010 | 0,907 |
| | OCDD | 318,9 | 0,0001 | 0,032 |
| PCDF | 2,3,7,8-Tetra-CDF | 5,9 | 0,100 | 0,586 |
| | 1,2,3,7,8-Penta-CDF | 5,7 | 0,050 | 0,284 |
| | 2,3,4,7,8-Penta-CDF | 12,8 | 0,500 | 6,392 |
| | 1,2,3,4,7,8-Hexa-CDF | 21,1 | 0,100 | 2,114 |
| | 1,2,3,6,7,8-Hexa-CDF | 18,6 | 0,100 | 1,862 |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (3,0) |
| | 2,3,4,6,7,8-Hexa-CDF | 8,3 | 0,100 | 0,826 |
| | 1,2,3,4,6,7,8-Hepta-CDF | 32,5 | 0,010 | 0,325 |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (3,5) |
| | OCDF | n.d. | 0,0001 | - (9,7) |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (47) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (6) |
| | 3,3',4,4',5-PeCB (126) | 15 | 0,1000 | 1,545 |
| | 3,3',4,4',5,5'-HxCB (169) | 18 | 0,0100 | 0,180 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 750 | 0,0001 | 0,075 |
| | 2,3,4,4',5-PeCB (114) | 336 | 0,0005 | 0,168 |
| | 2,3',4,4',5-PeCB (118) | 4424 | 0,0001 | 0,442 |
| | 2',3,4,4',5-PeCB (123) | 46 | 0,0001 | 0,005 |
| | 2,3,3',4,4',5-HxCB (156) | 2888 | 0,0005 | 1,444 |
| | 2,3,3',4,4',5'-HxCB (157) | 629 | 0,0005 | 0,314 |
| | 2,3',4,4',5,5'-HxCB (167) | 557 | 0,00001 | 0,006 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 289 | 0,0001 | 0,029 |
| | Total PCDD/PCDF | 566,7 | | |
| | Total non-ortho-PCB | 33 | | |
| Total mono-ortho-PCB | 9917 | | | |
| TEQ (WHO) based on PCDD/F | | | 26,736 | |
| TEQ (WHO) based on PCB | | | 4,207 | |
| TEQ (WHO) | | | 30,943 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (), n.a. = not analysed, Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computer roundings

| PCDD/PCDF and PCB in Human Serum | | | | |
|-----------------------------------|-----------------------------|-----------------|------------------------------|-----------|
| Values in pg/g (ppt), lipid based | | | | |
| Analysis-No. H-04-05-0200 | | 48 | 4/14/04, approximately 30 ml | |
| | Concentration | TEF (WHO) | TEQ (WHO) | LOD |
| PCDD | 2,3,7,8-Tetra-CDD | 4,5 | 1,000 | 4,493 |
| | 1,2,3,7,8-Penta-CDD | 10,9 | 1,000 | 10,863 |
| | 1,2,3,4,7,8-Hexa-CDD | 9,9 | 0,100 | 0,992 |
| | 1,2,3,6,7,8-Hexa-CDD | 65,1 | 0,100 | 6,508 |
| | 1,2,3,7,8,9-Hexa-CDD | 11,4 | 0,100 | 1,139 |
| | 1,2,3,4,6,7,8-Hepta-CDD | 66,8 | 0,010 | 0,668 |
| | OCDD | 447,3 | 0,0001 | 0,045 |
| PCDF | 2,3,7,8-Tetra-CDF | 1,9 | 0,100 | 0,193 |
| | 1,2,3,7,8-Penta-CDF | 1,6 | 0,050 | 0,079 |
| | 2,3,4,7,8-Penta-CDF | 5,3 | 0,500 | 2,643 |
| | 1,2,3,4,7,8-Hexa-CDF | 10,1 | 0,100 | 1,006 |
| | 1,2,3,6,7,8-Hexa-CDF | 8,8 | 0,100 | 0,883 |
| | 1,2,3,7,8,9-Hexa-CDF | n.d. | 0,100 | - (1,2) |
| | 2,3,4,6,7,8-Hexa-CDF | n.d. | 0,100 | - (3,7) |
| | 1,2,3,4,6,7,8-Hepta-CDF | 10,8 | 0,010 | 0,108 |
| | 1,2,3,4,7,8,9-Hepta-CDF | n.d. | 0,010 | - (1,8) |
| | OCDF | n.d. | 0,0001 | - (4,7) |
| non-ortho PCB | 3,3',4,4'-TCB (77) | n.d. | 0,0001 | - (32) |
| | 3,4,4',5-TCB (81) | n.d. | 0,0001 | - (4) |
| | 3,3',4,4',5-PeCB (126) | 20 | 0,1000 | 2,008 |
| | 3,3',4,4',5,5'-HxCB (169) | 28 | 0,0100 | 0,279 |
| mono-ortho PCB | 2,3,3',4,4'-PeCB (105) | 1831 | 0,0001 | 0,183 |
| | 2,3,4,4',5-PeCB (114) | 1329 | 0,0005 | 0,665 |
| | 2,3',4,4',5-PeCB (118) | 12235 | 0,0001 | 1,223 |
| | 2',3,4,4',5-PeCB (123) | 119 | 0,0001 | 0,012 |
| | 2,3,3',4,4',5-HxCB (156) | 8140 | 0,0005 | 4,070 |
| | 2,3,3',4,4',5'-HxCB (157) | 1929 | 0,0005 | 0,965 |
| | 2,3',4,4',5,5'-HxCB (167) | 2006 | 0,00001 | 0,020 |
| | 2,3,3',4,4',5,5'-HpCB (189) | 693 | 0,0001 | 0,069 |
| | | Total PCDD/PCDF | 654,3 | |
| | Total non-ortho-PCB | 48 | | |
| | Total mono-ortho-PCB | 28281 | | |
| TEQ (WHO) based on PCDD/F | | | 29,621 | |
| TEQ (WHO) based on PCB | | | 9,494 | |
| TEQ (WHO) | | | 39,115 | |

TEQ, TEF (WHO) = Toxic equivalent / -faktor by WHO for humans & mammals
n.d. = not detected, limit of detection (LOD) in (), n.a. = not analysed, Values with < contribute with 50%
(M) = maximum value, contains possible outside contamination
Small differences on totals result from computer roundings

- End of Report 2004-0413th -

Exhibit 2

**Summary of Dioxin Assays in DeLisle, MS Homes
in ppt
(using WHO 1998 TEFs)**

| Location No. | Soil | House Dust |
|---------------------|-------------|-------------------|
| 01 | 0.1 | 537 |
| 02 | NA | 3.2 |
| 03 | 0.5 | 170 |
| 04 | 6.2 | 189 |
| 05 | 5.0 | 82 |
| 06 | 0.2 | 42 |
| 07 | 4.3 | 178 |
| 08 | 0.9 | 51 |
| 09 | 1.3 | 56 |
| 10 | 1.9 | 93 |
| 11 | 0.1 | 128 |
| 12 | 0.2 | 5.1 |
| 13 | 0.1 | 13 |
| 14 | 1.1 | 150 |
| 15 | 5.3 | 24 |
| 16 | 1.6 | 79 |
| 17 | 8.2 | 69 |
| 18 | NA | 68 |
| 19 | NA | 110 |

For values from non-shaded entries:

SOILS (n = 14) – mean: 2.6, std. dev.: 2.6, 95% C.I.: 1.1-4.2

HOUSE DUSTS (n = 16) – mean: 127, std. dev.: 121, 95% C.I.: 62-191

Exhibit 3

Revised 12/16/04

**PREPUBLICATION DOCUMENT
DO NOT CITE OR DISTRIBUTE**

Background Dioxins in House Dusts

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Abstract - The levels of dioxins in house dusts are frequently associated with household exposures to emissions from incinerators, industrial stacks and other sources. Although the U.S. EPA has studied air, soil and water dioxin concentrations in locations considered as "unpolluted" background, comparable information for house dusts has been limited to studies outside the United States. The present study reports house dust dioxin concentrations in Columbia, Marion County, Mississippi, an area believed to be suitable for "unpolluted" dust background data. Results indicate an average TEQ for 14 samples of 20.3ppt, based on WHO 1998 TEF values.

Keywords - background, dioxins, house dust

INTRODUCTION

The health impact of airborne dioxins frequently has been associated with dioxin assays of dust samples [Dahlgren 2003, Kumagai 2002]. However, these studies have typically focused on the health risks posed by existing "dust loading", i.e., on the amounts of dioxins in dust from a measured surface area, without measurement of the amount of dust. Unfortunately, this method cannot distinguish between a small quantity of dust with a very high dioxin concentration and a large quantity of dust with a low dioxin concentration. Thus, such data are necessarily limited to estimations of health risks and cleanup needs based on current and future exposure to the existing dust. The largest example of such assessments is the study of dusts from the World Trade Center disaster (www.epa.gov/wtc/bga_attacha.pdf), for which the U.S. EPA utilized

mathematical models for risk factors such as skin-to-mouth dust transfer or inhalation of resuspended dust.

Without an assay of the concentration of dioxins in the dust it is impossible to estimate the health risk from prior inhalation and/or ingestion of airborne dioxins during the period in which the dust was being deposited, or for ongoing exposures to continuing dioxin sources. For persons exposed to short-term, high levels of contaminated air, dust loadings taken months later will fail to assess acute exposures. For persons having been, or continuing to be, exposed over long periods of time to airborne dioxins, the chronic health risks may be very much greater than would be estimated from considerations of only the future risks from dust loading factor analysis. Accordingly, any risk assessment other than that limited to current and future risk from existing dust must take into account the concentration of contaminant in the dust.

Since dust depositions are related to air concentrations [Lorber 2002, Hiester 2004], although not by a simple proportionality because of particle size effects on deposition rates and other contributors to dust composition, it is useful to have dust dioxin comparison concentrations from unpolluted areas. The U.S. EPA has studied air, soil and water levels in locations considered as "unpolluted" background [<http://cfpub2.epa.gov/ncea/cfm/part1and2.cfm>], but comparable information for house dusts has been limited to studies in Germany [Wittsiepe 1997] and Japan [Saito 2003], except for a very small set of Canadian data [Berry 1993].

Wittsiepe's report of "background" dust levels in Germany (n = 10, range 7.83-332 ppt, mean: 101ppt, using I-TEQ TEFs) cannot be compared directly with Saito's report of dusts in rural Japan (n = 10, range: 4.3-25.8, mean: 13.5, using WHO 98 TEFs) because of the differences in TEF values between I-TEQ and WHO 98 with respect to certain congeners [Van den Berg 1998], and the absence of complete congener profile data in the German report. The Canadian study, with only two house dust samples from vacuum cleaner bags (8.3 and 12 ppt I-TEQ) lacks sufficient information to provide a reliable background estimate.

It is unlikely that Wittsiepe's data are typical of U.S. house dust background since only the smaller particulate fraction (< 2.0 mm) of the dust was assayed, and - more importantly - since most of the samples (9 of 10) were collected in the urban and industrial Ruhr district, an area of Germany known to have high dioxin contamination [Hohn 1995].

The Japanese data also fail to reflect U.S. backgrounds for total house dusts, since the Japanese samples would typically fail to include "track in" dust similar to that in most American homes. Thus, although Saito's group also assayed only the smaller particulates (0.75µm - 1.0mm), which would normally yield higher concentrations than total particulates, the Japanese

custom of removing shoes when entering a home must necessarily have made the collected dusts different from typical American dusts. Household dusts in U.S. areas of low (background) airborne dioxins would normally reflect a major component of "track-in" dust.

In order to provide background data more representative of unpolluted areas in the United States, samples were collected from homes in Columbia, Marion County, Mississippi, a small community several miles distant from any identified industrial sources of dioxins, and a community in which open burning of trash is banned. Homes were selected on the basis that they either contained no fireplaces or wood-burning stoves or, if such were present, no chemically-treated wood had been burned.

Columbia, Mississippi was selected as a reasonable location for house dusts unpolluted by airborne dioxins on the basis of the following criteria:

- a) The community had been studied in the past for dioxin residues from a 1977 fire at a wood products plant, and the U.S. EPA determined in 1999 that the area was no longer significantly contaminated [www.epa.gov/region4/waste/npl/nplms/newsomms.htm].
- b) The city ordinances forbid the open burning of trash, a known source of airborne dioxins.
- c) The Environmental Defense Fund "Scorecard" [www.scorecard.org] listing of the top 25 emitters of dioxin and dioxin-like compounds in Mississippi shows no source closer than 29 miles (at Purvis, MS), and shows that Marion County, MS is not among the top 25 Mississippi counties for either PM-10 or Volatile Organic Compound emissions.
- d) Toxic Release Inventory (TRI) reports [www.rtknet.org/tri] for Marion County, MS contain no dioxin releases, nor are the industries identified in those reports of the types typically expected to generate significant dioxin releases [www.epa.gov/ncea/pdfs/dioxin/part3/chapter1-6.pdf].
- e) Rural Mississippi has one of the lowest concentrations of dioxin WHO 98 TEQ in the National Dioxin Air Monitoring Network (NDAMN) [Cleverly 2004].
- f) Columbia has a population of about 7,000 in a county of only about 25,000, so general household contributions to airborne dioxins are minimal.

MATERIALS AND METHODS

Sample Collection and Selection

Samples were collected by personnel from Aqua-Tech Laboratories, Inc., Bryan, Texas, using protocols consistent with U.S. EPA SOP# 2011 (Chip, Wipe, and Sweep Sampling, 11/16/94).

Two types of samples were collected, carpet dusts from home vacuum cleaners and general household dusts from *Shark*TM hand-held vacuum cleaners [www.sharkvac.com]. The latter uses a HEPA dust cup filter capable of trapping 99.97% of particles above 0.3 μ m aerodynamic mean diameter.

The dust from carpet vacuum cleaners was removed by cutting the vacuum cleaner bag with a pre-cleaned box cutter and transferring the sample to a 9oz. certified precleaned glass jar. New box cutters were used at each location to avoid any possibility of cross-contamination.

Separate *Shark*TM hand-held vacuum cleaners were used at each location to avoid any cross-contamination. Field blanks run by using both dry and wet (methylene chloride) wipes of the filter and nose cones revealed residual dioxins of only HpCDD (7.39 ng/Kg) and OCDD (32.97 ng/Kg) for the dry wipe and only OCDD (121.81 ng/Kg) for the wet wipe. The *Shark*TM units were used to collect general house dust from rarely-cleaned areas such as the tops of ceiling fans and behind and under large furniture. The filter cartridges were sealed in certified precleaned glass jars.

Sampling personnel wore hooded Ty-Vac suits, gloves, goggles and dust masks. Suits and other gear were placed in trash bags after leaving each residence to avoid any possibility of cross-contamination.

All samples were refrigerated by the sampling team and hand delivered, along with proper chain-of-custody documentation, to Columbia Analytical Services, Inc. in Houston, Texas.

At the time of sample collection, detailed questionnaires were completed for each household, and further telephone questionnaires were subsequently used, to determine if any of the collected samples might have been contaminated by materials such as carpet powders or household sprays that might have affected dioxin concentrations. Samples were also examined visually for evidence of significant amounts of sand or carpet powder that would have skewed the dioxin results low. A total of 34 dust samples were collected from 18 homes. Of these, 20 samples were discarded as contaminated by sand, carpet powders, or household sprays.

PCDD/PCDF Assays

The remaining 14 samples were assayed for polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/PCDF) by Columbia Analytical Services, Houston, Texas, using GC/MS by EPA method 8290. Cleanup of sample extracts used silica gel and activated carbon. All holding times were met for both sample preparation and sample analysis. Method blanks, lab control spikes, and lab control spike duplicates were used, and contract-required limits for percent recovery of 40-135% were met, all as set forth in Method 8290.

RESULTS

The results are summarized in Table 1, with *Shark*TM vacuum units indicated by "S" and home vacuum cleaners indicated by "H". Results from the two collection methods were comparable, as expected from previous studies [Colt 1998].

The average WHO 98 TEQ value for the 14 samples was 20.3ppt (standard deviation: 18.4, range: 1.30-53.7). Homes with fireplaces that did not use treated wood had dioxin backgrounds (average: 21.2ppt, range: 1.30-53.7ppt) comparable to, and not much higher than, the homes where no wood was burned (average: 19.2, range: 2.80-48.5).

None of the samples contained a detectable concentration of tetrachlorodibenzo-p-dioxin. The congener profiles of the 14 samples are summarized in Table 2.

DISCUSSION

The results appear to be reasonable as reflective of background dioxin levels in U.S. homes, suggesting that dust dioxin concentrations significantly higher than 20ppt may indicate increased health risks. The difference between measured dust contaminant concentrations and background concentrations may help to identify contaminant sources, but the total concentrations must be considered in assessing health risks [Smith 1996].

It is important to recognize that there are two levels of risk assessment associated with concentrations of toxins in house dusts. Certainly the existing methodology for assessing health risk from continuing exposure to existing dusts is critical to a determination of cleanup needs. However, of equal, and in some cases greater, importance is recognition of the fact that house dust contamination may be important evidence of past or ongoing exposures to airborne toxins. A prime example is the U.S. EPA assessment of dioxins in house dusts months after the World Trade Center disaster, when the dioxin concentrations would have been significantly diluted by subsequent "clean" dust deposition. Such an analysis is certainly useful in determining whether

or not dust cleanup is needed, but it totally fails to address the health risk of persons inhaling very high levels of dioxins during exposure to the dust clouds released during the disaster.

Similarly, an assessment of dioxins in houses exposed for many years to smoke from wood treatment plants burning pentachlorophenol-treated wood scrap, a few years after the practice had stopped, would assist in cleanup decisions, but would significantly underestimate the health risk from chronic past exposure to such smoke.

Proper risk assessment in such cases would need, in addition to dust concentration data, information on dust loadings (for assessment of cleanup requirements, if any) and information on past, present, and future exposure levels and exposure times, if the risk assessment is to take into account all of the critical factors associated with chronic or acute exposures. Thus, a comparison with the background data is a first step in identifying a location for which a complex and detailed risk assessment is warranted.

Further research is needed to develop good methodology for exposure reconstruction in cases for which analysis of current dust composition can only provide a piece of what is invariably a complex puzzle.

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Table 1 – PCDD/PCDF (ppt) Content of Background House Dusts

| <u>Sample ID</u> | <u>Collector</u> | <u>Wt.(g)</u> | <u>Fireplace</u> | <u>WHO 98 TEQ</u> |
|------------------|------------------|---------------|------------------|-------------------|
| CMS 01 | H | 11.2 | no | 7.7 |
| CMS 02 | H | 4.0 | no | 8.4 |
| CMS 03 | H | 11.4 | yes | 1.3 |
| CMS 04 | H | 11.6 | yes | 2.9 |
| CMS 05 | H | 10.5 | yes | 22.8 |
| CMS 06 | H | 10.7 | yes | 14.1 |
| CMS 07 | S | 3.0 | no | 48.5 |
| CMS 08 | S | 2.3 | no | 2.8 |
| CMS 09 | S | 2.0 | no | 8.2 |
| CMS 10 | S | 1.1 | no | 39.9 |
| CMS 11 | S | 4.9 | yes | 6.2 |
| CMS 12 | S | 4.2 | yes | 53.7 |
| CMS 13 | S | 1.0 | yes | 41.2 |
| CMS 14 | S | 3.5 | yes | 27.5 |

Table 2 – Congener Distribution (ppt) in 14 Samples of Background House Dusts

| <u>Congener</u> | <u>Mean</u> | <u>Std. Dev.</u> | <u>Range</u> | <u>P95 Max</u> | <u>MRL</u> |
|---------------------|-------------|------------------|--------------|----------------|------------|
| 2,3,7,8-TCDD | ND | - | - | - | 1.0 |
| 1,2,3,7,8-PeCDD | 1.62 | 2.86 | ND-10.5 | 3.27 | 2.5 |
| 1,2,3,4,7,8-HxCDD | 2.87 | 4.32 | ND-10.9 | 5.37 | 2.5 |
| 1,2,3,6,7,8-HxCDD | 26.2 | 33.0 | ND-119 | 45.2 | 2.5 |
| 1,2,3,7,8,9-HxCDD | 5.50 | 12.4 | ND-41.4 | 12.6 | 2.5 |
| 1,2,3,4,6,7,8-HpCDD | 661 | 616 | 105-2,050 | 1,020 | 2.5 |
| OCDD | 6,010 | 4,550 | 1,070-25,500 | 9,690 | 5.0 |
| 2,3,7,8-TCDF | 12.1 | 11.1 | ND-29.7 | 18.5 | 1.0 |
| 1,2,3,7,8-PeCDF | 1.57 | 4.15 | ND-15.1 | 3.97 | 2.5 |
| 2,3,4,7,8-PeCDF | 3.80 | 5.58 | ND-15.6 | 7.02 | 2.5 |
| 1,2,3,4,7,8-HxCDF | 15.3 | 21.4 | ND-60.1 | 27.7 | 2.5 |
| 1,2,3,6,7,8-HxCDF | 6.63 | 8.42 | ND-25.5 | 11.5 | 2.5 |
| 2,3,4,6,7,8-HxCDF | 10.5 | 15.9 | ND-46.8 | 19.7 | 2.5 |
| 1,2,3,7,8,9-HxCDF | 0.16 | 0.59 | ND-2.20 | 0.50 | 2.5 |
| 1,2,3,4,6,7,8-HpCDF | 161 | 171 | 13.3-585 | 259 | 2.5 |
| 1,2,3,4,7,8,9-HpCDF | 0.38 | 1.44 | ND-5.38 | 1.21 | 2.5 |
| OCDF | 214 | 233 | ND-676 | 348 | 5.0 |

MRL = minimum reporting limit; ND = not detected

Disclaimer:

Parts of this work were funded by Baron & Budd, P.C., Dallas, Texas, having no direction or control over the content of this article, which is the sole responsibility of the author.

OCONN.004715

Exhibit 4

DIOXIN AND HEAVY-METAL CONTAMINATION OF SHELLFISH AND SEDIMENTS IN ST. LOUIS BAY, MISSISSIPPI AND ADJACENT MARINE WATERS

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ABSTRACT Dioxins, furans, and trace metals were evaluated in shellfish and sediments from St. Louis Bay, Mississippi and adjacent waters of Mississippi Sound. Highest concentrations and the most toxic dioxin congener were found in St. Louis Bay sediments in closest proximity to the effluent outfall from the titanium dioxide refinery on the northern shore of the bay. Using conservative assumptions, we estimated the dioxin and furan burden of 17 measured congeners in St. Louis Bay sediments to be between 3.72 and 6.16 kg. Comparison of lipid-adjusted dioxins and furans in oysters (*Crassostrea virginica*) from this study with those collected from seafood markets and grocery stores in southern Mississippi in 1997 shows dioxin and furan contamination about 1.7 to 8 times higher in the samples from this study, depending on collection location. Oysters from St. Louis Bay and adjacent marine waters may accumulate higher concentrations of dioxins and furans than measured here, at other times during the year, due to the low lipid content of oysters in this single-season study. At other times, with typical higher oyster lipid levels, the dioxin content of oysters could increase by a factor of 8.5 to 12.7 times, commensurate with the expected increase in oyster lipids, although the rate of uptake of these contaminants is not known. Certain trace metals have increased markedly in St. Louis Bay shellfish since a 1978 baseline study that was conducted prior to the operation of the titanium dioxide refinery that produces large quantities of soluble waste metals such as chromium, nickel, and lead. In 2004, the percent value of chromium in oysters in St. Louis Bay was at least 1,167% greater than the 1978 values, and the percent value for nickel in oysters in the bay was at least 467% greater than the 1978 value. The percent value for chromium in 2004 from oysters outside the bay was between 7,700% and 11,300% greater than the 1978 reported in bay values. Rangia clams (*Rangia cuneata*) from St. Louis Bay tended to have greater increases than did oysters for all metals measured above detection limits in both studies, except for zinc, which declined in both shellfish species. Metals also increased in sediments, but soluble metals which are produced by, and apparently released from, the titanium dioxide refinery may be flushed out of the bay to higher salinity seawater before becoming adsorbed on fine silt and clay-size particles which are consumed by shellfish and/or deposited in sediments. Oysters from waters near the mouth of St. Louis Bay were also contaminated with dioxins, furans, and heavy metals. Based on widely published estimated safe and adequate daily dietary intake for chromium and nickel (the latter standard for hypersensitive individuals) the values recorded in this study indicate that less than one oyster per day should be consumed from the open harvest site sampled in adjacent Mississippi Sound. An evaluation of other regional sources of dioxin and dioxin-like compounds and heavy metals was conducted using data reported to the United States Environmental Protection Agency. Because of the lack of other identifiable large sources of these contaminants, the transport dynamics of soluble metals and the occurrence of highest dioxin and dioxin-like compound concentrations near the titanium dioxide refinery outfall, we conclude that the refinery is the most likely and most significant source of the measured dioxins, dioxin-like compounds, chromium, and nickel contamination found in St. Louis Bay and adjacent marine waters of Mississippi Sound.

KEY WORDS: dioxin, furan, trace metals, chromium, nickel, St. Louis Bay, oysters

INTRODUCTION

St. Louis Bay is a 3,860-ha elliptical-shaped, shallow embayment with a narrow entry to the western end of Mississippi Sound (Fig. 1). The bay receives freshwater input from 2 primary rivers, the Jourdan and the Wolf, and, according to a 1978 study (Lytle & Lytle 1982), suffered the least of all bays along the Mississippi coast from sources of anthropogenic pollutants. The study of Lytle and Lytle (1982) was part of a characterization of St. Louis Bay because of concerns about potential pollution resulting from the future placement and operation of a titanium dioxide refinery near the northern shore of the bay in 1979. The refinery is reported to produce quantities of dioxins, furans, PCBs, and heavy metal by-products as well as other hazardous chemicals, based on the refinery's annual reporting requirements to the United States Environmental Protection Agency's Toxic Release Inventory (TRI) (USEPA 2003). Such by-products are injected into ground wells

on the site, disposed of at on-site landfills, released as point source air emissions, fugitive air emissions, and surface water discharges according to the reporting data. There is an effluent pipe from the refinery, labeled as a sewer pipe on National Oceanic and Atmospheric Administration (NOAA) nautical charts 11371 and 11372A (NOAA 2001; NOAA 2004), located on the northern shore of St. Louis Bay, and releases from this pipe may constitute a portion of the reported surface-water discharges. In addition, airborne emissions from the refinery could be deposited, in part, by settling into the marine waters of St. Louis Bay, surrounding tidal marshes and the adjacent Mississippi Sound.

Based on the reported chemical production in close proximity to St. Louis Bay, the potential for release of a portion of the chemicals and their entry into the bay ecosystem and adjacent offshore marine waters, and the availability of the baseline study, we undertook the current study to assess the degree of contamination of marine shellfish and sediments in the bay and adjacent offshore waters of Mississippi Sound in the summer of 2004.

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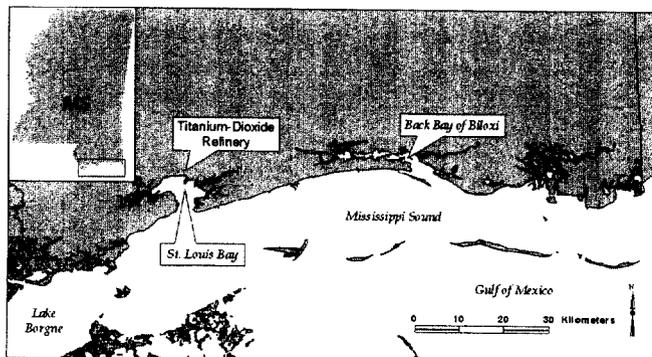


Figure 1. St. Louis Bay, Mississippi location map.

MATERIALS AND METHODS

Field Collection of Samples

Sediment and shellfish collections were made on July 11 and 12, 2004, from a 15.2-m length (50 foot) oyster dredging vessel, the F/V *Nova Star*, fitted with a 16 tooth oyster dredge weighing about 265 kg, known as a Mississippi dredge. Samples were collected under permit from the Mississippi Department of Marine Resources inside St. Louis Bay, between US Highway 90 and the CSX railroad bridges at the mouth of the bay and in adjacent waters of Mississippi Sound outside of St. Louis Bay at the locations shown in Figure 2 and Figure 4 (see Fig. 4 later in text).

A GPS (global positioning system) receiver (Garmin GPSMAP 76, WAAS-enabled) was used onboard the sampling vessel for tracking the sampling vessel's path and marking sediment sampling station waypoints. The receiver was mounted vertically on the bow of the vessel, as far as possible from all other electronics, to increase accuracy and reduce any possible interference. Observed accuracy was approximately 3.0 m. Track locations and time were automatically recorded about once per minute along all oyster-collection trawls. Waypoints and collection time were manually saved at appropriate locations. Tracks and waypoints were downloaded to a computer for plotting on digital versions of NOAA nautical charts 11371 and 11372A using GIS software. Start and stop endpoints of the shellfish dredges were also noted by hand recording and cross referenced to locations recorded by a separate GPS system used on board the sampling vessel.

The surface area of St. Louis Bay, north of the US Highway 90 bridge, south of Interstate Highway 10, including the adjacent tidal marshlands, was estimated using ArcView GIS software (ESRI, Redlands, California).

Sediments collected in July 2004 were compared with samples that had earlier been analyzed as part of a 1984 Mississippi-Alabama SEA GRANT investigation. The 1984 study (see Isphording, 1985) encompassed the entire Mississippi Sound, as well as all adjacent bays (as well as Lake Borgne, Louisiana). A total of 109 2-meter vibracores were collected, 6 of which were obtained in St. Louis Bay. Each was subjected to mineralogic analysis to determine the mineralogy of the clay-size ($-4 \mu\text{m}$) fraction, using x-ray diffraction, chemical analysis, using a Perkin-Elmer Model 6500 ICP spectrophotometer, carbon analysis, using a LECO carbon-sulphur analyzer, and sediment texture analysis. A bottom sediment texture map of the Mississippi Sound was constructed by carrying out size analyses on the upper 10-cm portion of each core using ASTM method D 422-63 (also used in the

present study). The size frequency distribution of each sediment sample was obtained and also a complete description of the measures of central tendency and dispersion. The same computer algorithm used to analyze the 1984 samples was similarly used to process sediment data for the July 2004 samples in order that meaningful comparisons could be made.

Shellfish Collection and Handling

Shellfish collected with the Mississippi dredge on or close to the substrate surface were brought on board and rinsed clean of visible sediments using ambient water at the end of each dredge collection. The objective was to collect American oysters (*Crasostrea virginica*, Gmelin 1791), but at a few locations incidental collections of common Rangia clams (*Rangia cuneata* G. B. Sowerby I, 1831) and hooked mussels (*Ischadium recurvum* Rafinesque 1820) were made. The shellfish were blotted dry and packed in aluminum foil (precleaned by treatment in a muffle oven for a minimum of 3 h at a minimum temperature of 450°C) and then packed inside plastic bags. The shellfish were cooled in heavily insulated containers with frozen ice packs. At the end of each sampling day, small amounts of dry ice were added to the samples and a programmed temperature recorder (Optic Stowaway Temp, Onset Computer Corp., Bourne, Massachusetts) was added to each container. All samples were shipped to the processing laboratory in Sequim, Washington by overnight courier on July 13, 2004, for delivery on July 14. Temperature was maintained between 1°C and 4°C in all containers. All samples were assigned a predetermined sample number and entered into a chain of custody logging system. The shellfish sample collection locations are shown in Figure 2 and Figure 3 and labeled in numerical order as collected. Some numerical sample designations were subdivided into sequential alphabetical designations (e.g., 7A and 7B) representing two or more dredge samples with a given sample number. Start and end points are labeled S and E, respectively. All sample transfers were accompanied by chain-of-custody documentation.

After processing, samples for dioxin and furan analysis were

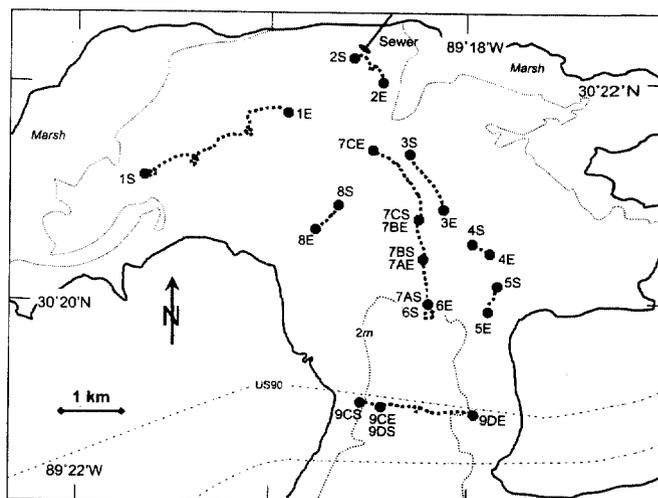


Figure 2. Shellfish collection tracks inside St. Louis Bay, Mississippi. Map adapted from NOAA nautical chart number 11372A. Tracks are shown in numeric and alphanumeric order with start points of the shellfish dredge tracks labeled with an S and end points labeled with an E. The sewer is the outfall from the dioxin titanium refinery shown in the referenced NOAA chart.

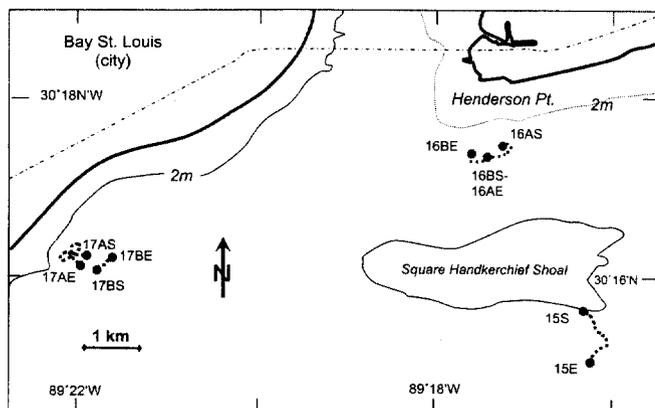


Figure 3. Shellfish collection tracks south of and adjacent to St. Louis Bay, Mississippi. The mouth of St. Louis Bay is shown at the top center of the map. Map adapted from NOAA nautical chart number 11371. Tracks are shown in numeric and alphanumeric order with start points of the shellfish dredge tracks labeled with an S and end points labeled with an E.

submitted to the analytical laboratory on July 19, 2004. Additional oysters from most collection sites were stored frozen and whole at the processing laboratory at -20°C for later possible analysis. Samples for metals analysis were submitted to the analytical laboratories between September 3 and October 27, 2004. Samples were collected according to protocols acceptable for both dioxin and metals analysis, as referenced in the following methods, but as an added precaution, control oysters from a non-industrialized site in Puget Sound, Washington were also processed using part or all of the dioxin-preparation procedure to verify that no artifact from the dioxin sample preparation process would affect the metals analysis.

Sediment Collection and Handling

Sediments were collected with a Petite Ponar grab sampler, precleaned with Alconox Laboratory Detergent (Alconox Corp., White Plains, New York). Each sediment sample was removed from the grab sampler using individually prepared nonmagnetic, noncorrosive stainless-steel sediment spoons wrapped in aluminum foil and precleaned by washing in laboratory detergent and heating as described previously. Samples were placed into certified precleaned 4 ounce (118.4 ml) amber glass sampling jars (Environmental Sampling Supply [ESS], Oakland, California) according to a method validated for collection of both organic contaminant and metals sample collection (PSEP 1997). Sediment was stored and shipped to the laboratory as described for shellfish samples. Sediment blanks were included for a manual reading of temperature in shipping containers using a calibrated thermometer on arrival at the laboratory. Sediment samples were logged and tracked using the chain-of-custody system described for shellfish samples. Sediments from a Puget Sound, Washington site were also handled with and without the sediment spoons used in St. Louis Bay to verify that no artifactual metals were added to the samples that would affect the metals analysis. Sediment samples were taken independently from shellfish samples and labeled from 1 to 13 as shown on Figure 4.

Sediment samples for grain-size analysis and total volatile organic content were removed from the grab sampler while onboard the sampling vessel and placed in freezer bags with paper tracking labels to match exterior marking with waterproof felt-tip pens.

Sample Processing and Storage at Laboratory

Upon receipt at the laboratory, the recorded temperature data from each shipment container were downloaded and examined to ensure that temperature had not exceeded 4°C . Sediment samples were then frozen at -20°C in a non-self-defrosting freezer. Shellfish samples for dioxin and furan analysis were maintained between 0° and 4°C until processing. Shellfish were either archived within their precleaned foil wraps, shucked and archived for metals analysis, or processed for dioxin analysis as follows.

All instruments and glassware for shellfish tissue processing for dioxin and furan analysis were precleaned and recleaned between individual sample processing by scrubbing thoroughly while immersed in Alconox soapy water, then rinsed by immersion and agitation in laboratory $18\text{-M}\Omega$ reagent-grade water, followed by unused rinse water poured over the instruments. The instruments or materials were then rapidly air dried on paper, rinsed with reagent grade 100% absolute methyl alcohol (Certified Analytical Reagent, ACS, USP Reagent), rinsed with dichloromethane (Certified Analytical Reagent, ACS, USP Reagent), and allowed to air dry. A method blank consisting of rinse water was also collected and analyzed.

Each replicate sample of oysters contained between 10 and 20 individuals, except as noted in Table 3 (see Table 3 later in text). Prior to shucking, each oyster was scrubbed with fresh tap water in a laboratory sink and measured for shell "length" the linear distance between the dorsal umbo tip and the ventral shell margin (the morphologic shell height). The oysters were opened on a cleaned surface (Alconox scrubbed and rinsed). The oyster meats did not contact the work surface during preparation and only oysters that were previously tightly closed were selected for analysis. The soft tissues were placed in aluminum weigh "boats" that were cleaned by heating as previously described, to determine individual wet weights.

A section for histological examination was removed and placed in a histological cassette, followed by immersion into fixative. The remaining oyster meat was placed in a cleaned beaker and homogenized to a liquid slurry form using a Pro Scientific (Oxford, Connecticut) 200-series homogenizer with a 20-mm, saw-tooth generator. Depending on the amount of homogenized tissue available, one or two laboratory splits of the samples were then poured into the ESS-certified clean amber-glass jars and the net amount of tissue weighed. Samples were then stored at $<4^{\circ}\text{C}$. Replicates not submitted to the laboratory within 2 days of processing were stored at -20°C .

Shellfish tissues for analytical chemistry analysis were dispatched to the analytical laboratory packed in a solid cooler with labels and matching chain-of-custody forms. Ice packs and a small quantity of dry ice (0.5–1.0 kg) were included within the sample containers. A blank sample for temperature recording upon receipt was included. Samples were sent by overnight courier for dioxin and PCB analysis and hand delivered or sent by courier for metals analysis.

For metals analysis, shellfish were opened using nonmagnetic corrosion-resistant stainless-steel shucking knives, previously validated for handling bivalve tissues used for trace-metals analyses (PSEP 1997; Stephensen et al. 1979). In addition, control oysters from a non-industrialized site were processed and analyzed in an identical manner to ensure that no artifactual metals were added to the samples.

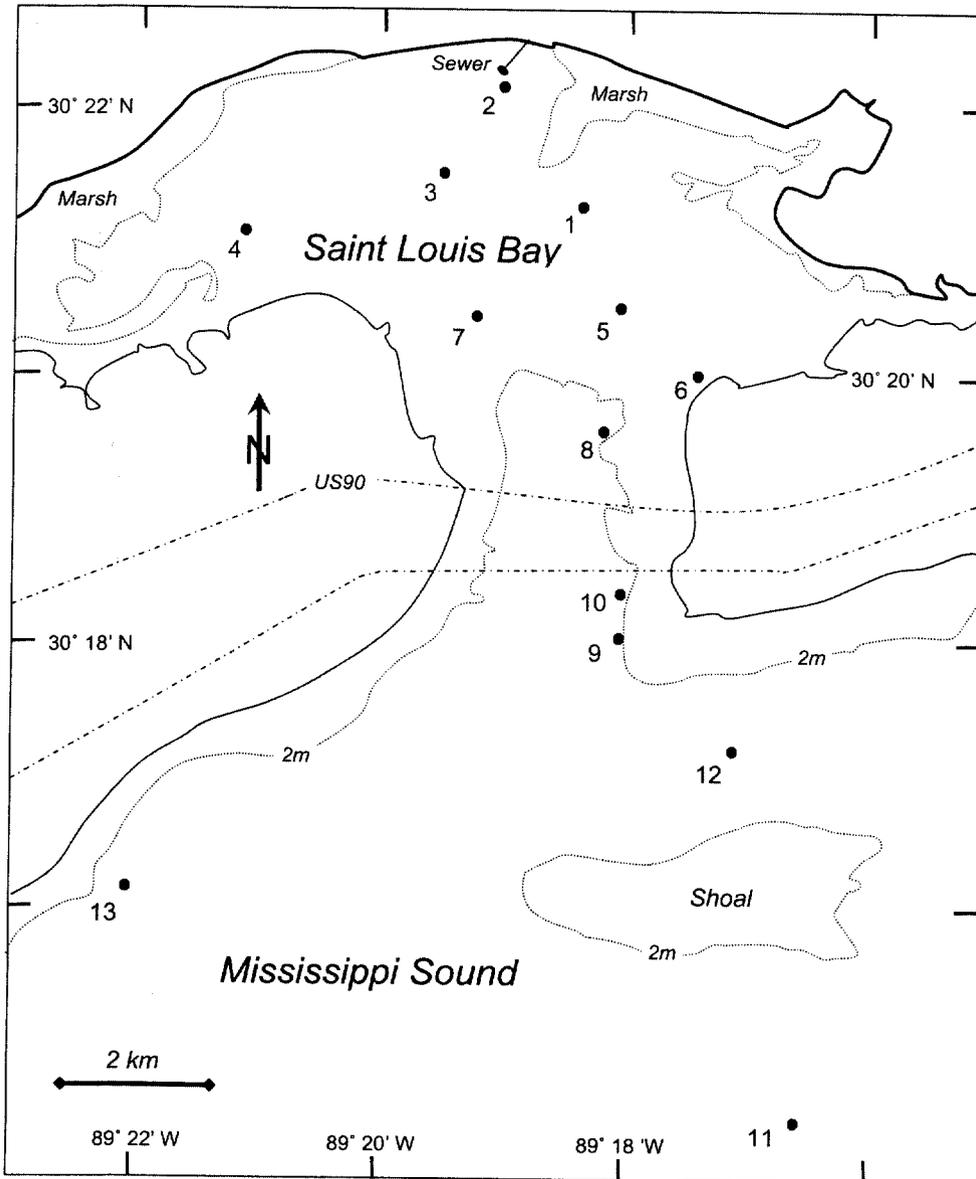


Figure 4. Sediment collection sites within and near St. Louis Bay, Mississippi. Map adapted from NOAA nautical charts 11371 and 11372A. Sediment stations are shown as black circles numbered sequentially from 1 to 13. The sewer is the outfall from the dioxin titanium refinery shown in the referenced NOAA charts.

Chemical Analysis of Shellfish Tissues and Marine Sediments

Dioxin and Furans

Frozen shellfish tissue homogenates and sediments were shipped as described above to Paradigm Analytical Laboratories (Wilmington, North Carolina) for analysis of sample content for 17 dioxin/furan congeners using the United States Environmental Protection Agency method SW846, method 8290 (USEPA 1997).

Polychlorinated Biphenyls

The same sample set used for dioxin and furan analysis was analyzed for polychlorinated biphenyls (PCBs) by Paradigm Analytical Laboratories using the United States Environmental Protection Agency, method 1668A. (USEPA 1999).

Trace Metals

An initial set of sediments and shellfish tissue samples were analyzed for total metals by the Battelle Marine Sciences Laboratory, Sequim, Washington using inductively-coupled, plasma-mass spectrometry (ICP/MS) as the analytical technique (except for mercury) using EPA methods 1638 and 200.8 (USEPA 1996a & 1994, respectively), adapted for analysis of solid-sample digests. Mercury was determined by cold-vapor atomic-absorption spectroscopy (CVAA), based on EPA method 245.5 (USEPA 1991a). For these analyses, samples were freeze dried and homogenized using a ball mill prior to digestion with nitric acid, hydrofluoric acids and peroxide in a Teflon vessel, and heated in an oven at 130°C ($\pm 10^\circ\text{C}$) according to the laboratory standard operating procedure and quality assurance/quality control documentation.

This sample procedure was expected to yield total metals, including those that are bound as crystal silicates.

A second set of sediment and tissue samples were analyzed by the same ICP/MS method (EPA Method 200.8 [USEPA 1994], but were digested using EPA method 3050B (USEPA 1996b) which is not designed to be a total digest for most samples but will dissolve almost all elements that could become environmentally available and is thus comparable to the United States Environmental Protection Agency method used by Lytle and Lytle (1982). These samples were analyzed by Analytical Resources, Tukwila, Washington.

All shellfish were processed whole so that measured metals may have been either incorporated into the tissues or resident in the digestive tracts. This processing represents the potential ingestion exposure of the metals to human consumers because oysters are commonly eaten whole or the entire oyster body is used in preparing the oysters for consumption.

Grain Size-Analysis and Volatile-Organic Content of Sediments

Grain-size analysis and percent volatile solids were determined using methods ASTM D422-63 and EPA 160.4, respectively (ASTM 2003; USEPA 1979). These analyses were performed by Aquatic Research Inc. of Seattle, Washington. Grain size and volatile organics were examined and compared with prior data from St. Louis Bay (Ishphording 1985).

RESULTS

Dioxins and Furans

Dioxin and furan concentrations expressed as toxic equivalencies for shellfish collected in and near St. Louis Bay are shown in Table 1. Toxic equivalencies (TEQs) are expressed as WHO-TEQs (Vanden Berg et al. 1998) and I-TEQs (USEPA 1989), for comparison with a previous evaluation of oysters from southern Mississippi (Fiedler et al. 1997). The set of international toxic equivalency factors (I-TEFs) returns TEQ values that are higher than those derived from using the World Health Organization TEFs due to differing TEF values for three congeners. In addition, the data available from the Fiedler et al. (1997) paper are based on using one half the limit of quantification value ($1/2$ LOQ) for nondetects. The LOQ is defined as 10 times the standard deviation of the average of a series of blank measurements and likely overstates the contribution of non-detects (Jensen & Bolgar 2001). Therefore, our comparison, from data derived using one half detection limit values for non-detects, to the Fiedler et al. (1997) values is a conservative estimate of the difference between the two data sets, because the 1997 values may have been lower than reported if the raw data had been presented as we present our raw data. Congeners measured are shown in Table 2. The shellfish tissue values for data generated in this study were converted to I-TEQs and WHO-TEQs with appropriate TEFs using the EPA-referenced method (USEPA 1989) advising that the common conservative approach for non-detected congeners is to set their value at one-half of the detection limit ($ND = 1/2$).

In addition, the I-TEQs were expressed adjusted for lipid so that they could be compared with the prior study by Fiedler et al. (1997) of dioxins and furans in oysters collected as part of a market-basket assessment of food products from southern Mississippi. Only the specific congener analytes common to both studies were used in the comparison. Table 1 shows that the WHO-TEQ

TABLE 1.
Dioxin toxicity equivalent concentrations for St. Louis Bay,
Mississippi shellfish samples.¹

| Shellfish Sample Tract Number | Percent Lipid | WHO-TEQ (ND = 1/2) [pg/g] ² | I-TEQ (ND = 1/2) [pg/g] ³ | I-TEQ (ND = 1/2) [corrected for lipid] [pg/g] ⁴ |
|---------------------------------------|---------------|--|--------------------------------------|--|
| 1 | 0.35% | 0.581 | 0.579 | 165.544 |
| 2 | 0.55% | 0.444 | 0.838 | 152.407 |
| 3 | 0.35% | 0.376 | 0.868 | 247.866 |
| 4 | 0.70% | 0.381 | 0.379 | 54.147 |
| 5 | 0.66% | 0.412 | 0.413 | 62.505 |
| 6 | 0.53% | 0.395 | 0.400 | 75.474 |
| 7A | 0.54% | 0.378 | 0.364 | 67.429 |
| 7B | 0.71% | 0.463 | 0.451 | 63.568 |
| 7C | 0.60% | 0.382 | 0.379 | 63.118 |
| 8 | 0.34% | 0.348 | 0.330 | 96.995 |
| 9C | 0.46% | 0.335 | 0.364 | 79.124 |
| 9D | 0.64% | 0.337 | 0.352 | 55.038 |
| 15 | 0.58% | 0.312 | 0.294 | 50.627 |
| 16 | 0.46% | 0.327 | 0.334 | 72.654 |
| 17 | 1.07% | 0.405 | 0.391 | 36.561 |
| Average all samples: | | 0.392 | 0.449 | 89.537 |
| Average oysters only (all except #1): | | 0.378 | 0.440 | 84.108 |

¹ Toxicity equivalencies (WHO-TEQ and I-TEQ) calculated using World Health Organization toxic equivalence factors (WHO-TEF, Vanderberg et al. 1997) and International toxic equivalency factors (I-TEF, USEPA 1989), respectively. All values expressed as pg dioxin equivalent per g of shellfish tissue, wet weight. Congeners measured are shown in Table 2.

² Values in this column are calculated using values for non-detects at $1/2$ the detection limit ($ND = 1/2$) (USEPA 1989).

³ Values in this column are given to provide a basis for comparison with Fiedler et al. (1997) who used I-TEF conversion factors and used $1/2$ the limit of quantification for no detect congener values.

⁴ Values in this column are adjusted for lipid, assuming that all dioxins and furans are contained in lipids, and thus represent the calculated concentration using such an assumption. Thus the values in the far right column are comparable to the values published by Fiedler et al. (1997), after adjustment so that only the congeners measured in each study are included in a comparison.

values ($ND = 1/2$) for the 17 congeners of dioxins and furans in oysters (total tissue basis) from within and near St. Louis Bay ranged from 0.312 pg/g to 0.463 pg/g wet tissue weight with an average value of 0.378 pg/g. Rangia clams collected from shellfish collection track 1 had a higher WHO-TEQ of 0.581 pg/gm. Oysters from inside the bay only (collection tracks 2 to 8) had an average WHO-TEQ of 0.398 pg/g and oysters collected from open harvest sites between the highway and railroad bridges at the mouth of the bay and from sites outside the bay had an average WHO-TEQ of 0.343 pg/g. The shellfish collection track with the highest WHO-TEQ inside the bay was collection track-7B, located in the midbay region, and the site with the highest TEQ outside the bay was shellfish collection track-17 (located ~7 km southwest of the center of the bay mouth and between 0.67 and 1.48 km offshore).

When the I-TEQ values for shellfish tissues were lipid adjusted (i.e., expressed as a concentration in the lipid fraction only) for comparison with those reported by Fiedler et al. (1997), the I-TEQ

TABLE 2.
Dioxin compounds and dioxin toxicity equivalent concentrations for St. Louis Bay, Mississippi sediment samples.^{1,2}

| Analyte | Sediment Collection Station Number | | | | | | | | | | | | |
|---|------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|-------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 2378-TCDD | | 0.449 | 0.407 | | | | | | | | | | 0.564 |
| 12378-PeCDD | 1.22 | 1.7 | 1.78 | 1.74 | 0.717 | 0.803 | 1.31 | 1.37 | 0.286 | | 1.31 | 2.3 | 1.83 |
| 123478-HxCDD | 3.4 | 5.26 | 5.41 | 5.01 | 1.99 | 2.32 | 4.09 | 4.22 | 0.691 | 2.73 | 3.91 | 7.36 | 5.27 |
| 123678-HxCDD | 6.49 | 9.67 | 10.6 | 9.75 | 3.63 | 4.53 | 8.57 | 8.2 | 1.39 | 5.34 | 6.98 | 14.2 | 10.3 |
| 123789-HxCDD | 14.7 | 22.2 | 23.4 | 22.9 | 8.41 | 9.77 | 18.4 | 18.4 | 2.99 | 10.8 | 13.4 | 29 | 18.7 |
| 1234678-HpCDD | 245 | 377 | 403 | 362 | 140 | 179 | 332 | 336 | 54.7 | 214 | 247 | 546 | 384 |
| OCDD | 5,590 | 7,950 | 7,910 | 6,920 | 3,460 | 4,120 | 6,750 | 7,140 | 1,220 | 4,330 | 4,630 | 10,100 | 7,310 |
| 2378-TCDF | 0.462 | 1.2 | 0.805 | 0.755 | 0.301 | 0.389 | 0.612 | 0.657 | 0.152 | | | 0.937 | |
| 12378-PeCDF | 0.313 | 0.796 | | 0.398 | 0.179 | 0.198 | 0.348 | 0.387 | | 0.241 | 0.3 | 0.575 | 0.473 |
| 23478-PeCDF | 0.353 | 0.787 | 0.582 | 0.532 | 0.232 | 0.249 | 0.484 | 0.489 | | 0.346 | 0.493 | 0.857 | 0.728 |
| 123478-HxCDF | 1.01 | 2.27 | 1.72 | 1.37 | 0.432 | 0.543 | 1.14 | 1.13 | | 0.642 | 0.79 | 1.62 | 1.33 |
| 123678-HxCDF | 0.989 | 1.76 | 1.6 | 1.36 | 0.449 | 0.568 | 1.23 | | 0.213 | | 0.777 | 1.67 | |
| 234678-HxCDF | 1.02 | 1.89 | 1.75 | 1.68 | 0.525 | 0.656 | 1.51 | 1.36 | 0.226 | 0.809 | 1.06 | 2.24 | 1.69 |
| 123789-HxCDF | 0.356 | | 0.505 | 0.395 | 0.184 | | | | | | 0.293 | | 0.489 |
| 1234678-HpCDF | 7.25 | 15.1 | 13.5 | 14.5 | 3.91 | 5.08 | 11.4 | 10.5 | 1.74 | 0.692 | 7.22 | 16.8 | 12.3 |
| 1234789-HpCDF | | 2.04 | 1.46 | 1.31 | 0.441 | 0.453 | 1.19 | 1.08 | 0.138 | 0.623 | 0.733 | 1.79 | 1.36 |
| OCDF | 15.4 | 40.6 | 26.7 | 31.5 | 0.769 | 10.1 | 22.3 | 18.9 | 3.54 | 13 | 11.9 | 31.1 | 25.5 |
| Sums (total dioxins and furans): | 5,888 | 8,433 | 8,403 | 7,375 | 3,622 | 4,335 | 7,155 | 7,543 | 1,286 | 4,579 | 4,926 | 10,757 | 7,774 |
| Average at in bay stations (1 to 8): | | | | 6,594 | | | | | | | | | |
| WHO-TEQ (ND = 1/2) | 7.25 | 11.41 | 11.78 | 10.66 | 4.17 | 5.05 | 9.11 | 9.12 | 1.62 | 4.93 | 7.18 | 15.33 | 10.56 |
| Average at out of bay stations (9 to 13): | | | | | | | | | | 5,864 | | | |

¹ Toxicity equivalent factors (WHO-TEQ) calculated using World Health Organization toxic equivalence factors (TEFs). All values expressed in pg analyte per gram of sediment dry weight. TEQ values calculated using 1/2 the detection limit value (ND = 1/2) for non-detect analytes (USEPA 1989).

² Blanks in analyte table indicate non-detects or values below the detection limit.

values for the clam sample was 165.5 pg/g lipid, the average value for oysters within the bay was 98.2 pg/g lipid, and the average value for oysters south of the highway bridge and outside the bay was 58.8 pg/g lipid. The two highest values for lipid adjusted I-TEQ were shellfish collection track 2 (152.4 pg/g lipid), located just south of the refinery outfall in St. Louis Bay and shellfish collection track 3 (247.9 pg/g lipid) also located nearby the outfall and southeast of Grassy Point (Fig. 2).

Total dioxins and furans and TEQ values for sediments are shown in Table 2. The two highest WHO-TEQ values in St. Louis Bay (11.41 and 11.78 pg/g sediment dry-weight basis) were located at sediment stations 2 and 3, respectively, which were the stations closest to the titanium dioxide refinery effluent outfall point, labeled as a sewer on National Oceanic and Atmospheric Administration (NOAA) Nautical Charts 11371 and 11372A and in Figure 2 and Figure 4. These two stations were also the only in-bay stations with detectable levels of 2,3,7,8-TCDD, the most toxic of the dioxin congeners. Sediment station 2 is located approximately 260 m south of the discharge of the refinery outfall pipe, and sediment station 3 is located approximately 1.6 km to the south-southwest of the outfall discharge (Fig. 4). The highest value outside the bay (15.33 pg/g) was located at sediment station 12 between Henderson Point and Square Handkerchief Shoal, which was also the only out-of-bay station with a detectable level of 2,3,7,8-TCDD. The average sediment WHO-TEQ value inside the bay (sediment stations 1 to 8) was 8.57 pg/g, and the average WHO-TEQ value for the stations outside of the bay (sediment stations 9 to 13) was 7.92 pg/g. Due to variation in half-life of constituent congeners (Sinkkonen & Paasivirta 2000) and lack of source test data, we did not attempt a quantitative comparison of congeners from the various stations.

Sediment Grain Size, Volatile Solids, and Association with Dioxin Concentrations

The sediments in this study were largely sandy-silts (median diameter, 82 μ m). Sediment grain size did not correlate well with total dioxin, but total volatile solids, consisting of all organic material and carbonates, showed a higher inverse correlation coefficient for sites inside the bay ($r = 0.86$; $n = 8$) than for sites outside the bay ($r = 0.73$; $n = 5$).

Total Dioxin Load Estimate for St. Louis Bay Sediments

The total load of the measured 17 congeners of dioxins and furans in St. Louis Bay sediments was estimated by using the average concentration of all congeners at each sediment site located within the bay, north of US Highway 90. The surface area of the bay was estimated at 40.9 km² and the area of the bay and surrounding marshlands was estimated at 54.1 km². However, a figure of only 75% of the bay surface area was used as a conservative factor in estimation of a minimum burden number. The marshlands surrounding the bay and comprising an additional 13.2 km² were not included in the minimum estimate calculation, although they may be periodically inundated with seawater at high tide. The maximum estimate calculation included the full area of the bay and the surrounding marshlands or an area 76% greater than the minimum estimated area (consisting of 75% of the bay surface area). Therefore the minimum calculation is conservative.

To estimate the total burden of the 17 measured dioxin and furan congeners in St. Louis Bay, the sediment concentration per gram was calculated by converting the dry weight concentrations of dioxins and furans to wet weight concentrations using an average moisture content of sediments of 66% (determined in the ana-

lytical preparation of sediments) and the empirically measured average of 1.35 g of wet sediment per cubic centimeter. Because sediment samples were taken and mixed from the top 4 cm of sediment, the burden was calculated for the top 4 cm of sediment only. This calculation yielded a total burden of measured dioxins and furans in the sediments of 3.72 kg for 75% of the area of St. Louis Bay, to a depth of 4 cm, assuming that the bay bottom was a planar surface. If the entire area of the bay as well as the marshlands were to be included, this estimate would increase by 76% to 6.56 kg. In addition, dioxins and furans may be present at sediment depths >4 cm.

Polychlorinated Biphenyls

The WHO-TEQs for PCBs (ND = 1/2) for sediment samples ranged from 0.113–0.225 pg/g on a dry-weight basis for all sample sites. The WHO-TEQs for PCBs (ND = 1/2) for oyster samples ranged from 0.108–0.125 pg/g on a wet-weight basis.

Trace Metals - Shellfish Tissues

Trace-metal values for shellfish, derived using the extraction method for bioavailable metals (second analytical set), inside St. Louis Bay and in locations near the mouth of the bay are shown in Table 3, referenced to sample locations shown in Figures 2 and 3. For edible oysters inside the bay, these values show large increases from the 1978 study in arsenic (percent value of 404% compared with 1978), chromium (percent value of at least 1,167% compared with 1978), and nickel (percent value of at least 467% compared with 1978). Selenium increased 48% and the other metals showed decreases from the 1978 study. In *Rangia* clams, also evaluated in

the 1978 study, there were increases in the content of all metals measured, which registered above detection limits (Table 3) and were measured in the 1978 and 2004 studies, with the exception of zinc. There was only a minor increase in mercury in clams. The increased concentrations in *Rangia* clams were greater than that for oysters with the largest increases in arsenic (percent value of 1,920% compared with 1978) and nickel (percent value of at least 1,225% compared with 1978). A value for chromium in *Rangia* clams was not reported in the 1978 study. Hooked mussels, considered a non-edible species, showed the lowest concentrations of metals. Based on this data set, the highest concentrations of chromium and nickel in any of the shellfish were from oysters taken at shellfish dredge site 16 (Fig. 3), an area open to oyster harvest, located about 1.7 km south of Henderson Point, which forms the eastern aspect of the mouth of St. Louis Bay.

The first data set (i.e., metals obtained by total digestion) yielded similar but somewhat higher values for metals, as expected. Because this could have been due to a contribution of mineral-bound and nonbioavailable metals and a small artifactual increase during processing (measured at 1 µg/g for Cr and about 0.5 µg/g for Ni, for tissue samples only) of the samples for dioxin analysis (not conducted on or applicable to the second sample set), we have excluded this data set from comparative evaluation with the 1978 data. However, it is included in summary form (Table 4) because it confirms the high values of metals in oysters from an open harvest area and emphasizes the need for public health agencies to consider these data in regard to the suitability of such oysters for human consumption and, at a minimum, to provide public notice of the potential for negative health effects to specific

TABLE 3.
Metals in shellfish in St. Louis Bay, Mississippi and out of bay locations.¹

| Shellfish Collection Site Number and Species | Metal Element Measured in Shellfish (µg/g wet weight) ² | | | | | | | | | | | |
|---|--|--------|-------|-------|--------|-------|--------|--------|-------|-------|-------|--------|
| | Ag | As | Be | Cd | Cr | Cu | Hg | Ni | Pb | Sb | Se | Zn |
| 1978 values for Eastern oysters (<i>Crassostrea virginica</i>) in St. Louis Bay | | 0.1222 | <0.08 | 1.61 | <0.1 | 31.5 | 0.0746 | <0.2 | <0.5 | <0.05 | 0.248 | 821 |
| 1978 values for wedge clams (<i>Rangia cuneata</i>) in St. Louis Bay | | 0.056 | <0.08 | <0.05 | NR | 2.46 | 0.107 | <0.2 | <0.5 | <0.05 | 0.493 | 16.5 |
| 3C Wedge clams (n = 4) | 0.39 | 0.93 | <0.04 | 0.12 | 2.30 | 3.60 | 0.04 | 3.30 | <0.20 | <0.04 | 0.50 | 9.90 |
| 7A Eastern oysters (n = 12) | 0.57 | 0.63 | <0.04 | 1.12 | 1.20 | 37.00 | 0.01 | 0.90 | <0.20 | <0.04 | 0.40 | 543.00 |
| 7A Wedge clams (n = 5) | 2.01 | 1.22 | <0.04 | 0.10 | 1.00 | 4.00 | 0.03 | 1.60 | <0.20 | <0.04 | 1.10 | 8.50 |
| 7B Eastern oysters (n = 6) | 0.53 | 0.55 | <0.04 | 0.95 | 1.70 | 34.00 | 0.02 | 1.40 | <0.20 | <0.04 | 0.30 | 549.00 |
| 7B <i>Ischadium recurvum</i> (hooked mussels) (n = 15) | 0.05 | 0.74 | <0.04 | 0.24 | 0.50 | 1.70 | 0.02 | 0.60 | <0.20 | <0.04 | 0.60 | 7.10 |
| 7C Eastern oysters (n = 3) | 0.30 | 0.30 | <0.04 | 0.62 | 0.60 | 22.00 | <0.01 | 0.50 | <0.20 | <0.04 | <0.40 | 342.00 |
| 9B Eastern oysters (n = 12) | 0.58 | 0.70 | <0.04 | 0.92 | 0.80 | 33.00 | <0.01 | 0.80 | <0.20 | <0.04 | 0.50 | 486.00 |
| 15 Eastern oysters (n = 10) | 0.71 | 0.77 | <0.04 | 1.03 | 0.20 | 28.00 | <0.01 | 0.40 | <0.20 | <0.04 | 0.60 | 252.00 |
| 15 Hooked mussels (n = 15) | 0.05 | 0.90 | <0.04 | 0.17 | 0.90 | 1.80 | 0.02 | 0.50 | <0.20 | <0.04 | 0.90 | 7.90 |
| 16 Eastern oysters (n = 5) | 0.87 | 0.99 | <0.04 | 1.37 | 7.70 | 49.30 | 0.02 | 7.30 | <0.20 | <0.04 | 0.60 | 580.00 |
| Average in bay Eastern oysters, this study | 0.47 | 0.49 | <0.04 | 0.90 | 1.17 | 31.00 | <0.01 | 0.93 | <0.20 | <0.04 | 0.37 | 478.00 |
| Average in bay wedge clams, this study | 1.20 | 1.08 | <0.04 | 0.11 | 1.65 | 3.80 | 0.12 | 2.45 | <0.20 | <0.04 | 0.80 | 9.2 |
| Percent value, 2004 compared to 1978, Eastern oysters ³ | | 404% | | 56% | >1170% | 98% | 17% | >467% | | | 148% | 58% |
| Percent value, 2004 compared to 1978, wedge clams | | 1920% | | 220% | | 154% | 112% | >1225% | | | 162% | 56% |

¹ Data set 2, as referenced in text, extraction using EPA Method 3050B.

² Values listed as < indicate the detection limit and therefore the concentration is less than the detection limit.

³ Change values listed as > indicate that the percent value in 2004 is at least the indicated percentage in comparison to the 1978 values because the latter were below the indicated detection limits. Blank values in the comparison rows indicate that both 1978 and 2004 values were below the limits of detection.

TABLE 4.
Metals in shellfish in St. Louis Bay, Mississippi and out of bay locations.¹

| | Metal Measured in Tissue ($\mu\text{g/g}$ wet weight) ² | | | | | | |
|--|---|-----------------|-------------------|------------------|-------------------|-----------------|-------------------|
| | Ag | As | Be | Cd | Cr | Cu | Hg |
| Avg. of 4 in-bay sites (7A, 7B, 7C, 8) \pm SD ³ | 0.31 \pm 0.02 | 0.34 \pm 0.03 | 0.003 \pm 0.001 | 0.63 \pm 0.08 | 4.213 \pm 3.35 | 20.5 \pm 1.01 | 0.006 \pm 0.001 |
| Range of same 4 in-bay sites | 0.29–0.34 | 0.32–0.39 | 0.002–0.003 | 0.54–0.73 | 1.15–8.68 | 19.5–21.7 | 0.005–0.007 |
| Avg. of 3 sites south of bay (9, 15, 17) \pm SD ³ | 0.31 \pm 0.01 | 0.44 \pm 0.10 | 0.002 \pm 0.000 | 0.53 \pm 0.12 | 6.91 \pm 4.68 | 17.2 \pm 5.70 | 0.006 \pm 0.002 |
| Range of same 3 sites south of bay ⁴ | 0.21–0.40 | 0.34–0.53 | 0.0014 (U)–0.002 | 0.46–0.66 | 3.86–12.30 | 11.6–23.0 | 0.004–0.007 |
| | Metal Measured in Tissue ($\mu\text{g/g}$ wet weight) ² | | | | | | |
| | Ni | Pb | Sb | Se | Tl | Zn | |
| Avg. of 6 in-bay sites (1, 2, 3, 5, 7, 8) \pm SD ³ | 2.75 \pm 1.96 | 0.08 \pm 0.02 | 0.005 \pm 0.00 | 0.21 \pm .01 | 0.001 \pm .000 | 461 \pm 68 | |
| Range of same 4 in-bay sites | 0.92–5.28 | 0.06–0.10 | 0.005 (U) | 0.20–0.22 | 0.001–0.002 | 407–550 | |
| Avg. of 3 sites south of bay (9, 11, 13) \pm SD ³ | 4.43 \pm 2.70 | 0.05 \pm 0.01 | 0.005 \pm 0.00 | 0.32 \pm 0.093 | 0.002 \pm 0.001 | 256 \pm 101 | |
| Range of same 3 sites south of bay ⁴ | 2.67–7.54 | 0.04–0.07 | 0.005 (U) | 0.23–0.42 | 0.001–0.002 | 159–361 | |

¹ Data set 1, as referenced in text, extraction using hydrofluoric acid method.

² Values followed by U indicate that the value is the detection limit and the value for that indicated site and element is thus below the detection limit.

³ Site numbers refer to site locations shown in Figure 3.

⁴ For silver, arsenic, cadmium, chromium, nickel, and selenium the highest values for open harvest areas south of St. Louis Bay, indicated by the upper range number, were for shellfish collection site 15, as indicated on Figure 2.

groups of the population. Examination of metals content from shellfish from data set 1 shows that values as high as 12.3 $\mu\text{g/g}$ for chromium and 7.54 $\mu\text{g/g}$ for nickel were found in edible oysters from open harvest shellfish collection site 15. Even allowing for a reduction in up to 1 $\mu\text{g/g}$ in these values, based on control studies applying only to this data set, these are still high values with regard to human consumption, as will be discussed in following text. Using the first and second data sets for metals, respectively, the chromium content of oysters in Mississippi Sound, adjacent to St. Louis Bay showed percent values of at least 11,300% and 7,700% compared with the 1978 values (below detection limit) reported for in Bay oysters in 1978. However, in utilizing the US Food and Drug Administration estimated safe and adequate daily dietary intake for specific metals (USFDA 1993a, b, c), we used only metals data set 2, designed to analyze for bioavailable metals.

Trace Metals-Sediments

The 1978 values for trace metals in sediments from St. Louis Bay were from sampling and analysis reported by Lytle and Lytle (1982) prior to the construction and operation of the titanium dioxide refinery. Based on comparison of the 1978 data with our values for sediment station 2, chromium, beryllium, nickel, arsenic, and lead increased (listed in descending order of magnitude) in St. Louis Bay sediments between 1978 and 2004 (Table 5). The percent value for copper in 2004 was 90% of that in 1978 and the similar value for zinc in 2004 was 80% of that in 1978. Cadmium, antimony, and selenium were below detection limits in the 1978 study and this data set from 2004. Mercury was detected at 0.107 $\mu\text{g/g}$ in 1978 and found to be 0.095 $\mu\text{g/g}$ in 2004. Although there were no 1978 data to compare sites outside of the bay

TABLE 5.
Comparison of sediment metals in St. Louis Bay 1978 versus 2004.¹

| | Metal Element Measured in Sediment ($\mu\text{g/g}$ dry weight) | | | | | |
|--|--|-------|--------|--------|-------|-------|
| | As | Be | Cd | Cr | Cu | Hg |
| 1978 Average Value in St. Louis Bay (SLB) | 7.05 | 0.789 | <0.087 | 10.67 | 10.04 | 0.107 |
| 2004 Value in SLB (Site 2) | 8.55 | 1.05 | <0.5 | 16.5 | 9 | 0.095 |
| Percent value, 2004 compared to 1978 (in bay values) | 121% | 133% | | 155% | 90% | 88.8% |
| 2004 Average Value outside SLB (Sites 12 & 13) | 6.1 | 0.85 | <0.5 | 15 | 10 | 0.090 |
| | Metal Element Measured in Sediment ($\mu\text{g/g}$ dry weight) | | | | | |
| | Ni | Pb | Sb | Se | Zn | |
| 1978 Average Value in SLB | 9.35 | 15.4 | <0.025 | <0.013 | 69.35 | |
| 2004 Average Value in SLB | 11.5 | 17 | <0.5 | <1.0 | 55.5 | |
| Percent value, 2004 compared to 1978 (in bay values) | 123% | 111% | | | 80% | |
| 2004 Average Value outside SLB (Sites 12 & 13) | 13.5 | 13 | <0.5 | <1.0 | 53 | |

¹ Data set 2, as referenced in text, extraction using EPA Method 3050B.

with the 2004 values, chromium and nickel values from sites outside but near St. Louis Bay were higher in 2004 than the values reported for these metals inside the bay in 1978.

The increase noted in some of these metals is undoubtedly an anthropogenic effect. Particle size analyses carried out by Isphording (1985) in St. Louis Bay versus those in the present investigation clearly show a coarsening trend for bay sediments over the past 20 y. The 1985 sediments were largely silty-clays (median diameter, 14.1 μm) whereas those at present are chiefly sandy-silts (median diameter, 57 μm , in-bay). As such, the expected trend would be for lower natural levels of heavy metals to be found in the sediments. Sorption of heavy metals in sediments is closely related to grain size (see Cordi et al. 2003) because sand-sized sediment (i.e., >62 μm) and medium to coarse silt-size sediment (those 10–62 μm) will consist almost entirely of the mineral quartz (SiO_2). Quartz shows almost no tendency to adsorb contaminants because it closely approaches its stoichiometric composition under natural conditions and has few site vacancies that produce positions where ions can "attach." The clay-sized sediments (by definition, those <4 μm in size) in St. Louis Bay, in contrast, consist largely of the Smectite Group clay mineral montmorillonite, $(\text{Ca},\text{Na})(\text{Al},\text{Mg},\text{Fe})_4(\text{Si},\text{Al})_8\text{O}_{20}(\text{OH})_4 \cdot n\text{H}_2\text{O}$. This mineral is characterized by numerous Schottky-Wagner (missing ion) defects that render the clay micelle surfaces "charged." Hence the mineral can abundantly adsorb organic and inorganic impurities and contaminants. Montmorillonite clays also possess very high cation exchange capacities (100–300 milliequivalents/liter). This property, similarly, renders them capable of adsorbing a wide variety of metals and organo-metallic species. Not unexpectedly, then, when the median diameters of the 13 samples collected in this study were compared with the total dioxin and furan levels from Table 2, an inverse correlation of $r = 0.70$ was obtained. A less strong, but statistically significant inverse correlation ($r = 0.54$) was also obtained when dioxin and furan levels from Table 2 were compared with the percentage of sediments in each sample in the 3- to 12-micron range. This size fraction is important because it includes the size range of particles that are ingested by filter feeding oysters. Given that the sediments demonstrably contain elevated levels of both dioxins and furans, it is not therefore surprising that St. Louis Bay shellfish exhibit heightened levels of both of these compounds.

In addition to contaminants associated with the clay minerals, the fine silt and clay fraction (particles <10 μm) also contains significant quantities of iron and manganese oxide and oxy-hydroxide compounds. These, similarly, are marked by extensive substitution of a wide variety of metal ions for both iron and manganese. Hence, a decrease in the quantity of fine silt and clay-size sediments over the 20-y period would be expected to produce a decrease in metal levels and other contaminants. The increase observed in this investigation must therefore be the result of "loading" of the reduced quantities of fine silt and clay due to high levels of contaminant influx.

DISCUSSION

Toxic Equivalents of Dioxins, Furans, and PCBs in Shellfish

The WHO-TEQ values based on a whole-shellfish soft tissue wet-weight basis averaged 0.392 pg/g for oysters and was 0.581 pg/g for the single sample of *Rangia* clams. While there is no defined action level in the United States, the US Food and Drug Administration advises that "Since there are no tolerances or other

administrative levels for dioxins in food or feed, the appearance of these compounds in a food or feed supply is of gravest concern" (USFDA 2000). The European Union (EU) has defined action levels of between 0.5 and 4.5 pg/g (based on WHO-TEQ) for dioxins, furans, and dioxin-like biphenyls in various seafoods related products (EC 2002). Because these action levels include dioxin-like biphenyls, and in setting the action level, studies showed that only 25% to 50% of the total dioxin equivalents came from dioxins and furans, the effective EU action level for dioxins and furans separately is closer to 1.0–2.0 pg/g. In 1981, The US Food and Drug Administration recommended a 25-pg/g maximum dioxin level to address contamination of fish in the Great Lakes. Subsequently, in 1997, the USFDA (1997) issued prohibition of the sale of catfish containing more than 1 pg/g dioxin, but subsequently rescinded this restriction (USFDA 1997). We compared the values for oyster dioxin and furan TEQs from this study with those reported previously by Fiedler et al. (1997). Only the congeners reported by Fiedler et al. (1997) that were also evaluated in this study were used, and I-TEQ ($\text{ND} = \frac{1}{2}$) values for nondetects in our data were used. The Fiedler values could be an overestimate of the actual toxic equivalents present because they use $\frac{1}{2}$ LOD values for nondetects. Thus, our comparison to their values of the increase in dioxins and furans includes a conservative estimation factor, due to the necessity of using their values based on $\frac{1}{2}$ LOD. The Fiedler et al. (1997) study was a market-basket survey of various food stuffs, including oysters, from grocery stores and seafood markets in southern Mississippi, although the source location of the oysters was not specified. Fiedler et al. (1997) report lipid-adjusted values (i.e., they expressed the total dioxin and furan analytes as a concentration of the lipid portion only of the animal) because, as they noted, dioxins and furans accumulate in the lipid compartment of animal tissues.

Using this lipid-adjusted means of expression, these authors reported values of from 21.0–31.4 pg/g I-TEQ for the oysters. Using the same method of calculation (but using $\frac{1}{2}$ detection limit values for nondetects), we found lipid-adjusted I-TEQ concentrations ranging from 54.2–247.9 pg/g for oysters in St. Louis Bay, 165.5 pg/g for *Rangia* clams in St. Louis Bay and concentrations ranging from 36.6–79.1 pg/g for oysters from open harvest areas south of and adjacent to St. Louis Bay. Thus, the comparison of lipid adjusted values from the 1997 paper to those of the current study indicates a doubling to near an order of magnitude greater values for dioxin and furan TEQs for St. Louis Bay oysters versus those from southern Mississippi in 1997. In most circumstances, this would be surprising because a number of studies have indicated that dioxin concentrations in the environment, in food stuffs, as well as human exposure levels, have been decreasing for several decades (e.g., USEPA 1991b; Smith et al. 1995, Pearson et al. 1995, Pinsky & Lorber 1998, Winters et al. 1998). Dioxin and furan concentrations in St. Louis Bay in 2004 were about 2.6 to 7.9 times higher than the low and high values, respectively, reported in the 1997 study. Dioxin and furan values outside of St. Louis Bay in 2004, in open harvest areas, are about 1.8 to 2.5 times higher than the low and high values, respectively, reported in 1997. The actual increase may be higher due to the use of $\frac{1}{2}$ LOQ values by Fiedler et al. in 1997. Our average value for total dioxin and furan TEQs is lower than a national average (0.448 ppt) reported by Jensen and Bolgar (2001) for mollusks (using $\frac{1}{2}$ detection limit values for nondetects). However, that study did not specify the collection sites or mix of species used in the reported number. The more significant comparison is the rise in values of contaminants

in oysters collected in southern Mississippi between 1997 and 2004, during a time period when dioxins were generally decreasing in the environment.

It should be noted that the female oysters collected for this study were not in a condition of peak reproductive development, when lipid levels would be expected to be higher. At that time, lipid levels can range from 10% to 15% as a proportion of total body weight, even after peak reproductive conditioning (Barber et al. 1988a, Barber et al. 1988b). Rather, the average lipid levels of oysters from all sites in our study were low, only 0.59%. Assuming an equal proportion of males and females, this indicates that the lipid content could be greater by a factor of 8.5–12.7, assuming no lipid increase in reproductively mature males. This indicates that at certain times of the season, the dioxin content of oyster samples could similarly increase by a factor of 8.5–12.7 to levels that would be of public health concern, although the rate of accumulation is unknown and thus the maximum potential accumulation is also unknown. However, the high potential accumulation rates would be of particular concern for sites outside of, but near, St. Louis Bay that are open for harvest.

The even higher TEQ values of sediments, compared with shellfish TEQ values, and potential new dioxins and furans added to the marine environment, provide the source for such additional accumulation of these carcinogens. A paper published in 1996 (Comber et al. 1996) indicated that relatively high values of dioxins and furans were acceptable in freshwater sediments. However, these guidelines were based on toxicity of the sediments to trout eggs and fish and did not address toxicity to organisms residing in marine sediments. The risk posed by sediment dioxins and furans to mollusks residing in or near the sediments is a function of multiple factors including sediment resuspension, congener half-life, sediment transport, addition rate of new congeners, and removal rate of dioxins by natural processes.

Calculation of TEQ values for PCBs in shellfish and sediments showed that they were below recognized levels of concern.

Estimation of Total Dioxins and Furans in Bay Sediments

As noted in the Results section, we conservatively estimated the total load of the measured 17 congeners of dioxins and furans in sediments of St. Louis Bay at 3.72 kg. This estimated value would increase by 76% to 6.56 kg if marshlands and the total bay area were included.

Visual inspection of the data (Table 2) suggests similarity between the dioxin and furan content of all the sites with relatively high proportions of OCDD and 1,2,3,4,6,7,8-HpCDD; 1,2,3,7,8,9 HxCDD; and 1,2,3,6,7,8 HxCDD in all samples, both inside and outside St. Louis Bay. However, we judged that a numerical analysis of the similarity of congener composition between sites in this study and between our values and the reported discharge values from the titanium dioxide refinery (USEPA 2003) would not be meaningful because the residence time of the dioxin and furan components at each site is unknown, and the half-life of congeners in sediments varies markedly (Sinkkonen & Paasivirta 2000).

Heavy Metals in Shellfish and Sediments of St. Louis Bay and Adjacent Marine Waters

Our study found a marked increase in the bioavailable heavy metals, namely chromium, nickel, and arsenic in oysters in St. Louis Bay and adjacent waters of Mississippi Sound compared

with the prior survey. Chromium and nickel were not detected in oysters in St. Louis Bay in 1978 and arsenic was detected at about 25% of the 2004 concentration in 1978 oyster samples. Evaluation of *Rangia* clams shows that the burden of all metals measured above detection limits, except zinc, have increased in shellfish in St. Louis Bay since 1978, with the greatest increases in arsenic and nickel.

Metals appear to have also increased in sediments in St. Louis Bay and adjacent marine waters. However, because the large increases in chromium and nickel accumulation in shellfish appear spatially linked to the titanium dioxide refinery, which produces soluble metal chlorides, the discharge of such compounds may, in large part, be carried outside of St. Louis Bay where precipitation and dispersion in the higher salinity waters of Mississippi Sound would occur. Thus, sediment data are of limited value in estimating the contamination of St. Louis Bay waters by metals from the titanium dioxide refinery because the refinery process that utilizes the chloride-ilmenite process (USEPA 2001) results in acidified soluble metal chlorides (MDEQ 2003) which, assuming these are the most likely source of contaminants, would be expected to be largely flushed out of St. Louis Bay as dissolved matter, where they would tend to precipitate and be dispersed in the more saline waters of Mississippi Sound. It is also presumed that this process produces primarily chromium-III, rather than the more highly toxic and carcinogenic chromium-VI.

Metal Content of Edible Oysters and Recommended Safe Consumption Levels

Table 6 shows the estimated safe and adequate daily dietary intake (ESADDI) for chromium-III and nickel and compares these to the content of the metals in oysters from St. Louis Bay and adjacent waters of Mississippi Sound in this 2004 study (USFDA 1993b, USFDA 1993c). Although these values are stated to represent only the historical record, according to the US Food and Drug Administration, they have not been replaced by new USFDA recommendations or guidelines and have been widely adopted as the standard for ESADDI (Beers & Berkow 2004; PDR 2004). Using these ESADDI values indicates that the oysters, which previously had no detectable chromium and nickel in 1978 and about 25% of the 2004 value of arsenic, are now sufficiently burdened with these metals that less than one oyster per day can be consumed from open harvest areas near St. Louis Bay without exceeding the ESADDI levels for chromium-III and nickel for hypersensitive individuals. The oysters inside St. Louis Bay, currently a closed area due to bacterial contamination, have lower concentrations of these metals but are markedly elevated compared to 1978.

The increases in chromium and nickel are the most significant in terms of ESADDI of these metals (Table 6). Based on these values, and assuming that oysters are the only source of dietary chromium, for example, the consumption of oysters from inside St. Louis Bay should not exceed about 3 ½ per day. However, oyster harvest from the bay is not permitted because of bacterial contamination. More significantly, based on average chromium levels (assumed to be chromium-III) in oysters from adjacent waters outside the bay, such oysters should not be consumed at a rate of more than two medium oysters per day. At the site with the highest chromium level, medium-sized oysters should not be consumed at a rate of more than 0.8 oysters per day to not exceed the ESADDI.

TABLE 6.
Estimated safe consumption levels of oysters from St. Louis Bay and near Bay open harvest areas.¹

| | Chromium III ² | Nickel (general population) ³ | Nickel (hypersensitive individuals) ³ |
|---|---------------------------|--|--|
| Estimated safe and adequate daily dietary intake (ESADDI): | 200 | 1200 | 50 |
| | µg/person/day | µg/person/day | µg/person/day |
| Average concentration in oysters from in Bay sites (µg/g wet weight) | 1.17 | 0.93 | 0.93 |
| Specific consumption level of concern from in Bay sites (g oysters per day) | 171 | 1290 | 54 |
| Number of oysters (34 g) consumed daily to reach consumption level of concern | 5.0 | 38.0 | 1.6 |
| Maximum concentration in oysters from in Bay sites (µg/g wet weight) | 1.7 | 1.4 | 1.4 |
| Specific consumption level of concern from in Bay sites (g oysters per day) | 118 | 857 | 36 |
| Number of oysters (34 g) consumed daily to reach consumption level of concern | 3.5 | 25.2 | 1.1 |
| Average concentration in oysters from near Bay sites (µg/g wet weight) | 2.9 | 2.8 | 2.8 |
| Specific consumption level of concern from near Bay sites (g oysters per day) | 69 | 424 | 18 |
| Number of oysters (34 g) consumed daily to reach consumption level of concern | 2.0 | 12.5 | 0.5 |
| Maximum concentration in oysters from near Bay site (µg/g wet weight) | 7.7 | 7.3 | 7.3 |
| Specific consumption level of concern from near Bay sites (g oysters per day) | 26 | 164 | 7 |
| Number of oysters (34 g) consumed daily to reach consumption level of concern | 0.8 | 4.8 | 0.2 |

¹ These calculations of estimated safe consumption levels of oysters are based on the more conservative metals data set 2.

^{2,3} USFDA 1993. Values from guidance documents for chromium and nickel in shellfish (also PDR 2004, Beers & Berkow, 2004).

For individuals hypersensitive to nickel (estimated to be about 10% of females and 2% of males in a European population, for example [Flyvholm et al. 1984]) and who are thus susceptible to nickel eczema, oysters with average nickel concentrations outside the bay should not be consumed at a rate of more than 0.5 oyster per day or at a rate of more than 0.2 oyster per day from sites with the highest recorded nickel content, based on the ESADDI. Based on the USFDA (1993a) advisory, arsenic levels are probably not of concern, although elevated over those of 1978, because 90% or greater of the arsenic found in shellfish is usually in organic form, rather than the toxic inorganic form. The analysis performed in this study did not discriminate between organic and inorganic arsenic. All of the above computations of the ESADDI of these metals assume that oysters are the sole dietary source of the metal.

The relatively high chromium content in the oysters in this study is surprising due to the discrimination of Eastern oysters against accumulation of chromium in relation to other metals (Huanxin et al. 2000). These authors found that chromium concentrations were lowest in relation to sediment concentrations when compared with several other metals. Our study established the content of chromium in whole oyster meats, some of which may have been in the digestive tract, associated with food particles, including those that would have complexed with soluble chromium compounds. However, as indicated previously, the total content of bioavailable chromium is important due to the consumption of whole oysters as a food product.

Transport of Contaminants out of St. Louis Bay

Studies of St. Louis Bay and the adjacent waters of Mississippi Sound indicate that a salinity gradient exists across the mouth of St. Louis Bay, and that the low salinity outflow of the bay consistently occurs on the western side and continues to follow the

shoreline westward for some distance (Eleuterius 1976). This circulation pattern helps explain the higher than average TEQs for dioxins in shellfish from sample tract number 17 and the relatively high value for total dioxins and furans at sediment site 13 as well as the lower values at sediment sites 9 and 10. However, considerable mixing occurs outside the mouth of St. Louis Bay and depends on weather and sea state conditions. Weather fronts from autumn through spring may push waters south of the bay either northeastward or southeasterly depending on the wind direction. Such conditions could account for mixing and higher accumulation of contaminants such as total dioxins and furans at sediment station 12 and chromium in oysters in shellfish dredge tract 16. According to a circulation model of the bay (Cobb & Blain 2002), there can be a net west to east flow south of the mouth of St. Louis Bay resulting from ebb tide flows and wave induced currents. Chromium, presumed to be released in soluble form into St. Louis Bay, would be likely to accumulate in oysters near the bay than in sediments because soluble chromium compounds would be expected to precipitate or complex with fine particles that are ingested by filter-feeding oysters.

Other factors acting to control distribution of contaminants observed in the fauna and sediments again involved both the grain-size distribution of sediments at a given site and mineral speciation at the site. Higher levels of furans and dioxin are found where the content of fine silt and clay-size sediment is greatest. Clay minerals, however, are more likely to settle out where a change to a higher salinity is encountered. This causes the clay particles (micelles) to flocculate and thus "clump" to form hydraulically larger sized sediment, which settles more quickly to the bottom. This is particularly apparent at sites 7, 8, 12, and 13, each of which contains approximately 20% or more of clay-size particles. Each of these sample locations is also the site of elevated congeners of

dioxin and furans that are similar, or exceed levels found immediately offshore from the titanium-dioxide refinery.

Sources of Contamination

Potential sources for dioxin, chromium, and nickel contamination of St. Louis Bay and the nearby waters of Mississippi Sound were reviewed using the United States Environmental Protection Agency Toxic Release Inventory (TRI) Program's TRI Explorer (www.epa.gov/enviro/html/tris/) and the EPA Envirofacts Warehouse (<http://www.epa.gov/enviro/index.html>). The Toxic Release Inventory Program makes data available to the public. However, it is important to recognize that the program does not mandate monitoring, and some of the TRI data are based on monitoring protocols whereas other data are derived by using various estimation techniques. Because facility activities and patterns of disposal or other releases can vary dramatically from one year to the next multiyear data were evaluated, as available.

Toxic release data from facilities in Hancock and Harrison Counties, the Mississippi counties directly adjacent to St. Louis Bay, were compiled for all years available. TRI data are available through 2002, with early release of 2003 TRI data making those numbers available in November 2004, but with the caveat that "...the traditional public data release, which includes more quality checks..." is expected in Spring 2005. At this time, the 2003 data are in the form of an electronic facility data release, which have not completed all verification. However, as the 2003 data are consistent with prior years for the facilities that have been reviewed for this study, and the EPA website states that the data have "undergone the majority of the data quality checks routinely conducted by EPA's TRI Program," we included this year in the multiyear compilations.

EPA Toxic Release Inventory records report release of dioxins only for the years 2000 to 2003, due to regulatory changes effective in the year 2000, when certain new persistent bioaccumulative toxic (PBT) chemicals were added to the TRI list of reportable chemicals.

In reviewing the EPA TRI records, no significant sources of dioxin contamination were found in the St. Louis Bay watershed, other than the titanium dioxide refinery on the northern shore of St. Louis Bay. In fact, TRI records show no release of dioxin or dioxin-like compounds reported in Hancock County for 2000 to 2003. In Harrison County, only 2 facilities reported release of dioxins: the titanium dioxide refinery and the Mississippi Power Company Jack Watson Power Plant. Total reported release of dioxin and dioxin-like compounds for the Mississippi Power Company Watson Plant for the years 2000, 2001, and 2002, was, respectively, 0.3691 g, 0.3425 g, and 0.3109 g. For the same years, the titanium dioxide refinery reported release of 19,493.17 g, 18,201.2 g, and 20,078.11 g. The total amount of dioxins released on-site for the years 2000 to 2003 for the Mississippi Power Company Jack Watson Power Plant was 1.39 g, compared with 72,817.41 g disposed of or released on-site by the titanium dioxide refinery for the same time period. Dioxin release by facilities in the other counties in the Mississippi Coastal Watershed was examined also. In 2002, a representative year, the total amount of dioxin and dioxin-like compounds reported released was as follows: Jackson County, 3.8 g; Lamar County, 1.57 g; Pearl River County, 1.2 g; and Stone County, 4.47 g.

Over 99.99% of the dioxin and dioxin-like compounds released by the titanium dioxide refinery are listed as being disposed of in

"other on-site landfills." "Other landfills" (Section 5.5.1B on the TRI Form R) are defined by the EPA TRI program as "those landfills which are not authorized under Subtitle C of the Resource Conservation and Recovery Act (RCRA) to accept hazardous wastes. These landfills are commonly referred to as non-hazardous waste landfills and may be regulated under a variety of other Federal, state, and local programs." (USEPA TRI Explorer, http://yosemite.epa.gov/oiaa/explorers_fe.nsf/Doc1/Other+Landfills?). The titanium dioxide refinery does not use RCRA Subtitle C landfills for disposal of dioxins, as indicated in Section 5.5.1A on the TRI Form R completed for dioxins in 2000 to 2003. The RCRA Subtitle C landfill is designed and authorized to accept hazardous waste for disposal, with requirements for lining to prevent leakage of landfill contents.

Given the large quantity of dioxin and dioxin-like compounds that are disposed of on-site, the type of disposal, the plant's proximity, and the lack of any other significant sources of dioxins in the vicinity, it seems likely that the titanium refinery is the most significant source of the dioxins found in St. Louis Bay. The distribution of dioxin and furan compounds in St. Louis Bay also implicates the refinery as the source. Such compounds could enter the bay by several pathways, including fallout from airborne emissions as well as fugitive emissions from surface-water runoff or discharges. The latter inference is supported by the fact that the two highest concentrations of dioxins and furans in St. Louis Bay sediments were found at the two stations closest to the facility's surface-water discharge pipe (identified as the "sewer" noted in Fig. 1, Fig. 3). In addition, the two oyster samples with the highest lipid-adjusted I-TEQ values were from shellfish dredge sites 2 and 3, nearest to and close to, respectively, the facility's surface-water discharge pipe.

The potential for shellfish to accumulate greater concentrations of dioxin as the lipid content increases is suggested by the higher TEQ values for the measured dioxins and furans in sediments in and near St. Louis Bay. These WHO-TEQ values ranged from 4.17–11.78 pg per gram for in bay sites, with the highest sites recorded closest to the titanium dioxide refinery outfall (sediment collection sites 2 and 3, Fig. 3). However, relatively high sediment values were recorded at two open harvest sites near the mouth of St. Louis Bay (sediment collection sites 12 and 13). The elevated concentrations in sediments at these sites may be due to waterborne transport out of the bay and local current patterns in the vicinity of sediment collection sites 12 and 13. As noted earlier, during wave-tidal coupled action there is consistent flushing of the mouth of the bay into Mississippi Sound during all phases of the tide.

The US Environmental Protection Agency Toxic Release Inventory (USEPA 2003) was examined for potential sources of chromium and nickel in the St. Louis Bay watershed. The titanium dioxide refinery on the northern shore of St. Louis Bay was found to release the largest amounts of chromium and nickel, and appears to be the only facility in close enough proximity to significantly affect the metals levels in St. Louis Bay. According to the figures reported by the titanium dioxide refinery to the USEPA Toxic Release Inventory, the refinery disposed of 304,928 kg (672,252 lb) of chromium compounds and 32,888 kg (72,505 lb) of nickel compounds in 2002. These are assumed to be metal chlorides based on the described manufacturing process for the refinery (USEPA 2001; MDEQ 2003). The majority of the chromium (303,907 kg = 670,000 lbs) and nickel (32,659 kg = 72,000 lb) were disposed of in Class 1 wells, whereas only 6.4 kg (14 lb) of

chromium compounds and 45.5 kg (100 lb) of nickel compounds were reported to be released to surface water discharges (into St. Louis Bay) in 2002.

Multi-year data compilations were done to compare the amounts of chromium and nickel released by the titanium dioxide refinery with the two other sources of chromium and nickel in the counties bordering St. Louis Bay. For the years 1995 to 2003, the only years that the titanium dioxide refinery reported release of chromium and nickel compounds, the total quantity released was 238,872 kg (526,623 lbs) of nickel compounds and 3,168,142 kg (6,984,558 lbs) of chromium compounds. As noted earlier, most of the chromium and nickel compounds were injected into Class 1 wells. However, over this 9-y period, nickel compounds were also released as follows: 160 kg (353 lbs) stack or point source air emissions, 1260 kg (2778 lbs) discharged into St. Louis Bay, and 1996 kg (4400 lbs) placed in "other landfills" (not RCRA Subtitle C landfill). The corresponding amounts of chromium compounds for this 9 y period were: 131 kg (287 lbs) stack or point source air emissions, 156 kg (344 lbs) discharged into St. Louis Bay, and 10,841 kg (23,900 lbs) placed in "other landfills".

The Mississippi Power Company Watson Plant in Harrison County reported release of nickel compounds for the years 1998 to 2003 totaling 1299 kg (2864 lb) stack or point air emissions and 1134 kg (2501 lb) discharged to surface waters. The corresponding amounts for chromium compounds for these years (except no Cr release reported in 2002) were 946 kg (2085 lb) stack or point source air emissions and 349 kg (770 lb) discharged to receiving streams or water bodies. Plant Watson is located 28.2 km (17.5 air miles) east-northeast of Grassy Point in St. Louis Bay and at least 72.4 km (45 water miles) from Grassy Point via Biloxi Bay and Mississippi Sound. An examination of the prevailing winds in the area indicates that no significant heavy-metal components in the plant's air emissions would be expected to reach St. Louis Bay; likewise, the water distance and the lack of a direct water route to St. Louis Bay makes it highly improbable that the Bay would be affected by discharges from the Mississippi Power Company power plant. In addition to these two release routes, this plant places nickel and chromium compounds in surface impoundments; however, this release of chromium and nickel would not affect St. Louis Bay.

The other source of chromium compounds and nickel compounds in the vicinity is General Electric Plastics, located at Port Bienville in Hancock County, MS. This plastic polymer facility is located approximately 30.6 km (19 air miles) southwest of Grassy Point in northern St. Louis Bay and at least 45.1 km (28 water miles) via the Pearl River and Mississippi Sound from Grassy Point. This facility reports their toxic releases in ranges, as permitted by the EPA. These ranges are large enough to make it impossible to know how much nickel or chromium has been released to the air over the years reported (1999–2003). For each of these years, the amounts for chromium compounds and nickel compounds in fugitive air releases are noted to be 5.0–226.5 kg (11–499 lbs). The yearly amounts for both compounds released to water are noted to be 0.45 to 4.5 kg (1–10 lbs) for each of two water bodies. However, the total quantity released on-site is only 45.5 kg (100 lbs) of each metal compound per year, so the total amount of chromium compounds for the 5-y period is 227.0 kg (500 lbs), and for nickel compounds, the total released on-site for this period is also 227.0 kg (500 lbs). Given the relatively modest amounts of chromium and nickel released, coupled with the dis-

charges (via air and water) from St. Louis Bay, it seems unlikely that the releases from this facility affected the bay.

No other USEPA-permitted discharges of chromium or nickel compounds were identified from either Hancock or Harrison Counties. As noted, General Electric Plastics and Mississippi Power Company Watson Plant likely do not contribute to the metal contamination of St. Louis Bay. The distances via air and water over which these contaminants would have to travel to reach St. Louis Bay and the physical, meteorological, and hydrological barriers to migration would preclude, in our opinion, any significant addition by these two sources to the metal contaminants in St. Louis Bay.

The titanium dioxide refinery has been discharging nickel and chromium compounds into the water of St. Louis Bay and into the air near the bay for at least 9 y. In addition, it seems possible that some of the nickel and chromium compounds placed in the landfills could, over time, leach out and contribute to the contamination of the bay.

Because the metals are likely to be metal chlorides, they would be expected to be soluble but likely precipitate and form particle-bound complexes when released and mixed into waters of increasing salinity. Thus, leakage of such compounds from the northern aspect of St. Louis Bay would likely result in a substantial portion of such metal chlorides being transported to the mouth of the bay and out of the bay to the higher salinity waters of Mississippi Sound where they would tend to precipitate out of solution. Therefore, the measured amounts of leachable and bioavailable chromium and nickel remaining in St. Louis Bay would represent only a fraction of the amount released into the bay. This further explains why a source of metal chlorides in the bay could result in higher accumulations of the metals in shellfish outside the bay than in the bay.

We also examined the potential for heavy-metal aerosols to reach St. Louis Bay from air-emission point sources along the Mississippi River industrial corridor. That corridor runs from Baton Rouge downriver past New Orleans, Louisiana, and includes numerous petroleum refineries and chemical-manufacturing plants. Baton Rouge is 160 km (100 mi) due west of St. Louis Bay and New Orleans (the closest point along the industrial corridor) is 80 km (50 mi) southwest of the bay. Year 2002 EPA-TRI data (USEPA 2003) show that 134.4 kg (296 lb) of chromium and chromium compounds and 3,778 kg (8,322 lb) of nickel and nickel compounds were released from industrial sources within the "River Parishes" along the corridor.

We analyzed windrose data from the years 1987, 1988, 1990, and 1992 recorded at Louis Armstrong International Airport at New Orleans (MSY) to determine the potential for heavy-metal aerosols to reach St. Louis Bay from the industrial corridor. The windrose data show that winds that could potentially transport chromium and nickel aerosols occur only 11.8% of the time from the west through the southwest. Theoretically, only 11.8% of the chromium and nickel had the potential to be transported directly to the bay (15.8 kg = 34.9 lb of Cr; 445.8 kg = 982.0 lb of Ni). At least 75% of those westerly-through-southwesterly winds had velocities of 18.5 km/h (11.5 mi/h) or less; and the average velocity was 15.0 km/h (9.3 mi/h) for the entire period from all quadrants. Given the significant distances over which those aerosols would have to travel to reach St. Louis Bay (80–160 km; 50–100 mi), and the tendency of those aerosols to continually settle out before reaching the bay, we believe those aerosols would have no sig-

nificant impact on chromium and nickel levels we found in sediments and shellfish in that bay.

Because of the specific source of metals, particularly chromium and nickel, the increase of these in sediments and particularly in shellfish, the association of dioxin with the refinery outfall, and the lack of other reporting large sources of these contaminants in the watershed, we conclude that the most likely source of these elevated contaminants in St. Louis Bay and the adjacent waters of Mississippi Sound is the titanium dioxide refinery on the northern shore of St. Louis Bay.

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