ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

ENVIROMAIL # 22

April 2004
Revised August 2008

Analysis of Dioxins

Part 3 – Interpreting the Analytical report

Of the 210 possible chlorinated dioxin and furan compounds, only 17 exhibit acute toxicity. These 17 compounds show widely varying toxicities with the most toxic congener (2,3,7,8-TCDD) considered 1000 – 10000 times more toxic than the least toxic of the 17, namely OCDD and OCDF.

Therefore it does not suffice to simply measure total dioxins and furans, or even to measure only the individual concentrations of the 17 toxic compounds. In practice, each of the 17 toxic compounds is allocated a factor (TEF) based on its toxicity relative to 2,3,7,8-TCDD. This allows the total toxicity or **Toxic Equivalence** (TEQ) of the analysed sample to be readily determined. The calculated TEQ values provide an excellent way to compare the toxicity of different samples.

An explanation of the various components of the analytical report follows:
(Reference the numbers below to the numbers on the example report)

1. Compound Lists

In the upper left hand side of the report is a list of the 17 dioxin and furan compounds considered toxic by WHO and NATO. Listed below these 17 compounds are the ***Group Totals*** for **all** of the Tetra (4 chlorines) through Octa (8 chlorines) substituted dioxins and furans, both toxic and non-toxic.

2. Concentration

This column lists the actual concentration in the sample for each compound, or compound group, as determined by analysis. (Soil results are reported on a dry weight basis.)

3. Level of reporting (LOR)

The LOR defines the minimum concentration routinely reported by the laboratory. (Lower LOR's are readily achievable if required.)

4. Toxic Equivalency Factor (TEF)

Each of the 17 toxic compounds has a factor (TEF) assigned to it relative to its toxicity. 2,3,7,8-TCDD is the most toxic and has been allocated a TEF of 1.0, while OCDD and OCDF are the least toxic and have a factor of 0.001 (I-TEF).

Worldwide, there are multiple TEF schemes with NATO (I-TEF) and WHO (WHO-TEF) being the most commonly used. ALS reports the NATO (I-TEF) values as standard, but can report any TEF scheme on request.

5. Toxic Equivalence (TEQ)

The concentration of any compound detected at or above the LOR is multiplied by the TEF for that compound to calculate its Toxic Equivalence (TEQ). Where the concentration of a compound is less than LOR (reported as "<LOR" in column 2) then one of three values is used to calculate its TEQ.

- **TEQ_{ZERO}** – Concentration listed as "<LOR" are assigned a concentration of zero. This gives the minimum possible TEQ of those compounds in the sample.
- **TEQ_{LOR}** – Concentrations listed as "<LOR" are assigned a concentration equal to the LOR. This gives the maximum possible TEQ of those compounds in the sample.
- **$TEQ_{0.5LOR}$** – Concentrations listed as "<LOR" are assigned a concentration equal to half of the LOR. This gives a TEQ of compounds in the sample halfway between TEQ_{ZERO} and TEQ_{LOR}.

ALS reports TEQ_{ZERO} and TEQ_{LOR} as standard, but can report any combination of these three options on request.

6. Labelled Compound Recovery ($^{13}C_{12}$ Rec %)

Fifteen isotopically labelled compounds are added to each sample prior to extraction. These compounds are used to quantitate sample results and also provide an absolute recovery value for the extraction (similar to a surrogate addition). As this recovery is already taken into account in the sample analysis, results do not need to be corrected for this recovery.

7. Total TEQ (∑TEQ)

This is the sum of the individual TEQ values, and allows the total toxicity of the sample to be evaluated. This value relates the total toxicity of the sample back to a concentration of 2,3,7,8-TCDD, the most toxic isomer.

8. Total Dioxins (∑PCDD/Fs)

This is the total amount of all Tetra- to Octa- substituted dioxins and furans in the sample. Toxic Equivalency Factors (TEFs) are not used in the calculation of this total and this value would only be used when the **Total** dioxin content is required.

For further information contact your nearest ALS laboratory (see www.alsglobal.com) or the ALS Dioxin Laboratory (Brisbane) technical support staff at services.brisbane @alsenviro.com

ANALYTICAL RESULTS FOR DIOXINS AND FURANS

ALS Environmental

Laboratory Sample ID:
Client Sample ID:
Sample Mass (g): 10.0
Extract ID: -
Moisture Content (%) 0.00

Sample Matrix: Soil
Date Sampled:
Date Extracted:
Date Analysed:

(1) Compound	(2) Conc pg/g	(3) LOR pg/g	(4) WHO-TEF	(5) WHO-TEQ [1] (zero)	(5) WHO-TEQ [2] (LOR)	(4) I-TEF	(5) I-TEQ [1] (zero)	(5) I-TEQ [2] (LOR)	(6) $^{13}C_{12}$ Rec (%)
2378-TCDD	44.5	0.5	1	44.54	44.54	1	44.54	44.54	50.7
12378-PeCDD	125.8	2.5	1	125.80	125.80	0.5	62.90	62.90	57.8
123478-HxCDD	43.3	2.5	0.1	4.33	4.33	0.1	4.33	4.33	67.5
123678-HxCDD	86.7	2.5	0.1	8.67	8.67	0.1	8.67	8.67	71.9
123789-HxCDD	86.9	2.5	0.1	8.69	8.69	0.1	8.69	8.69	-
1234678-HpCDD	667.6	2.5	0.01	6.68	6.68	0.01	6.68	6.68	71.1
OCDD	1441.9	10.0	0.0003	0.43	0.43	0.001	1.44	1.44	53.8
2378-TCDF	1.1	0.5	0.1	0.11	0.11	0.1	0.11	0.11	43.1
12378-PeCDF	<LOR	2.5	0.03	0.00	0.08	0.05	0.00	0.13	51.9
23478-PeCDF	2.7	2.5	0.3	0.80	0.80	0.5	1.34	1.34	51.7
123478-HxCDF	6.6	2.5	0.1	0.66	0.66	0.1	0.66	0.66	63.2
123678-HxCDF	5.6	2.5	0.1	0.56	0.56	0.1	0.56	0.56	61.6
234678-HxCDF	6.6	2.5	0.1	0.66	0.66	0.1	0.66	0.66	65.6
123789-HxCDF	2.6	2.5	0.1	0.26	0.26	0.1	0.26	0.26	63.3
1234678-HpCDF	41.9	2.5	0.01	0.42	0.42	0.01	0.42	0.42	57.2
1234789-HpCDF	<LOR	2.5	0.01	0.00	0.03	0.01	0.00	0.03	60.3
OCDF	40.5	5.0	0.0003	0.01	0.01	0.001	0.04	0.04	-
		(7)	**3.1606**	202.63	202.73	**2.882**	141.30	141.45	

Group Totals	*Conc pg/g*	*LOR [3] pg/g*	*No of peaks*
Tetra-dioxins	1989.7	6.5	13
Penta-dioxins	2845.8	22.5	9
Hexa-dioxins	3199.5	17.5	7
Hepta-dioxins	2129.8	5.0	2
Octa-dioxin	1441.9	10.0	1
Tetra-furans	241.3	7.5	15
Penta-furans	129.4	40.0	16
Hexa-furans	148.1	30.0	12
Hepta-furans	87.9	7.5	3
Octa-furan	40.5	5.0	1
Σ PCDD/Fs (8)	12253.8		

Notes

LOR = Limit of reporting
I-TEF = International toxic equivalency factor
I-TEQ = International toxic equivalence (pg/g)
WHO-TEF = World Health Organistaion toxic equivalency factor
WHO-TEQ = World Health Organisation toxic equivalence (pg/g)
T = tetra
Pe = penta
Hx = hexa
Hp = hepta
O = octa
CDD, dioxin = chlorinated dibenzo-*p*-dioxin
CDF, furan = chlorinated dibenzofuran

[1] I-TEQ$_{(zero)}$ and WHO-TEQ$_{(zero)}$ calculated treating <LOR as zero concentration (pg/g)

[2] I-TEQ$_{(LOR)}$ and WHO-TEQ$_{(LOR)}$ calculated treating <LOR as LoR concentration (pg/g)

[3] Totals LORs are calculated by mutliplying the number of peaks by the indivdual LOR per compound