International POPs Elimination Project

Fostering Active and Efficient Civil Society Participation in Preparation for Implementation of the Stockholm Convention

The Liberec Municipal Waste Incinerator – A significant source of POPs

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IPEP has three principal objectives:

- Encourage and enable NGOs in 40 developing and transitional countries to engage in activities that provide concrete and immediate contributions to country efforts in preparing for the implementation of the Stockholm Convention;

- Enhance the skills and knowledge of NGOs to help build their capacity as effective stakeholders in the Convention implementation process;

- Help establish regional and national NGO coordination and capacity in all regions of the world in support of longer term efforts to achieve chemical safety.

IPEP will support preparation of reports on country situation, hotspots, policy briefs, and regional activities. Three principal types of activities will be supported by IPEP: participation in the National Implementation Plan, training and awareness workshops, and public information and awareness campaigns.

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1. General information about hotspot

1.1 Description of the site

The municipal waste incinerator in Liberec is located 50°45´50´´ north latitude and 15°03´75´´ east longitude (see detailed map in Picture 1 in the Annexes).

Liberec with its 97 400 inhabitants is the sixth largest city in the Czech Republic located on the north side of the country approximately 10 km from the Polish border and about 20 km from the German border (see map in Picture 1 in the Annexes). This city is located in the valley of the river Lužická Nisa, which after leaving Czech Republic flows along the border between Poland and Germany. The city is surrounded by mountains – the Jizera Mountains on the north-eastern side and Jested Mountain (1071,6 m above sea level) lie to the south-west of the city. The municipal waste incinerator (MWI) is located almost in the middle of the city, in an area called Rochlice next to the central heating station and about 50 - 100 meters from the bank of the Lužická Nisa River.

Photo No. 1: Municipal Waste Incinerator (MWI) Termizo Liberec.

1.1 More details about the hot spot

The municipal waste incinerator in Liberec has operated since 1999. It was built by the companies Skoda TS Plzen (Czech Republic) and Von Roll (Switzerland) between 1997 and the middle of 1999 and trial operations started in mid-1999. It is operated by the Termizo Company.

The capacity of the incinerator, which is almost fully utilised (see Table 1), is 96,000 tons of municipal solid waste per annum. It is a mass burn incinerator with single chamber and after-burner furnace. Municipal solid waste is loaded onto a grate that moves it through the combustor.

Comment [AW1]: Is the original correct? - most grates are rocker grates rather than moving grates. Adding moves 'it' covers this anyway.

Until 2003 the incinerator was equipped with filters to reduce dust, sulphur dioxide and oxides of nitrogen emissions. Activated carbon injection was used from 2002-2003 in an attempt to reduce PCDD/Fs emissions but this was only partly effective. Since 2003 GORE-TEX Remedia catalytic filter bags have been used to further reduce dioxin emissions into air.

During the Integrated Pollution Prevention Control permit procedure this year the operating company has asked for permission to increase the annual waste throughput to 117,600 tons per year without any additional changes to the plant.

Table 1: Overview about amounts of burned municipal solid waste in MWI Termizo Liberec. Source: Dvorakova, I. 2004.[i]

Year	**2001**	**2002**	**2003**
Amount of waste in t/year	82,860	96,000	91,200

2. POPs releases

2.1 Air releases

Over the period from 1999 - 2003 PCDD/Fs emissions ranged between 0.185 and 7.3 ng I-TEQ/m^3. Since the catalytic filter bags were installed in 2003 PCDD/Fs levels in air emissions have been reduced below 0.1 ng I-TEQ/m^3 (0.033 and 0.0213 were measured in December 2003). MWI Termizo Liberec produces 47,000 - 54,000 m^3 of flue gas per hour and operates 8000 hours per year. A summary of data about dioxins air releases is given in Table 2.

Comment [AW2]: These figures seem low - normally an MSW incinerator produces between 5,000 and 6,000 m3 per tonne of waste. At 96,000 tpa this plant burns 12 tonnes per hour and so it would be expected to produce about 60,000 to 72,000 m3 per hour. Can they be checked as it makes a significant difference to the air emission factors and the total releases?

Table 2: Dioxins (PCDD/Fs) levels in flue gas from MWI Termizo Liberec.

Year, date	July 1999	12^{th} October 1999	29^{th} August 2000	2001	2003	December 2003	2004	2005
PCDD/Fs in ng I-TEQ/m^3	5.982	3.2	7.3	1.98	0.185	0.0213 and 0.033	0.022	0.0175

Table 3: Emissions data about PCBs in flue gas from MWI Termizo Liberec in December 2003 (after installation of catalytic filter for dioxins). Source: Jursa, V. 2003.[ii]

Compounds	Measured level in flue gas (ng/m^3)	Calculated for reference volume of oxygen (ng/m^3)[1]	Emission factor (mg/t)	Emissions per hour (mg/h)
Σ PCBs	2.464	2.145	0.011	0.117
Σ PCBs in I-TEQ	0.0049	0.0043	0.000021	0.00023

Table 4: Emissions data about PAHs in flue gas from MWI Termizo Liberec in December 2003 (after installation of catalytic filter for dioxins). Source: Jursa, V. 2003.[iii]

Compounds	Measured level in flue gas ($\mu g/m^3$)	Calculated for reference volume of oxygen ($\mu g/m^3$)[a]	Emission factor (g/t)	Emissions per hour (g/h)
Σ PAHs	0.063	0.055	0.00027	0.0030

2.2 POPs releases to land from the Liberec MWI

Comment [AW3]: Comments on ash concentrations should precede the descriptions of the treatment waters.

There are a range of wastes contaminated by POPs from the Liberec MWI. These include bottom ash, boiler ash and the wastes from the treatment of air pollution control devices ashes. These are treated with an acid bath which is intended to extract heavy metals from fly ashes. Its wastes include:

1) filter cake
2) treated fly ash, (which is then mixed with bottom ash): and
3) waste water which is discharged into the public sewer.

The quantities of waste produced each year by the incinerator are detailed in Table 5:

Table 5: Types and amounts of wastes produced by Liberec MWI

Type of waste	Amounts of produced waste per year in tons		
	2001	**2002**	**2003**
Filter cake (19 01 05)	1085..22	1051..44	1154.8
Waste water from flue gases treatment etc. (19 01 06)	106.12	121.54	21.5 *
Mixed bottom ash with treated fly ash (19 01 12)	33 703.92	38 754.17	2316.09 **
Other ashes (mainly boiler ash; 19 01 13)	128	113	92

Source: Dvorakova, I. 2004.[iv]

* only the tonnage transferred out of the plant included - waste water treated at plant‘s own waste water treatment facility is not included here.
** A substantial part of this waste has been utilised as a ‘product’ (construction material) since the beginning of 2003. The apparent production has fallen because it is no longer recorded as a waste.

[1] reference volume of oxygen is 11% according to Czech legislation valid in the date of measurement.

The levels of PCDD/Fs measured in some types of waste generated by the MWI Termizo Libeberec are detailed in Table 6:

Table 6: PCDD/Fs in Liberec MWI wastes

Type of waste	Measurement No. 1 ng I-TEQ/kg	Measurement No. 2 ng I-TEQ/kg
	2000	
bottom ash (2911)	4.37	19.7
treated fly ash (2912)	362	363
mixed bottom ash with treated fly ash (2913)	62	66
boiler ash (11249)*	11.3	-
	2005	
mixed bottom ash with treated fly ash (11357 / 1 / 2005)	97	-

Sources: Ecochem 2000,[v] Axys Varilab 2000,[vi] and Ecochem 2005a.[vii]

Data about levels of some other POPs in these wastes are presented below (see Table 13).

2.3 POPs releases to water by MWI Liberec

Levels of POPs in waste water were measured on request of Arnika - Toxics and Waste Programme during IPPC permitting process. The results are given in Table 7:

Table 7: POPs in Liberec MWI waste water

POPs	HCB	PCDD/Fs	6 PCBs congeners	Sum of PAU
Measured level	<0.010 μg/l	0[2] pg I-TEQ/l	<0,0084 μg/l	<0,18 μg/l

Sources: Ecochem 2005b,[viii] Ecochem 2004,[ix] and Ecochem 2005c.[x]

Whilst significant levels of POPs were not found in waste water from MWI Termizo Liberec the PCDD/Fs limit for waste water set in the IPPC permit is still 0.3 ng TEQ/l.

3. Potential pollution pathways

3.1 Air pollution dispersion and other pathways

The area close to the centre of the city is potentially the most affected by air emissions from the municipal waste incinerator (see Picture 3 in the Annexes). The prevailing wind directions are shown in Table 8 and it can be seen that the wind regularly blows over the incinerator and towards the city centre

[2] Only OCDD was detected at level < 39 pg/l (LOD for used method was set up for this congener at level of 39 pg/l). Other PCDD/Fs congeners were not detected.

Table 8: Prevailing wind directions

Wind direction	N	NE	E	SE	S	SW	W	NW	calm
Total in %	5.99	1.00	2.02	15.99	7.99	10.00	12.00	18.99	26.02

Source: Smetana, R. (2005), dispersion study.[xi]

Another potential pollution pathway is from the waste incineration residues that have been used for a variety of different purposes since the start of MWI operation. This is discussed further below (see Chapter 6.).

It should be pointed out that there are several more potential sources of PCDD/Fs, PCBs and HCB in this city (see Picture 2 in Annexes and following chapter).

3.2 Other potential sources of POPs releases?

Whilst there are several other potential sources of POPs in the city only a few have been measured for POPs emissions to air. They have not been measured for POPs releases to land or water.

Other potential sources of POPs releases in the city include:

a) a metallurgical plant for secondary steel production in northwestern part of the city
b) heating station burning heavy oil adjacent to the MWI
c) hospital waste incinerator to the north of the MWI
d) the crematorium
e) the car production plant Peguform
f) domestic heating systems

These potential sources are marked on the map in Picture 2 in Annex 1.

The secondary steel production plant is located approximately 2 km to the west of the MWI. Personal information from the team who measured emissions from the site indicated that high levels of PCBs have been measured in its flue gases in 1990's but no data is in the public domain.

The heating station PCDD/Fs emissions were measured only in 1998. PCDD/DF levels of 0.225 ng I-TEQ/m^3 were reported. There is a hospital waste incinerator at Liberec Hospital. PCDD/Fs air emissions reported from this incinerator were 0.404 ng I-TEQ/m^3 in 2001 and 0.088 - 0.095 ng I-TEQ/m^3 in 2003. The highest level of PCDD/Fs reported in air emissions from this incinerator was 18.828 ng I-TEQ/m^3 in 1996. Whilst the emission concentrations were higher than the MSW incinerator, total PCDD/DF releases were smaller as the flue gases flow is much lower at between 2,100 and 3,000 m^3 per hour.

Comment [AW4]: Check this as clinical waste incinerators normally produce upto about 17,000 m3/tonne. this would indicate that the plant is only handling about 150 kg/hr which is quite a small clinical waste incinerator.

Brown coal was used for the majority of domestic heating in the past, but this changed in the second half of the 1990's, following large state subsidies for switching to alternatives. Since then the change in the levels of PAHs measured in ambient air in the city has decreased. (see following chapter and graph in Picture 4).

4. POPs measurements in the Liberec environment

4.1 Ambient air POPs measurements in the environment in Liberec

Since 1995 POPs have been measured in ambient air in Liberec almost twice per year (in winter and summer). The results have been presented in several studies (City of Liberec 1999, OHS Frydek-Mistek 2000, OHS Frydek-Mistek 2001, City of Liberec 2003).[xii, xiii, xiv, xv] It is only in 1999 that there were no measurements done.

When the trends of the PCDD/Fs and PAHs concentrations in ambient air since 1995 - 2001 are compared they are found to progress in opposite directions. While the PCDD/Fs concentrations in ambient air increased rapidly between 1998 and August 2000, the levels of PAHs have fallen rapidly between 1996 and 1997.

There was another rapid change in PCDD/Fs ambient air levels between 2001 and 2002. In the Rochlice area near the incinerator the levels of PCDD/Fs were 14 - 15 fg I-TEQ/m^3 in 2002 compared with 77 - 82 fg I-TEQ/m^3 in 2000.

This is consistent with the changes in the PCDD/F releases from MWI according to data published in the IPPC application report (Dvorakova, I. 2004).[xvi] In 2001 the MWI released 0.643 g I-TEQ whilst in 2002 it was reduced to 0.0898 g I-TEQ. The reduction in emissions correlates well with the decrease in ambient air levels as there was an 86% reduction in emissions and an 82% reduction in ambient concentrations. We therefore consider that the MWI was most likely to be the major source of PCDD/Fs in ambient air of the city Liberec during period July 1999 - 2001 rather than domestic heating, which was, in any case, largely converted to gas and electricity heating by the end of the 1990's.

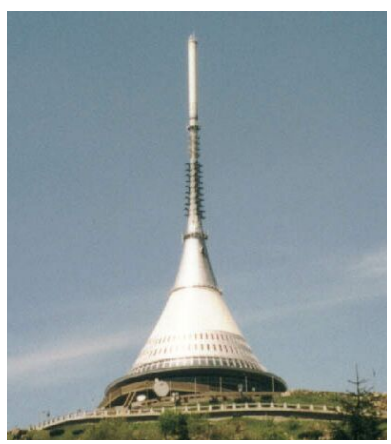


Photo No. 2: Liberec - Ještěd Mountain.

PCBs were also measured in ambient air in Liberec at the same time as PCDD/Fs and PAHs. High ambient levels of PCBs (758 fg I-TEQ/m^3) were recorded at the top of Ještěd Mountain (see Photo No. 2) during August 2000 which can be compared to winter levels of just 1.6 fg I-TEQ/m^3). Paint used for the building was found as a likely source of these high ambient PCBs levels and as PCBs are semi-volatile they evaporate at higher rates during summer time (OHS Frydek-Mistek 2001).[xvii] Emissions from domestic heating, by contrast, would clearly have been higher during the winter than in the summer.

4.2 Other POPs measurements in the environment in Liberec

A sample of soil near taken from near the MWI in Autumn 2001 was analysed for PCDD/Fs and PCBs. The levels found were 16.9 pg I-TEQ/g and 9.1 pg I-TEQ/g for PCDD/Fs and PCBs respectively. When compared with other data - from the Czech Republic (Holoubek, I., Cupr, P. 2004)[xviii] these levels can be considered to be elevated and consistent with a local emission source.

Another sample measured for POPs was the fish (trout) catch in the Lužická Nisa River in Autumn 2001. The fish was reported to contain 35.2 pg WHO-TEQ/g of fat and 165.9 pg WHO-TEQ/g of fat for PCDD/Fs and for PCBs respectively (see Table 5).

Table 9: PCDD/Fs analysis results for fish from different parts of the Czech Republic.

Place	Fish species	Sample No.	PCDD/Fs level in pg WHO-TEQ/g of fat	Date of sampling
Lampertice	trout	4037	16.2	February 2004
Ostrava	barbel	4038	61.4	October 2003
Liberec	trout	2903	35.2	September 2001
Milovice	Ictalurus nebulosus	3643	22.9	July 2003
Milovice	roach	3644	17.5	July 2003
Lysá nad Labem	crucian carp	3645	5.6	July 2003
Lysá nad Labem	Ictalurus nebulosus	3646	6.9	July 2003

IPEN organized a global sampling project testing free-range chicken eggs for POPs at the beginning of 2005. Liberec was chosen as one of the potential hotspots and 10 free-range chicken eggs were collected (see Photo No. 3) and delivered to laboratories in Prague for analysis. Whilst PCDD/DF levels in eggs sample from Liberec were not high, these eggs were found to contain the highest levels of hexachlorobenzene from the whole collection of samples from 17 countries (250 ng/g fat). Measured levels compared with other chicken egg samples worldwide are shown in Tables I - V and graphs in Pictures 7 - 10 in Annex 1. The sampling location is marked on the maps in Pictures 2 and 3. More details about the results can be found in the IPEN reports.[xix, xx]

Photo No. 3: This is a view which have people living in neighbor part of Liberec City called Rochlice. The chicken fancier who provided eggs from backyard chickens for sampling lives in this part of the city.

5. Total PCDD/Fs releases estimates from MWI Termizo Liberec

5.1 Balance of dioxin flows

We have tried to calculate an approximate balance of PCDD/Fs in the various releases from MWI Termizo Liberec according to data measured before the catalytic filter for dioxins was installed at the end of 2003. Results of this calculation are given in Table 10 and further details of the methodology are included below (see Chapter 5.2).

Our assessment indicates that the gaseous emissions contributed about 3% to the total dioxin emissions of this incinerator. The remaining 97% were present in mixed bottom ash. Because of the mixing of fly ash and bottom ashes, it is not straightforward to estimate the exact contribution of APC residues.

It is, however, possible to roughly estimate the contribution of dioxins contained in the separated slag, which is about 4.5%. This would mean that APC residues contribute about 92.5% of the dioxins.

Fly ashes and further residues from flue gases treatment form the highest proportion of dioxins releases to the environment i.e. between 56 and 99.5 %. These results are consistent with the dioxin burdens from other similar waste incinerators with emissions to air contributing only a relatively small percentage of the total releases. The release of dioxins contained in fly ashes is the major pathway into the environment and these ashes can present a serious threat to human health and the environment.

5.2 Calculation of releases of PCDD/Fs contained in wastes produced by the incinerator into the environment

In contrast to other similar plants in the Czech Republic, measurements of dioxin contents have been carried out in wastes produced by the incinerator in Liberec. Some of the results of these measurements are shown in Table 6. In addition, 213.6 ng I-TEQ/kg was also found in the mixture of fly ash and bottom ash[xxi]. The operator of the incinerator claims that the mixture of fly ash with bottom ash does not have hazardous characteristics, and since the 2001 it has been certified by the authorities as appropriate for marketing this mixture as a construction material.

Mixing of hazardous with non-hazardous wastes to dilute the concentrations to a level below the hazardous waste threshold is a bad environmental practice and is contrary to the requirements of the Hazardous Waste Directive. In this case the mixture of fly ash and bottom ash still contains relatively high concentrations of dioxins Furthermore the use of such ash in Newcastle, UK, resulted in serious dioxin contamination of eggs and poultry.[xxii]

Comment [AW5]: I can expand this if it would be helpful

The dioxins have simply been diluted rather than treated and should still be included in the reported wastes from the site and in calculation of total releases of PCDD/Fs into the environment.

UNEP has proposed and drafted a „Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases", part of which is a tool for calculation of total releases of dioxins into the environment by the use of emission factors. We have tried to use this Toolkit for calculation of the amounts of PCDD/Fs contained in the wastes produced by the incinerator in Liberec and the result is shown in Table 10.

Subsequently, we made the same calculation using known information concerning the amounts of wastes produced by the incinerator in Liberec and including the levels of dioxins found in these wastes. Dioxins in waste water were below the limits of detection and data for filter cake were not available[3]. For calculations concerning the year 2003, only estimates of releases of PCDD/Fs in 'product/material', for which the mixture of bottom ash with fly ash was certified, could be made. Our calculations were based on

[3] For our calculation, we have used the concentration of dioxins found out in treated fly ash also for the filter cake. In reality, it can be expected that the filter cake contains much higher level of dioxins than in our calculation.

data on wastes production given in support of an application for an IPPC certificate (see Table 5). Information on the calculations is contained in Table 10.

Table 10: Calculation of PCDD/Fs releases per year for MWI in Liberec based on UNEP's Toolkit and on real measurements.

	Annual release to:						Total annual release in g TEQ/a
	g TEQ/a Air	g TEQ/a Water[4]	g TEQ/a Land[5]	g TEQ/a 'Products'	g TEQ/a Fly ash	g TEQ/a Bottom Ash	
Toolkit	0.0480	0	0	0	1.44	0.144	**1.5840**
Reality 2002a	0.0898	?	?	0	0.3828	8.2780	**8.7506**
Reality 2002b	0.0898	?	?	0	0.3828	2.4030	**2.8756**
Reality 2003a	0.0370	?	?	8	0.4203	0.1440	**8.6013**
Reality 2003b	0.0370	?	?	2.25	0.4203	0.1440	**2.8513**

In each of the cases, calculation according to real values has been carried out in two variants designated "a" and "b", in view of the fact that levels of dioxins found in the mixture of fly ash with bottom ash differ significantly. The real amount of dioxins contained in this waste is likely somewhere between the two.

The results given by the Toolkit[xxiii] were very different from the calculations based on measured values. In fact, measured annual releases of dioxins were 1.8 – 5.5 times higher than calculated ones using the Toolkit. There are several reasons for this:

1) The Toolkit assumes much lower quantities of residual wastes after combustion of one ton of solid municipal waste.

2) The Toolkit does not consider situations where mixing of bottom ash with fly ash would occur. Therefore, much lower level of dioxins in bottom ash is assumed.

3) Emission factors for releases of PCDD/Fs into the environment are given as single numbers without ranges.

In spite of the fact that this calculation concerns only one municipal waste incinerator in the Czech Republic, it can play an important role from the point of view of calculation of total releases of dioxins into the environment, considering the fact that this incinerator forms 25% of the total capacity of municipal waste incinerators in the Czech Republic.

Comparison of the actual values for this incinerator with the hypothetical calculation according to the Toolkit documents highlight significant shortcomings of this tool. In the present case, its use would result in a large underestimation of total dioxins produced by the incinerator. On the other hand, it is, as a matter of course, questionable whether

[4] There were 20 - 120 tons of waste water from fly ash bath process produced by MWI in Liberec, but PCDD/Fs levels were not measured in it.
[5] It is a question how to evaluate releases of PCDD/Fs from mixed bottom ash and fly ash when it is applied during land recovery for example.

classification of the incinerator in Liberec into the best, 4, class according to the Toolkit is correct. However, we based our calculation on a classification which would be, in our opinion, chosen by Czech authors of the POPs inventory.

6. Problematic use of mixed slag and fly ash from MWI Termizo Liberec

6.1 History of use of waste incineration residues from MWI Termizo Liberec

For many years fly ash, bottom ash and further wastes from incinerators in the Czech Republic were disposed of in hazardous waste landfills. In 1997 a legal decree on wastes set a limit on dioxin content in wastes of 10 ug/kg. Wastes exceeding this limit have to be stabilised and then disposed of in a landfill site designed for and taking only hazardous wastes. At the same time, the fees for disposal of wastes to hazardous waste landfills have increased significantly. The combination of these measures has meant that the operators of waste incinerators have sought ways to avoid payment of high fees for fly ash disposal - they have also sought to avoid measurements of dioxins in fly ashes. The state authorities have assisted the achievement of both these aims.

The Liberec incinerator has been designed in such a way that fly ash is mixed with bottom ash. The incinerator, having a capacity of 96,000 tons of wastes per year, produces between 25 and 40 thousand tons of this mixture each year[6]. In spite of the fact that not only the fly ash alone, but also this mixture, exceeded the limit set out in the law[xxiv], the incinerator was allowed in 2000 to dispose of the mixture in a municipal waste landfill, and not in a hazardous waste landfill, as set out by the law.

Comment [AW6]: How does this exceed 10 ug/kg? the levels in table 6 show only 362 ng/kg

Photo No. 4: Municipal waste landfill in Košťálov, where fly ash and bottom ash mixture from MWI Liberec is deposited since year 2000.

The mixture of bottom ash with fly ash was landfilled until 2003 at landfills in Košťálov and near Český Dub. Neither were hazardous waste landfills. Some of these wastes were also used to fill up the old underground coal mine near Žacléř in north eastern part of Bohemia.[xxv]

Since 2000 the situation has changed as the new law on wastes and a decree to it have cancelled the limit for the content of dioxins in wastes. They have set out that fly ashes from waste incinerators, no matter what the contamination levels, must be, stabilised and then disposed of

[6] Specific amounts for years 2001 - 2003 are shown in Table 5.

to a landfill taking only hazardous waste. At the same time the company Termizo, operator of the incinerator in Liberec, has obtained a certificate allowing it to market the mixture of fly ash and bottom ash as a construction material.

Photo No. 5: Fly ash and bottom ash mixture sampling at bicycle path in the Protected Landscape Area Jizerské hory.

6.2 New findings

The Ministry of the Environment of the Czech Republic set out orientation limits for decontamination of old ecological burdens in 1996. Some measurements of the mixture of fly ash and bottom ash from the incinerator in Liberec exceed the limit B[7] set out by the binding instruction of the Ministry. Exceeding limit B in soils is considered a pollution that can have negative influence on human health and on individual components of the environment and that requires further measures.

Comment [AW7]: Presumably ALL measurements exceed 0.1 ug/kg / 100 ng/kg?

Comment [AW8]: I don't think that this is correct - how can it be 10 or 100 x lower?

Arnika found the ash mixture had been used in a Landscape Protected Area of the Jizera Mountains and took samples from a bicycle path. The path had been constructed by the Strabag Company in Oldřichov v Hájích municipality, with support from the European Union Funds, for 1.121 million CZK (see Press Release in Annex 2).

The path in the Jizera Mountains is probably not the only site where the mixture of slag and fly ash from MWI Termizo Liberec was used. The Strabag Company still stores SPRUK on a site near the exit from Mníšek municipality in direction to Frýdlant close to a brook (see Photo No. 7).[8] Moreover, the mixture was purchased by a number of other companies: Čefos Větrov (as a sub-base material for an access road to a planned landfill), ASANO Český Dub (for reclamation of landfill in Český Dub), Ingeo, a limited liability company (as a material for engineering a landfill in Košťálov), Gesta, joint-stock company, Rynoltice (for engineering fill in plants operated by the company - landfills and solidification plants), BEC odpady, and SSŽ Liberec, a company building roads and railways (for filling of roads). Arnika also found the mixture in a pile in front of the entrance to the landfill Čefos Větrov (see Photo No. 6).

[7] Limit B = 0.1 ug I-TEQ/kg dry weight

[8] This statement is valid in the time when the report was prepared (at the beginning of April 2006).

Arnika took several samples of the mixture after a basic investigation at the sites in Jizera Mountains. These were always composite samples from different parts of the site to assure their representative content of mixed construction material from the mixture of slag and fly ash. Three composite samples were sent to Axys Varilab laboratory for POPs analysis. The content of PCDD/Fs, PCBs and HCB in samples is shown in Table 11.

Photo No. 6: Waste landfill "Čefos Větrov", where mixed ashes from MWI Termizo Liberec were used for road cover and at the landfill itself.

Comparable levels of dioxins were also measured in a half year composite sample of the mixture taken in MWI Termizo Liberec and analyzed by the Ecochem laboratory (see last row in Table 11).

Table 11: Unintentional POPs levels in mixed slag and bottom ash from MWI Termizo Liberec sampled as construction material in comparison with a measurement based on half year sampling of the mixture directly from the incinerator

Sampling locality	PCDDs/Fs	TEQ PCDDs/Fs	TEQ PCBs	Total TEQ	HCB
	pg WHO-TEQ/g-	pg I-TEQ/g-	pg WHO-TEQ/g	pg WHO-TEQ/g	ng/g
Oldřichov v Hájích - bicycle path	66.0	57.6	1.6	67.6	0.53
Větrov - heap in front of landfill area	134.2	122.0	8.6	142.8	2.10
Mníšek - manipulation place	89.9	78.8	-	-	2.85
MWI Termizo Liberec	106.0	97.0	-	-	-

. Sources: Axys Varilab 2005,[xxvi] and 2006,[xxvii] Ecochem 2005a.[xxviii]

PBDEs were also analyzed in two samples taken by Arnika and were found at levels 0.714 (2.715) ng/g dry matter in sample from Oldřichov v Hájích and 5.849 (6.849) ng/g dry matter in sample from Větrov.[9] These levels are quite low compared with the values reported in the literature for indoor house dusts. PBDEs have previously been reported in the emissions of municipal waste incinerators (Agrell, C., A. F. H. ter Schure, et al. (2004). "Polybrominated diphenyl ethers (PBDES) at a solid waste incineration plant I: Atmospheric concentrations." Atmospheric Environment **38**(30): 5139-5148).

Comment [AW9]: Are these levels thousands or tens? It is important to be consistent with decimal points '.' and thousands dividers ',' eg 5,849.5 etc

[9] Figures in braquets are calculated by using for congeners below detection limit LOD=1.

After sampling Arnika requested an expert evaluation of the POPs found in samples by a team under the leadership of Professor Ivan Holoubek. Results of this evaluation are given in Annex 3.

Another expert assessment was carried out on measurements of heavy metals and ecotoxicity according to Czech waste management legislation. Results of ecotoxicity tests are summarized in Table 8. An expert assessment prepared by Ing. Gabriela Košařová, a person authorized for evaluation of dangerous properties of wastes came out with a clear conclusion: The mixture can not be used in open landscape areas at the surface because of its unstable properties and high levels of some heavy metals (especially lead). Also two out of the four tests of ecotoxicity did not meet Czech limits for wastes that can be used at the landscape surface.[xxix]

The Termizo Company ordered another opinion from the same team used by Arnika (Professor Ivan Holoubek) for evaluation of POPs levels, their bioavailability and toxicity. This new opinion also focused on POPs levels in the background area of Oldřichov v Hájích. Its authors measured composite samples of soil; sample marked as "Ash - no name"[10], composite sample from bicycle path and mixed slag and fly ash from MWI Termizo Liberec. The results of this review are summarized in Table 13.[xxx]

Photo No. 7: Heap of mixed ashes from MWI Liberec at manipulation site of the Strabag company near Mníšek (September 2005).

Table 12: Results of ecotoxicity tests of mixed slag and fly ash sample from Mníšek - manipulation place carried out by the laboratory Ecochem.

Parameter	Result	Limit	Used method
Acute toxicity on fish Poecilia reticulata	Average mortality 0 %	*no fish would dye*	*ČSN EN ISO 7346-2*
Acute toxicity on Daphnia magna	Average immobilization 55,0 %	*30%*	*ČSN EN ISO 6341*
Test on algae Scenedesmus subspicatus	Average inhibition 93,2 %	*30%*	*ČSN EN ISO 28692*
Test on seeds of Sinapis alba	Average inhibition 11,5 %	*30%*	*MoE methodic*

[10] This sample was declared by the team as ash from domestic heating stoves at public presentation of study. In fact that was residual waste from facility producing and renovating car brakes (according to information obtained from people living nearby the place). This suports relatively high levels of PCBs indicator congeners measured in that sample. The origin of "Ash - no name" sample is not discussed in the Holoubek, I. et al. report.

Source: Ecochem 2006.[xxxi]

The new expert opinion was that mixture used at bicycle road would not cause any harm when used properly according to the permit. Toxicity tests provided by experts showed the presence of chemicals with toxic potential, but not in the bioavailable fraction.

Looking at the levels of dioxins found in MWI Termizo Liberec mixed ash sample and those in composite sample from the bicycle path there is large difference. Although this difference was not discussed by the experts, it could be explained in two ways: first that the mixed sample from the bicycle path has been mixed with other materials like stone and gravel that lowered the average levels of dioxins and/or, secondly, that the dioxins had already leaked out of the mixture used for the bicycle path.

This is similar to the situation when the Czech State Inspection for Environment argued against the leaking of dioxins on the basis of an analysis that showed levels of 4.2 pg WHO-TEQ/g dry matter of dioxins in a sample of mixed slag and fly ash taken from the cover of the Košťálov landfill. Again, it shows a large difference when that result is compared with the level of 66.0 pg WHO-TEQ/g dry matter found during that period in the mixture sampled directly at the Liberec MWI.

6.2 Leachability of dioxins from waste incineration ashes

The methods used by professor Holoubek and his team for assessing the leachability of POPs did not include the method proposed by Takeshita and Akimoto.[xxxii]

Takeshita and Akimoto proposed the leachability of PCDD/F from fly ash by rain using a fly ash column. They showed that PCDD/F associated with water-soluble salts such as NaCl and $CaCl_2$ in the ash were eluted in the beginning of the elution, whereas those associated with slightly water-soluble particles such as calcium hydroxide were eluted in the latter half. Another report from 1995 focused on leaching of dioxins from fly ash and soils under fire-extinguishing water activity suggested that fire-extinguishing water use resulted in significant amounts of PCDD/F in the leachate.[xxxiii]

Korean scientists Yong-Jin Kim, Dong-Hoon Lee a Masahiro Osako studied PCDD/Fs leachability under circumstances comparable to those in landfills theoretically and in laboratory conditions. In a theoretical review, it was shown that dissolved humic matter (DHM) could influence the actual solubility and leachability of PCDD/F. The higher concentration of DHM showed the higher leachability of PCDD/F. In the leaching test, three different DHM concentrations and pHs of solutions were adopted to fly ash samples imaging the various characteristics of municipal solid waste leachate. It was proved experimentally that the leachability of PCDD/F increased with increasing DHM concentration in all pH conditions. The highest leachability was shown at the highest pH. Isomer distribution patterns of PCDD/F in all leachates were similar.[xxxiv]

A previous study of these scientists states that a mixture of bottom ash and fly ash shows a higher leachability of dioxins.[xxxv] This leads to the opinion that DHM are formed due to the presence of non-combusted carbon in bottom ash. The results also show several shortcomings in procedures of waste testing, because dioxins behave differently than heavy metals. Because of that, the authors of the study propose to rethink certain methods of testing.[xxxvi]

Table 13: POPs in analyzed samples from Oldřichov v Hájích. Source: Holoubek, I. et al. 2006.[xxxvii]

Sample	**TEQ PCDD/Fs**	**TEQ PCBs**	**Σ WHO-TEQ**	**HCB**	**Σ PBDE**	**Σ PAU**	**Σ OCP**	**Σ PCB indic.**
	pg WHO-TEQ/g	pg WHO-TEQ/g	pg WHO-TEQ/g	ng/g	ng/g	ng/g	ng/g	ng/g
"BACKGROUND" *)	5.0 xx)	0.35	5.35	0.69	0.21	2.5	21	2.1
„BICYCLE PATH" **)	7.7 xx)	0.5	8.2	0.65	0.25	3.0	11	1.9
„ASH - NONAME" ***)	6.4 xx)	3.4	9.8	0.65	0.14	6.5	30	125
„ASH TERMIZO" x)	48 xx)	1.6	49.6	5.5	0.89	7.3	10	4.4
Limit A MoE methodic instruction	1	NA	NA	50	NA	1	50	20
Limit B MoE methodic instruction	100	NA	NA	2,500	NA	190	2,000	2,500

*) analysis of composite sample from 4 individual samples
**) analysis of composite sample from 3 individual samples
***) ash - its origin is not known
xx) mixture of waste incineration ashes (residues) from MWI Termizo, a. s.

xx) All data below detection levels were calculated as LOD level, which gives higher figures. For examples level of dioxins for samples calculated by using "0" value for non-detects would be according to protocols about analysis attached to the report as follows:

"BACKGROUND" *)	1.2
„BICYCLE PATH" **)	7.5
„ASH - NONAME" ***)	2.8
„ASH TERMIZO" x)	48.0

It is clear that these lower figures provide a different picture of the contamination.

Sakai, Urano and Takatsuki published another study focused on the leaching of dioxins and PCBs from fly ash. Leaching tests with and without surfactants were conducted in order to understand the influence of surfactant-like substances on POPs leaching. In those tests, LAS (Linear Alkylbenzene Sulfonate) and humic acid was used as surfactant-like substances. Shredder residues from car/electrical goods recycling and fly ash from a municipal solid waste (MSW) incinerator were used in content analyses and leaching tests. Furthermore, an experiment was carried out to understand the influence of fine particles to the leaching concentration of POPs. The results of the leaching tests indicate that surfactant-like substances increase the leaching concentration of POPs, and fine particles related closely to the transporting behavior of POPs.[xxxviii]

7. Conclusions and recommendations

7.1 Conclusions

Data about unintentional POPs measured in MWI Liberec show that a modern waste incinerator can meet EU standards if fitted with catalytic bag filters and activated carbon injection and can thus significantly decrease levels of dioxins released into air. However even a modern incinerator complying with the EU emission standards also produces large quantities of dioxins in residues. According to calculations for the Liberec MWI, 97% of the dioxins were found in the residues even before the incinerator used a catalytic dioxin filter. It is likely that an even higher percentage of the total dioxin releases from this MWI will now be found in the ash.

Photo No. 8: MWI Termizo Liberec, January 2005.

This shows the importance of focusing not only on air releases, but also on unintentional POPs releases in wastes. After being pushed to deal with dioxins in residues the company Termizo has promised to install technology that will clean up dioxins from the fly ashes flow from the De-diox catalytic filter. This will be technology developed by Czech scientists called non-combustion technology ' Copper Mediated Destruction' („CMD“) method developed by the Czech scientist Vladimír

Pekárek from the Institute of Chemical Process Fundamentals, Czech Academy of Sciences.[xxxix, xl]The proposed technology should decrease dioxin levels in waste incineration residues. However it is considered that separated collection and recycling of municipal solid waste can be a better option to prevent POPs releases from municipal waste incineration as well as from landfill fires. Another option leads to material substitution that will decrease the amount of halogenated compounds and possible dioxin precursors in products.

7.1 Recommendations regarding the Dioxin Toolkit:

Very different numbers were obtained from the case of calculating total emissions using the Toolkit[xli] compared with calculations based on measured values. There are several reasons for this:

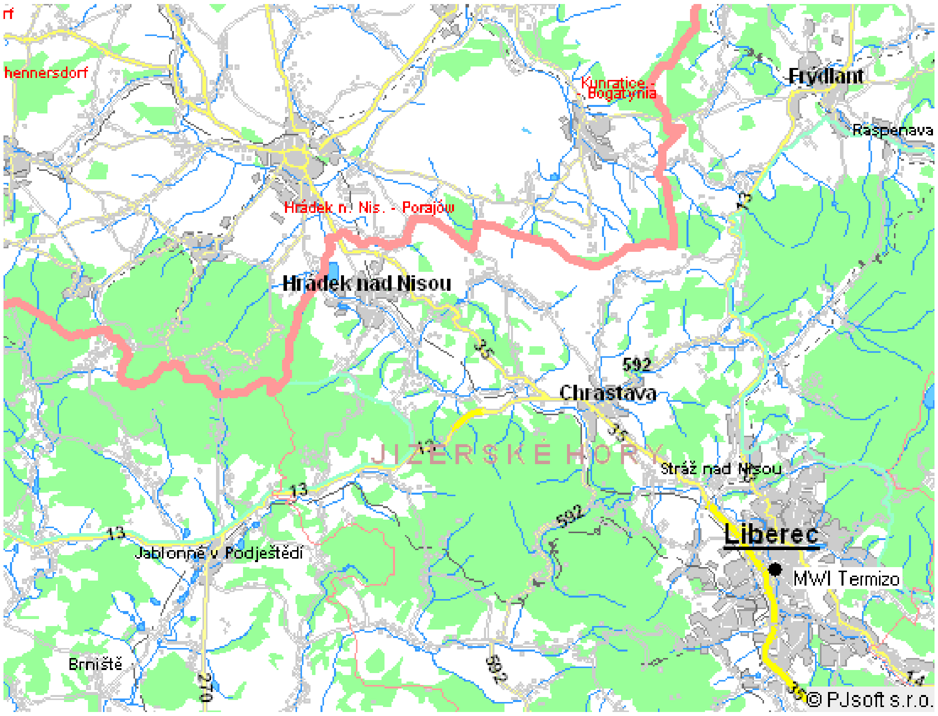
1) The Toolkit supposes a much lower tonnage of residual wastes and ashes after the combustion of one ton of solid municipal waste.

2) The Toolkit does not envisage that mixing of bottom ash with fly ash would occur. Therefore, a much lower level of dioxins in bottom ash is set.

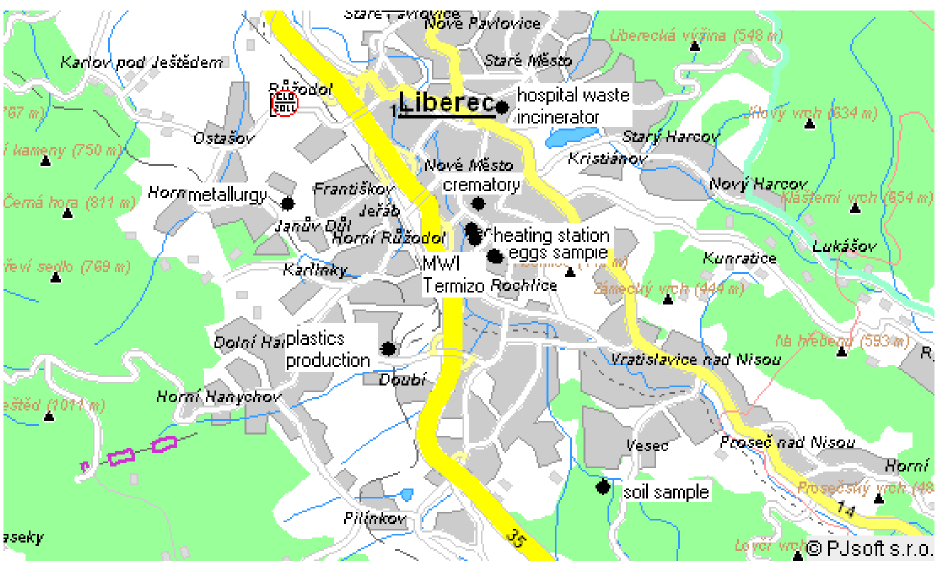
3) Emission factors for releases of PCDD/Fs into the environment are given as simple numbers without ranges.

Annex 1. Maps, tables, graphs

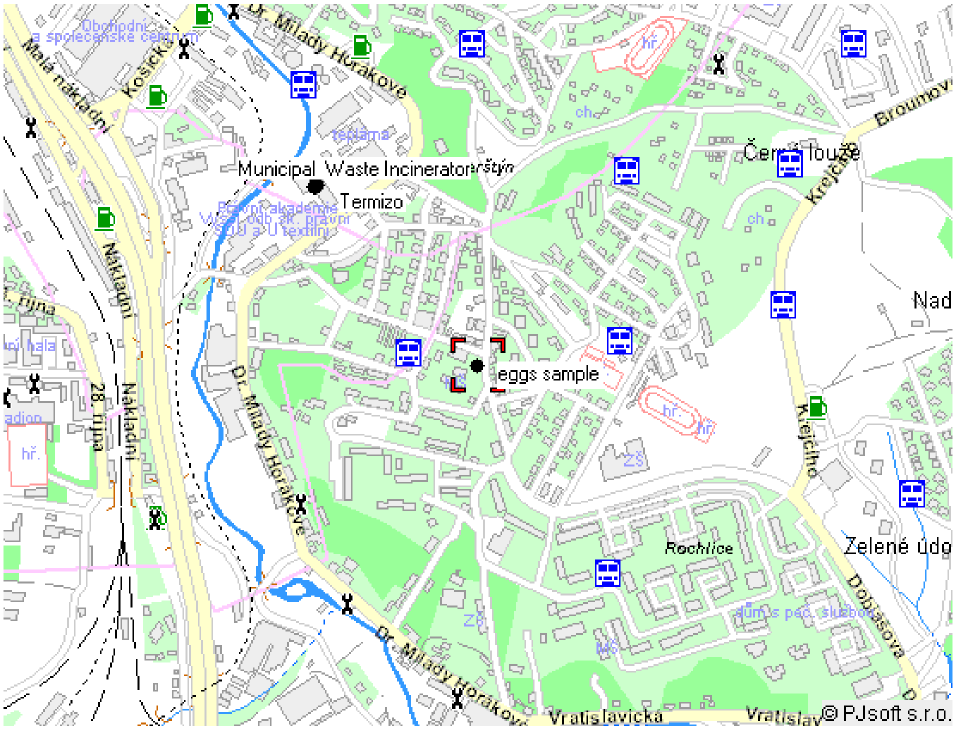
Picture 1: General map of the region with hot spot (MWI Termizo). Pink line marks Czech - Polish and Czech - German borders.



Picture. 2: Map of the city with marked potential POPs sources and samples taken for POPs analysis in the past (soil in 2000) and year 2005 (eggs sample).

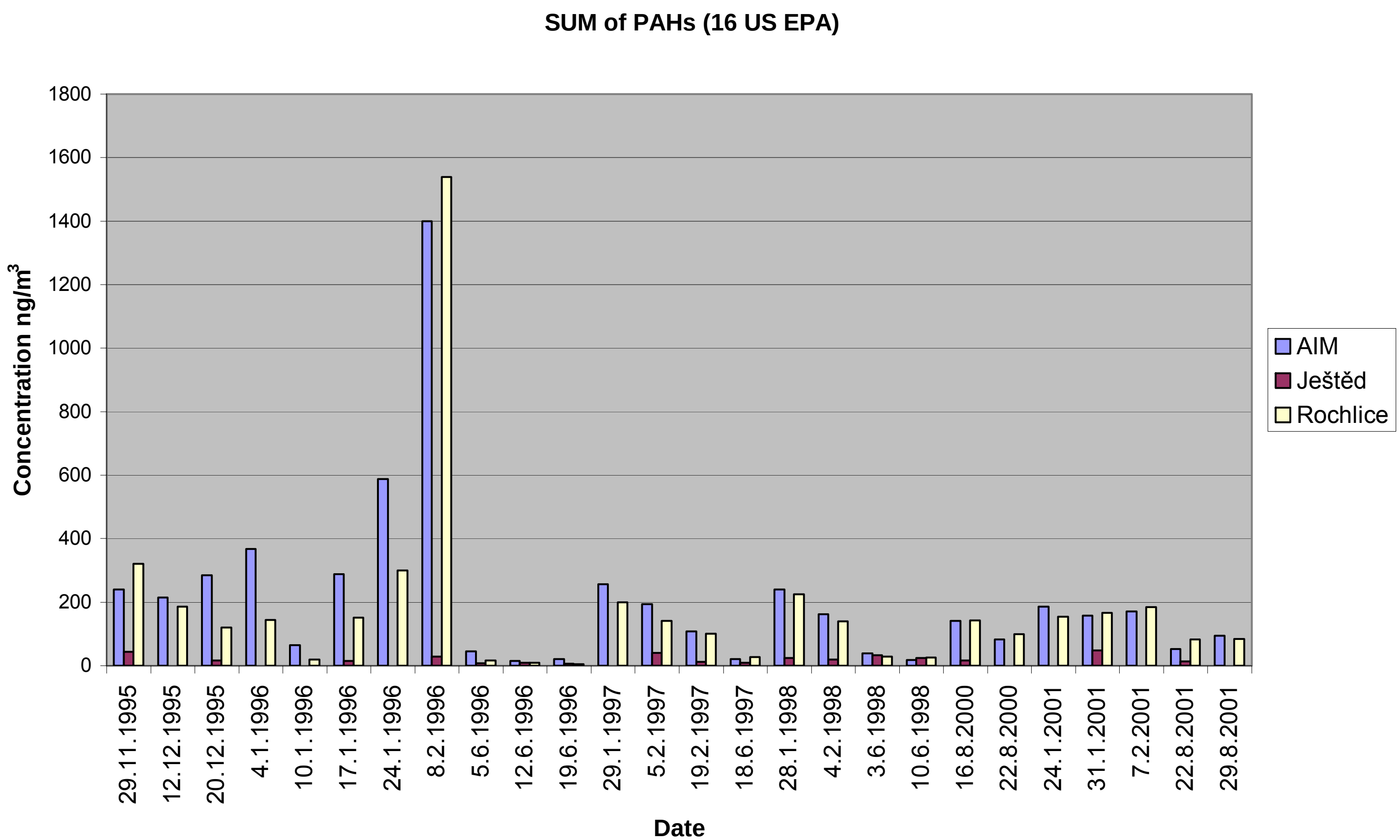


Picture 3: Map of the closer neighbourhood of the Municipal Waste Incinerator Termizo with marked place, where was taken chicken eggs sample for POPs analysis.

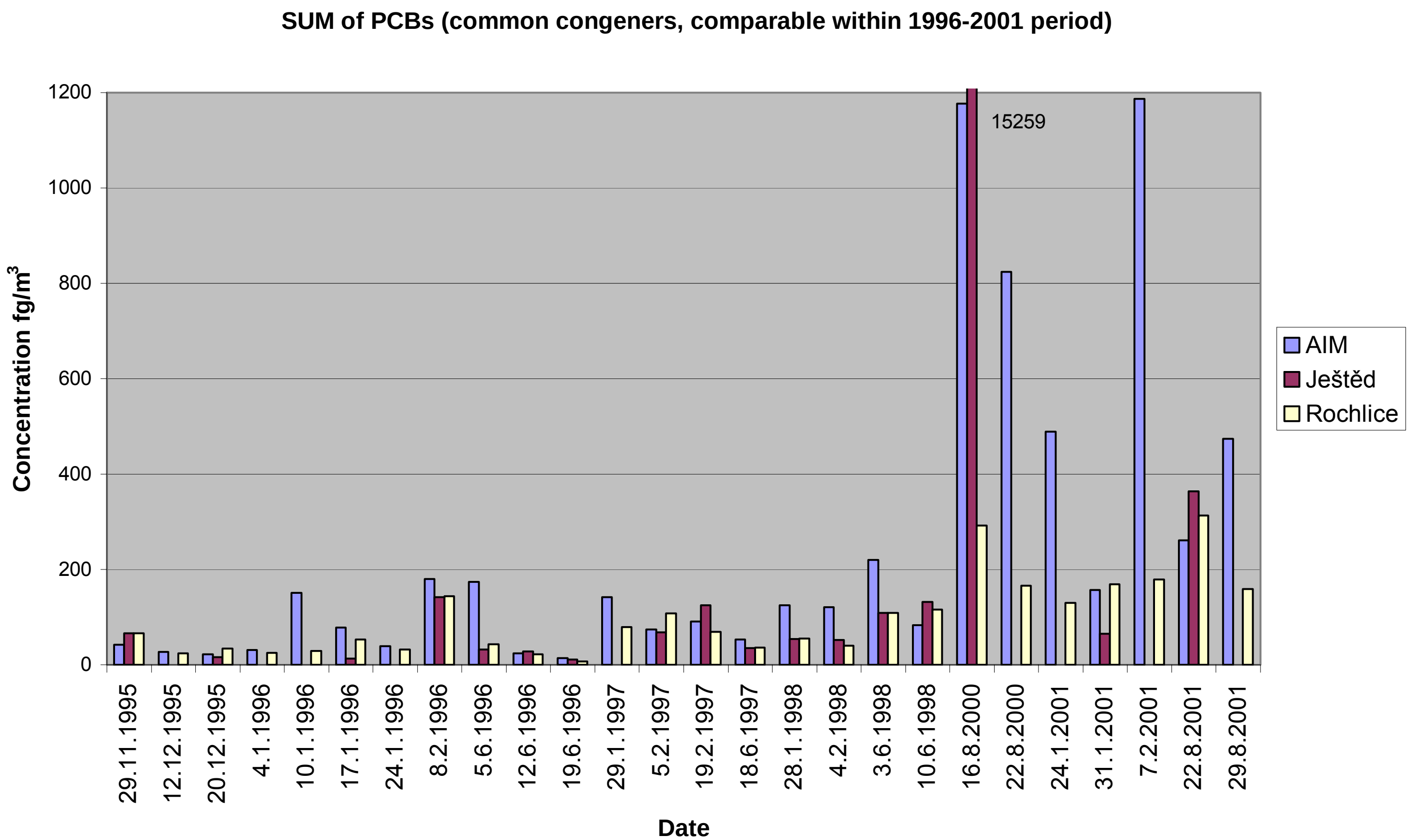


Source of following graphs: OHS Frydek-Mistek 2002[xlii]

Picture 4: PAHs concentrations measured in ambient air in Liberec



Picture 5: PCBs concentrations measured in ambient air in Liberec (source: OHS Frydek-Mistek 2002)



Picture 6: PCDD/Fs concentrations measured in ambient air in Liberec (source: OHS Frydek-Mistek 2002)

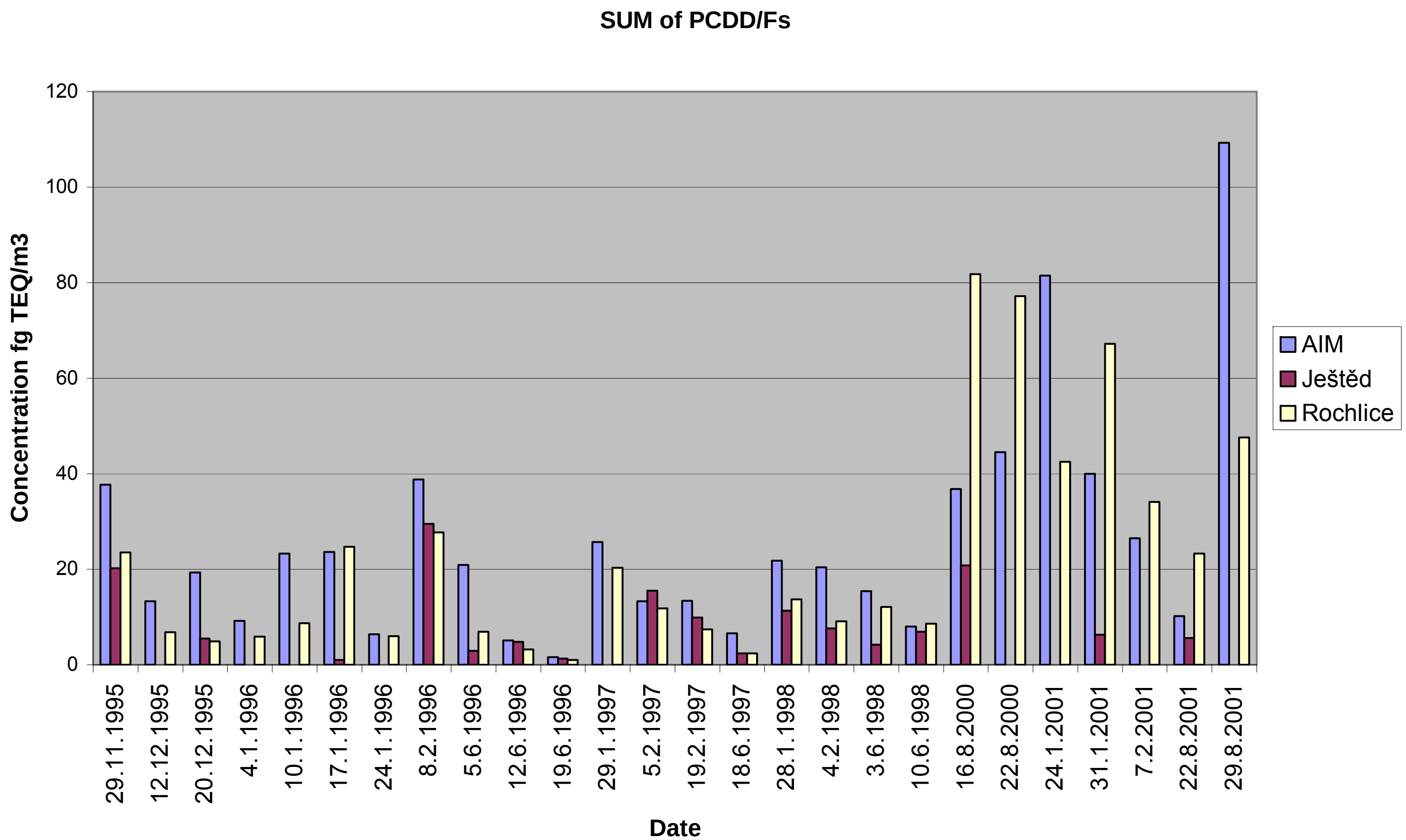


Table I: Sampling locations, concentrations of total PBDEs, HBCD, lindane and Beta HCH in composite egg samples, and characterization of sampling sites. Source: Blake, A. 2005.[xliii]

Sample Location	Σ PBDEs (ng/g fat)	HBCD (ng/g fat)	Lindane (ng/g fat)	Beta HCH (ng/g fat)	Characterization of sample site
Belarus - Bolshoi Trostenec	NA	NA	0.58	2.40	Dumpsite (fires)
Bulgaria - Kovachevo	NA	NA	1.10	19.50	Power plants, industrial area
Czech Republic - Liberec (fresh eggs)	2.0	< 3.0	2.00	0.60	Municipal waste incinerator, secondary steel production
Czech Republic - Liberec (boiled eggs)	0.8	< 3.0	2.30	0.43	Municipal waste incinerator, secondary steel production
Czech Republic - Lysá nad Labem	10.5	6.8	NA	NA	Hazardous waste incinerator
Czech Republic - Usti nad Labem	1.0	< 3.0	0.68	0.54	Chlorine chemical industry site, hazardous waste incinerator
Egypt - Helwan	NA	NA	0.66	52.50	Metallurgy, cement kilns
India – Eloor	NA	NA	3.00	85.40	Organochlorine pesticides production
India - Lucknow	NA	NA	18.90	390	Medical waste incinerator
India – Takia	NA	NA	23.40	3100	Organochlorine pesticides production
Kenya - Dandora	29.3	160.3	1.40	1.10	Dumpsite (fires)
Mexico – Coatzacoalcos	30.8	90.8	2.20	1.40	Petrochemical complex
Mozambique - Santos	12.3	18.9	1.30	4.50	Cement kiln burning waste
Pakistan - Peshawar	NA	NA	0.75	4.70	Mixed waste dumpsite
Philippines – Barangay Aguado	33.6	8.7	1.30	6.80	Medical waste incinerator
Russia - Gorbatovka	NA	NA	0.50	100.00	Chlorine chemical industry site, hazardous waste incinerator
Russia - Igumnovo	NA	NA	1.10	36.30	Chlorine chemical industry site, hazardous waste incinerator
Senegal - Mbeubeuss	NA	NA	2.00	4.00	Dumpsite (fires)
Senegal - Sangalkam	NA	NA	21.40	41.10	Pesticides application area
Slovakia - Kokshov-Baksha	29.3	89.2	0.48	1.80	Municipal waste incinerator
Tanzania - Vikuge	NA	NA	2.30	310	Obsolete pesticides storage
Turkey – Izmit	106.8	42.8	0.60	3.70	Hazardous waste incinerator
Uruguay - Minas	1.8	89.2	0.51	2.00	Cement kilns burning waste
USA - Mossville	23.4	7.2	1.70	0.27	PVC and oil industries

Table II: Levels of dioxins (PCDD/Fs) in pool samples of free range chicken eggs from 17 countries.

Country/locality	Year	Number of analyzed eggs	Measured level in pg/g (WHO-TEQ) of fat	Source of information
Uruguay, Minas	2005	8/1 pool	2.18	Axys Varilab 2005
Czech Republic, Liberec I	2005	3/1 pool	2.61	Axys Varilab 2005
Czech Republic, Liberec II	2005	3/1 pool	2.63	Axys Varilab 2005
Czech Republic, Usti nad Labem	2005	6/1 pool	2.90	Axys Varilab 2005
Pakistan, Peshawar	2005	3/1 pool	2.91	Axys Varilab 2005
Tanzania, Vikuge	2005	6/1 pool	3.03	Axys Varilab 2005
Turkey, Izmit	2005	6/1 pool	3.37	Axys Varilab 2005
Belarus, Bolshoi Trostenec	2005	6/1 pool	3.91	Axys Varilab 2005
Mozambique, Santos	2005	6/1 pool	5.08	Axys Varilab 2005
USA, Mossville	2005	6/1 pool	5.97	Axys Varilab 2005
Czech Republic, Lysá nad Labem	2004	4/1 pool	6.77	Axys Varilab 2004
Philippines, Barangay Aguado	2005	6/1 pool	9.68	Axys Varilab 2005
Slovakia, Kokshov-Baksha and Valaliky	2005	6/1 pool	11.52	Axys Varilab 2005
Russia, Gorbatovka	2005	4/1 pool	12.68	Axys Varilab 2005
India, Eloor	2005	6/1 pool	13.91	Axys Varilab 2005
India, Lucknow	2005	4/1 pool	19.80	Axys Varilab 2005
Mexico, Coatzacoalcos	2005	6/1 pool	21.63	Axys Varilab 2005
Kenya, Dandora	2004	6/1 pool	22.92	Axys Varilab 2005
Senegal, Mbeubeuss	2005	6/1 pool	35.10	Axys Varilab 2005
Russia, Igumnovo	2005	4/1 pool	44.69	Axys Varilab 2005
Bulgaria, Kovachevo	2005	6/1 pool	64.54	Axys Varilab 2005
Egypt, Helwan	2005	6/1 pool	125.78	Axys Varilab 2005

Picture 7: Graph levels of PCDD/Fs in different free range chicken eggs samples according to data in Table II.

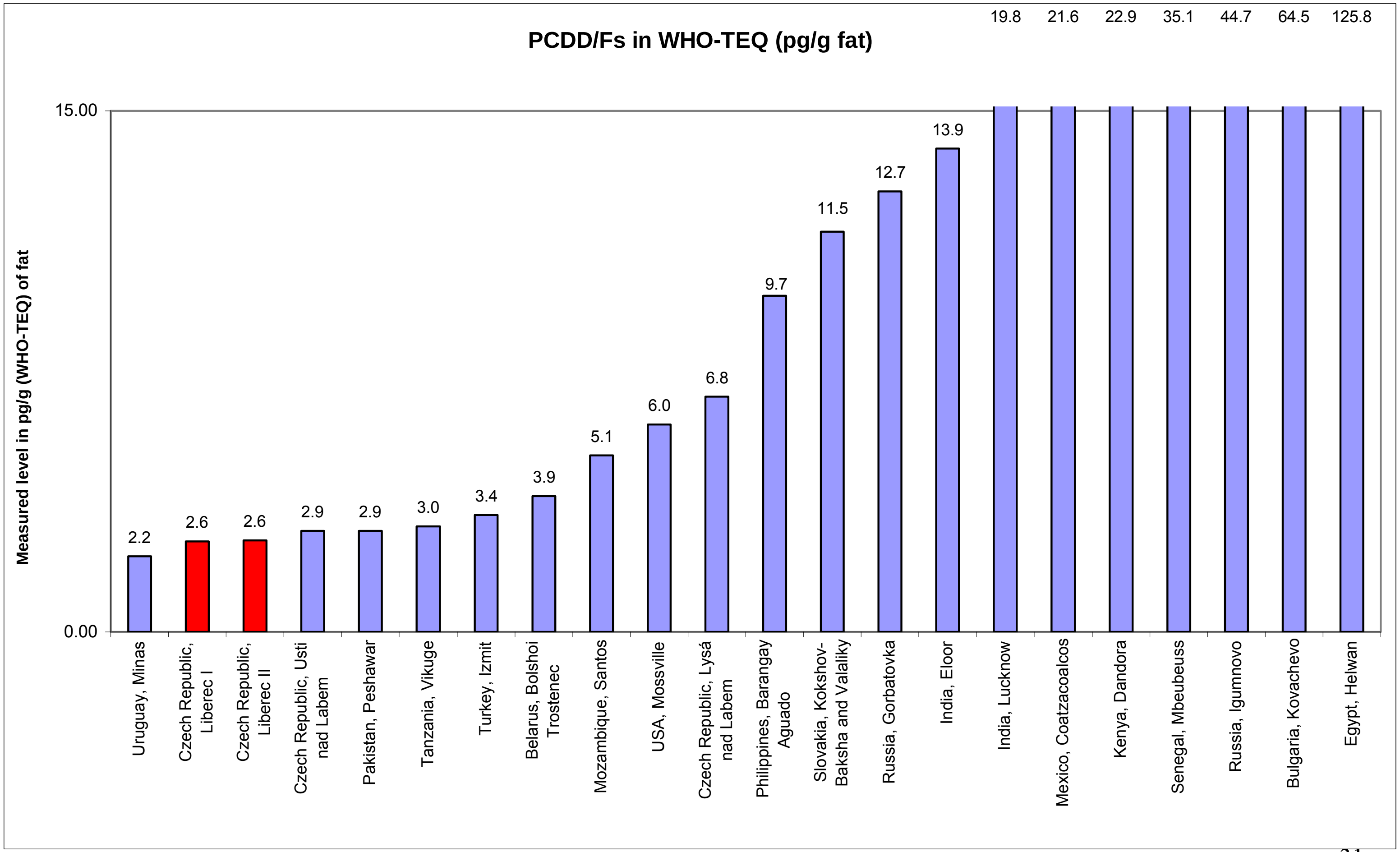


Table III: PCBs levels found in different free range chicken eggs samples.

Country/locality	Year	Number of analyzed eggs	Measured level in pg/g (WHO-TEQ) of fat	Source of information
Czech Republic, Liberec I	2005	3/1 pool	0.60	Axys Varilab 2005
Tanzania, Vikuge	2005	6/1 pool	0.70	Axys Varilab 2005
Pakistan, Peshawar	2005	3/1 pool	0.80	Axys Varilab 2005
Turkey, Izmit	2005	6/1 pool	0.93	Axys Varilab 2005
Czech Republic, Liberec II	2005	3/1 pool	1.07	Axys Varilab 2005
India, Eloor	2005	6/1 pool	1.17	Axys Varilab 2005
Czech Republic, Usti nad Labem	2005	6/1 pool	1.22	Axys Varilab 2005
USA, Mossville	2005	6/1 pool	1.74	Axys Varilab 2005
Philippines, Barangay Aguado	2005	6/1 pool	3.30	Axys Varilab 2005
Senegal, Mbeubeuss	2005	6/1 pool	3.44	Axys Varilab 2005
Uruguay, Minas	2005	8/1 pool	3.75	Axys Varilab 2005
Mozambique, Santos	2005	6/1 pool	4.37	Axys Varilab 2005
Slovakia, Kokshov-Baksha + Valaliky	2005	6/1 pool	4.60	Axys Varilab 2005
Mexico, Coatzacoalcos	2005	6/1 pool	4.69	Axys Varilab 2005
Bulgaria, Kovachevo	2005	6/1 pool	5.03	Axys Varilab 2005
Kenya, Dandora	2004	6/1 pool	8.10	Axys Varilab 2005
Russia, Gorbatovka	2005	4/1 pool	9.08	Axys Varilab 2005
India, Lucknow	2005	4/1 pool	9.40	Axys Varilab 2005
Belarus, Bolshoi Trostenec	2005	6/1 pool	9.83	Axys Varilab 2005
Egypt, Helwan	2005	6/1 pool	11.74	Axys Varilab 2005
Russia, Igumnovo	2005	4/1 pool	18.37	Axys Varilab 2005
Czech Republic, Lysá nad Labem	2004	4/1 pool	22.41	Axys Varilab 2004

Picture 8: Graph levels of PCBs in WHO-TEQ in different free range chicken eggs samples according to data in Table III.

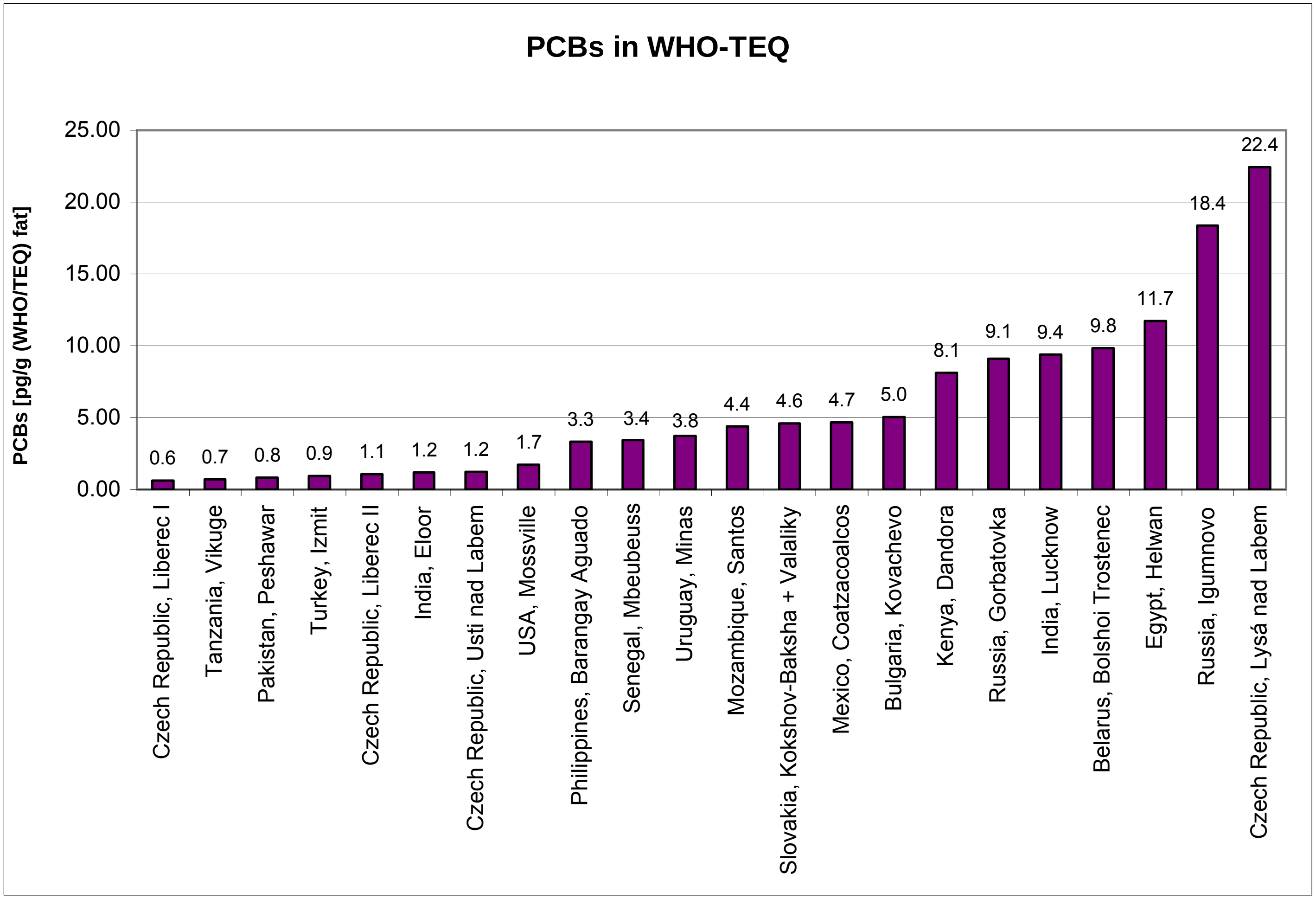


Table IV: Seven PCB congeners levels found in different free range chicken eggs samples.

Country	Year	Number of analyzed eggs	Measured level in ng/g fat	Source of information
USA, Mossville	2005	6/1 pool	1.70	Axys Varilab 2005
Bulgaria, Kovachevo	2005	6/1 pool	3.04	Axys Varilab 2005
Tanzania, Vikuge	2005	6/1 pool	4.10	Axys Varilab 2005
Pakistan, Peshawar	2005	3/1 pool	4.14	Axys Varilab 2005
India, Eloor	2005	6/1 pool	4.46	Axys Varilab 2005
Turkey, Izmit	2005	6/1 pool	5.13	Axys Varilab 2005
Egypt, Helwan	2005	6/1 pool	6.80	Axys Varilab 2005
Czech Republic, Liberec I	2005	3/1 pool	13.69	Axys Varilab 2005
Czech Republic, Liberec II	2005	3/1 pool	21.61	Axys Varilab 2005
Czech Republic, Usti nad Labem	2005	6/1 pool	26.32	Axys Varilab 2005
Uruguay, Minas	2005	8/1 pool	29.00	Axys Varilab 2005
Senegal, Mbeubeuss	2005	6/1 pool	29.17	Axys Varilab 2005
Mexico, Coatzacoalcos	2005	6/1 pool	30.62	Axys Varilab 2005
Kenya, Dandora	2004	6/1 pool	31.10	Axys Varilab 2005
Mozambique, Santos	2005	6/1 pool	39.17	Axys Varilab 2005
Philippines, Barangay Aguado	2005	6/1 pool	60.90	Axys Varilab 2005
Russia, Gorbatovka	2005	4/1 pool	63.50	Axys Varilab 2005
Belarus, Bolshoi Trostenec	2005	6/1 pool	70.87	Axys Varilab 2005
India, Lucknow	2005	4/1 pool	75.34	Axys Varilab 2005
Russia, Igumnovo	2005	4/1 pool	167.30	Axys Varilab 2005
Slovakia, Kokshov-Baksha + Valaliky	2005	6/1 pool	189.00	Axys Varilab 2005
Czech Republic, Lysa nad Labem	2004	4/1 pool	315.80	Axys Varilab 2004
Czech Republic, Lysa nad Labem	2005	1 individual	337.60	VSHCT 2005

Picture 9: Graph levels of seven PCB congeners in different free range chicken eggs samples according to data in Table IV.

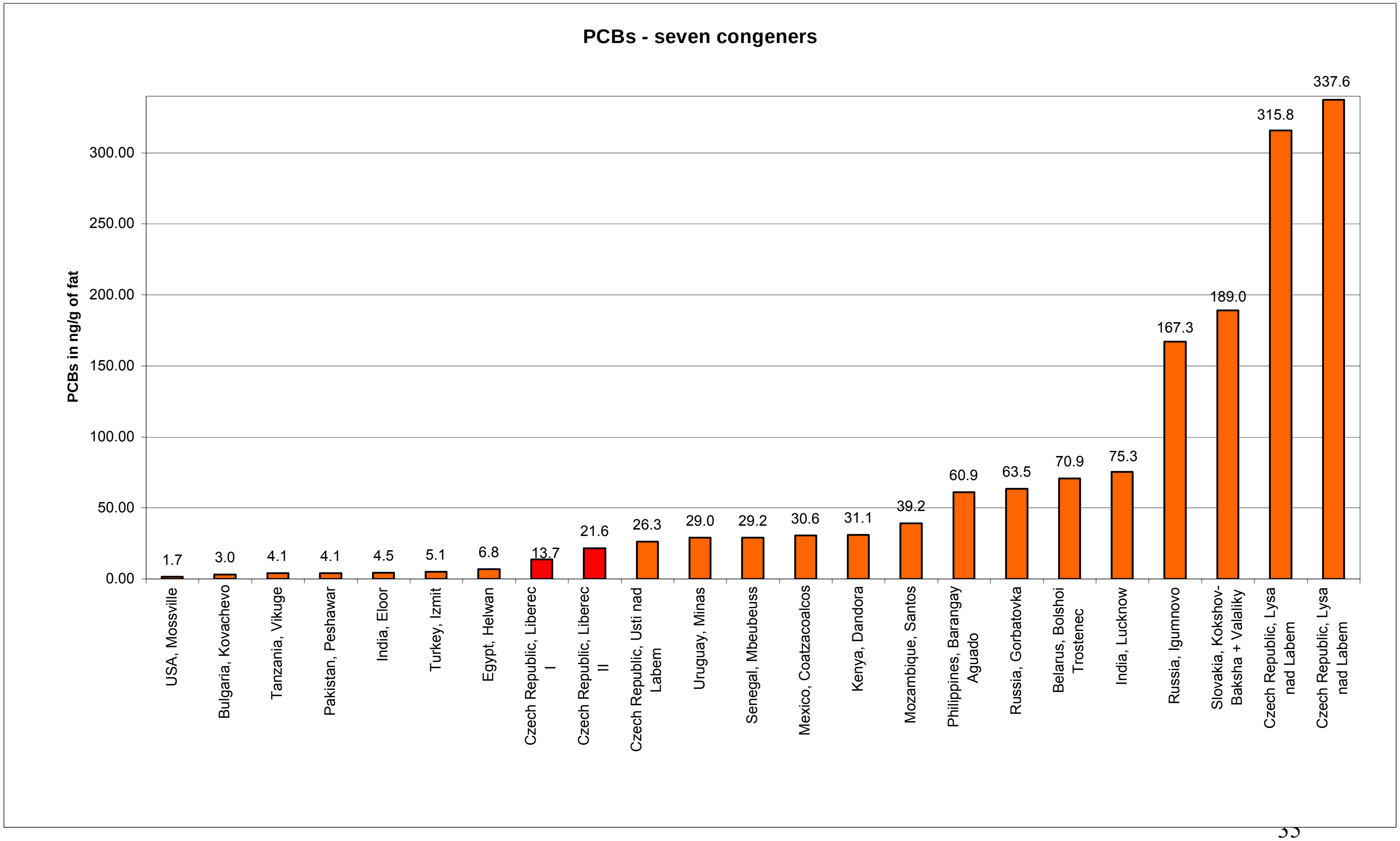


Table V: HCB levels found in different free range chicken eggs samples.

Country	Date/year	Group	Number of measured samples	Measured level in ng/g of fat	Source of information
Mozambique, Santos	2005	free range	6/1 pooled	0.92	Axys Varilab 2005[xliv]
Czech Republic, Mestec Kralove	2003	free range	3	1.0	SVA CR 2004[xlv]
Uzbekistan, Nukus	2001	free range	-	1.0	Muntean, N. et al. 2003[xlvi]
Pakistan, Peshawar	2005	free range		1.1	Axys Varilab 2005
USA, Mosville	2005	free range	6/1 pooled	1.2	Axys Varilab 2005
Uruguay, Minas	2005	free range	8/1 pooled	1.4	Axys Varilab 2005
Senegal, Mbeubeuss	2005	free range	6/1 pooled	1.7	Axys Varilab 2005
Philippines, Barangay Aguado	2005	free range		1.7	Axys Varilab 2005
Kenya, Dandora	2004	free range	6/1 pool	4.4	Axys Varilab 2005
Belarus, Bolshoi Trostenec	2005	free range	6/1 pool	4.7	Axys Varilab 2005
Turkey, Izmit	2005	free range	6/1 pooled	5.3	Axys Varilab 2005
India, Eloor	2005	free range	6/1 pooled	7.7	Axys Varilab 2005
Slovakia, Kokshov-Baksha	2005	free range	6/1 pool	10.7	Axys Varilab 2005
Russia, Igumnovo	2005	free range	4/1 pooled	11.8	Axys Varilab 2005
Czech Republic, Beneshov	2004	free range	4/1 pool	14.9	Axys Varilab 2004
Egypt, Helwan	2005	free range	6/1 pooled	15.1	Axys Varilab 2005
Slovakia, Stropkov	before 1999	free range	1	16.6	Kocan, A. et al. 1999 [xlvii]
Uzbekistan, Chimbay	2001	free range	-	19.0	Muntean, N. et al. 2003
Tanzania, Vikuge	2005	free range	6/1 pool	19.1	Axys Varilab 2005
Bulgaria, Kovachevo	2005	free range	6/1 pooled	25.5	Axys Varilab 2005
Mexico, Coatzacoalcos	2005	free range	6/1 pooled	34.5	Axys Varilab 2005
India, Lucknow	2005	free range	4/1 pooled	34.5	Axys Varilab 2005
Czech Republic, Usti nad Labem	2005	free range	6/1 pool	35.8	Axys Varilab 2005
Slovakia, Michalovce	before 1999	free range	1	40.7	Kocan, A. et al. 1999
Czech Republic, Lysa nad Labem	2004	free range	1	46.4	Axys Varilab 2005
Russia, Gorbatovka	2005	free range	4/1 pooled	68.9	Axys Varilab 2005
Czech Republic, Liberec	2005	free range	3/1 pool	250.0	Axys Varilab 2005

Picture 10: Graph showing levels of HCB in different free range chicken eggs samples according to data in Table V.

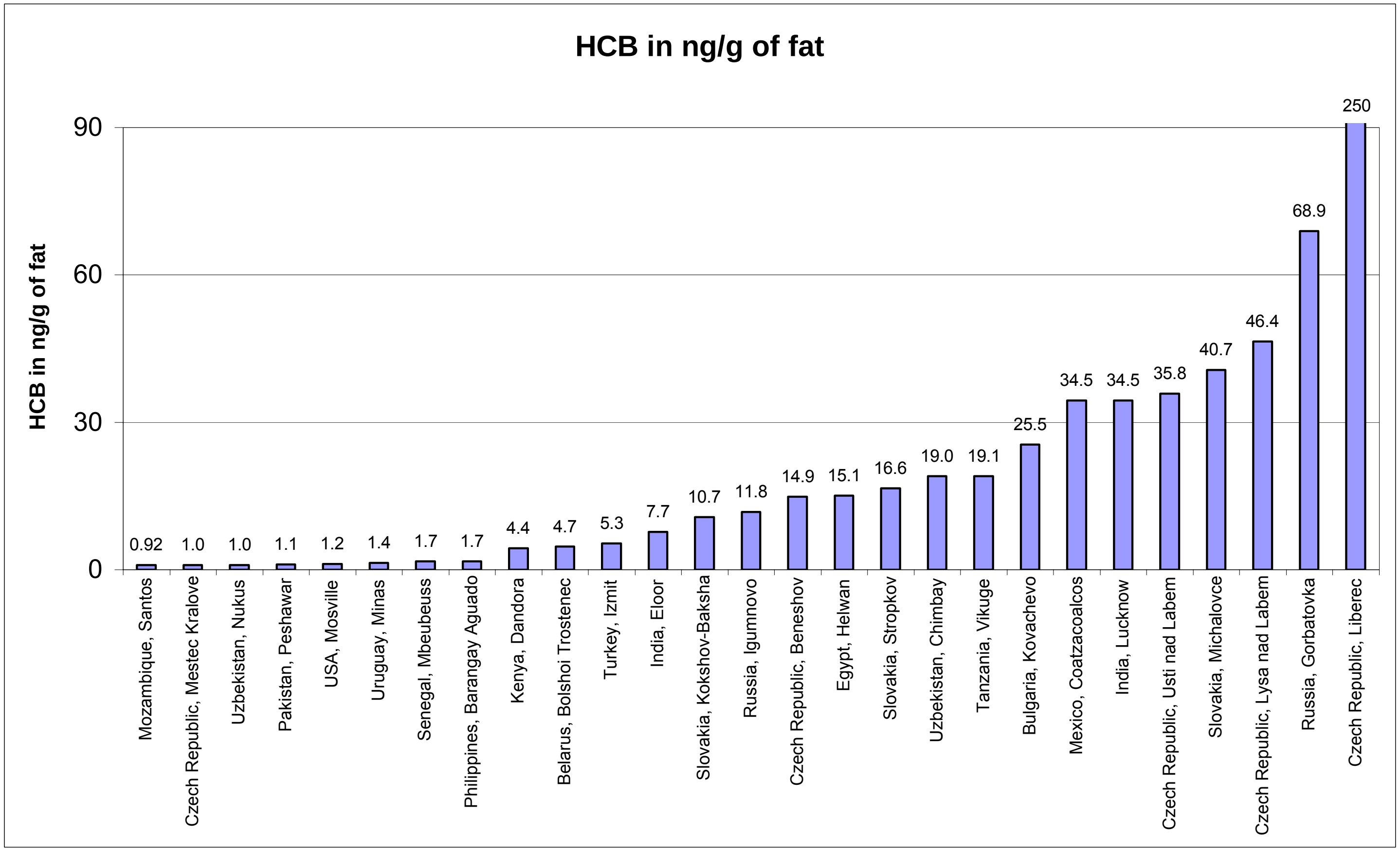


Table VI: Aggregated data on contamination of selected areas of the Czech Republic by persistent organic pollutants (PAHs, PCBs, OCPs, PCDDs/Fs, DL PCBs from archive of Project TOCOEN – Toxic Organic Compounds in the Environment) which are a property of the Consortium RECETOX-TOCOEN: median, (minimum-maximum), n = number of analyzed samples. * sampling continued also in 2002 and is going to continue. Source: Holoubek, I. et al. 2005. [xlviii]

Locality Charakteristics of sampling	**Number of sampling localities**	**Sampling period**	**PAHs (16 USEPA)**	**PCBs (7 indicators)**	**HCHs (4 izomers)**	**DDTs (DDT + DDE + DDD)**	**HCB**	**PCDDs/Fs**	**TEQ**	**DLPCBs (77+126+169)**	**TEQ DL PCBs**
			[ng.g^{-1}]					[pg.g^{-1}]			
Košetice, Central European POPs backgorund locality	9	1988-2001*	244.3 (5.8 – 5 412) n = 87	4.19 (0.07 – 116) n = 63	0.59 (0.02 – 182) n = 82	3.6 (0.20 – 294) n = 88	0.55 (0.04 – 9.18) n = 99				
	5	1998-2001*						87.11 (22.8 – 1 241) n = 9	1.3 (0.3 – 16.4) n = 9	7.91 (3.05 – 234.2) n = 9	0.25 (0.08 – 5.24) n = 9
Zlín, industrial aglomeration (indust., agricutltural and background localities)	17	1993	3 145 (220 – 22 025) n = 62	16.47 (1.1 – 345.8) n = 63	0.89 (0.22 – 8.51) n = 63	9.39 (0.72 – 1 018) n = 63	3.28 (0.02 – 44.2) n = 63	307.1 (75.3 – 2 238) n = 10	2.42 (1.27 – 4.45) n = 10	53.4 (6.59 – 84.3) n = 10	0.78 (0.16 – 1.94) n = 10
	29	1997-2000									
	5	2001									
Beroun, industrial aglomeration (indust., agricutltural and background localities)	25	2001	523.9 (123.1 – 6 778) n = 25	6.87 (4.36 – 29.2) n = 25	1.03 (0.34 – 1.62) n = 25	8.8 (2.19 – 216) n = 25	2.54 (0.54 – 10 295) n = 25	276.2 (98.3 – 1 279) n = 25	1.82 (0.97 – 7.11) n = 25	40.76 (11.2 – 158.7) n = 25	0.52 (0.19 – 2..92) n = 25
Mokrá, surrounding of industrial source	12	1998-2001*	283.0 (29.0 – 2 953) n = 120	4.11 (1.78 – 27.5) n = 120	0.74 (0.11 – 64.7) n = 120	14.45 (0.80 – 6 120) n = 120	0.75 (0.06 – 8.39) n = 120				
	6	2000-2001*						61.2 (42.2 – 703.5) n = 12	0.78 (0.42 – 13.7) n = 12	11.97 (3.04 – 172.6) n = 12	0.29 (0.11 – 4.08) n = 12
Border mountains, backgorund localities without local sources, influenced only by a distant transport	14	1994-1995, 1998-2001	3 213 (242 – 8 188) n = 23	26.2 (7.9 – 82.8) n = 21	1.34 (0.22 – 5.78) n = 15	55.0 (6.08 – 1 908) n = 21	2.21 (0.47 – 11.9) n = 21	1 900 (624.5 – 8 383) n = 23	28.5 (11.2 – 141.6) n = 23	242.6 (0.18 – 575) n = 15	6.4 (0 – 12.01) n = 15
Highways, surrounding of Cezch highways	112	1999	192.8 (6.8 – 10 776) n = 60	3.9 (1.14 – 227.3) n = 45	1.18 (0.17 – 14.6) n = 45	12.88 (0.43 – 356.5) n = 45	0.92 (0.05 – 6.6) n = 45	NA	NA	NA	NA

Annex 2: Arnika Press Release

The European Union paid for contamination of a protected landscape area by fly ash

November 1, 2005

LIBEREC (Arnika -Toxics and Waste Programme) - A mixture of toxic fly ash with slag from the Liberec incinerator, which was sold by the Termizo company, without authorisation, for construction purposes for more than a year, contaminated the environment in the Protected Landscape Area Jizerské hory (Jizera Mountains). Arnika found this, at the instance of local citizens, when it took samples from a bicycle path which had been constructed by the Strabag Company in Oldřichov v Hájích municipality, with support from the European Union Funds, for 1.121 million CZK.

"At first sight, the path looked like any other one. However, after more thorough inspection, it turned out that a mixture of fly ash and slag, sold by the Liberec incinerator, was used in the embankment in the layer 10 centimetres below surface. We took samples and ordered their analysis for the contents of dioxins and further substances in the accredited laboratory Axys Varilab in Skochovice," stated head of the Arnika's campaign Toxics Free Future, Jindřich Petrlík, DSc.

Results of the analyses (1) confirmed that the fear of the local citizens was right: "The tests showed that the path going through a protected landscape area contains, approximately, the same amount of dioxins as contaminated sediments in the vicinity of the Spolana company," said Petrlík.

The tests proved that a whole spectrum of persistent organic pollutants: dioxins (PCDD/F), polychlorinated biphenyls (PCB), hexachlorobenzene (HCB), and polybrominated diphenylethers (PBDE), were present in the samples. All these substances persist in the environment for a long time, and show negative effects on health of people and animals.

The fact that the Strabag Company used the mixture, sold by the Termizo company under designation SPRUK, for the construction of the path was confirmed also by the Czech Environmental Inspection Agency in response to Arnika's impulse. The bicycle path was constructed this summer. For a part of this time, the municipal waste incinerator Termizo Liberec did not possess a valid certificate authorising it to sell the mixture of slag and fly ash as a material for construction purposes. This follows, apart from other things, from the statement obtained from the Ministry of Industry and Trade.

"We consider really alarming that a construction company dares to bring toxic fly ash into forests in a protected landscape area. We do not care whether they have a certificate authorising them to do it, or not. The fact is that dioxins are present there. It is not important whether it is legal. This concerns our health," commented on the situation Květa Zíková from Oldřichov v Hájích (2).

Jindřich Petrlík, M.S., remarked that the path in the Jizera Mountains probably is not the only locality where the toxic mixture ended up. The Strabag Company still stores SPRUK on a site near the exit from Mníšek municipality in direction to Frýdlant city, in vicinity of a brook. Moreover, the mixture was purchased by a number of other companies: Čefos Větrov (as a sub-base material for an access road to a planned landfill), ASANO Český Dub (for reclamation of landfill in Český Dub), Ingeo, limited liability company (as a material for technical securing of a landfill in Košťálov), Gesta, joint-stock company, Rynoltice (for technical filling in plants operated by the company - landfills and solidification plants), BEC odpady, and SSŽ Liberec (for filling). Arnika found the mixture on a heap in front of entrance to landfill Čefos Větrov.

Annex 3: Final parts of the analysis done by Arnika - Toxics and Waste Programme as requested by Holoubek, I. et al. 2005 [xlix]

Evaluation of analysis results for construction material samples

POPs content found in two samples of construction material composed of a mixture of slag and fly ash according to submitted protocols about analysis done by laboratory AXYS VARILAB, s.r.o. is as follows:

Sampling locality	PCDDs/Fs	TEQ PCDDs/Fs	TEQ PCBs	Σ TEQ	HCB
	[pg WHO-TEQ.g^{-1}]	[pg I-TEQ.g^{-1}]	[pg WHO-TEQ.g^{-1}]	[pg WHO-TEQ.g^{-1}]	[ng.g^{-1}]
Oldřichov v Hájích	66,0	57,6	1,6	67,6	0,53
Větrov	134,2	122,0	8,6	142,8	2,1

This means that the material taken for sampling cannot be considered as a soil as the material is utilized as a building material and, according to terminology used in Appendix 1 of the Metodic instruction of the Ministry of Environment (Official bulletin of the Ministry of Environment No. 3/1996) it is earth.

But if we simply numerically compare concentration found in the evaluated construction material with concentrations in soil in the Czech Republic, the levels are higher in terms of PCDDs/Fs than contaminated soil in the industrial areas. The measured levels are on the level of Criteria B (= intervention limit) for the assessment of earth pollution (according to Appendix 1 of the Methodic instruction of the Ministry of Environment (Official bulletin of the Ministry of Environment No. 3/1996). Concentrations of indicatory PCBs usually measured in soils were not included in the submitted materials and concentrations of HCB are lower than it is usual in various types of soil in the Czech Republic.

Conclusions

- The assessed samples can be considered as indicative and informative. As for further assessment, we recommend taking samples by licensed persons or by accredited methods.
- The material taken for sampling cannot be assessed as soil and thus also not as soil in agricultural or background areas because it is used as a building material which, however, gets into contact with the soil. According to terminology of the Methodic instruction of the Ministry of Environment (Official bulletin of the Ministry of Environment, No. 3/1996) it is earth.
- Numerical comparison of levels found in the assessed building material with levels in Czech soil points to higher content in the case of PCDDs/Fs rather than in contaminated soil in industrial areas. The discovered levels are on the level of Criteria B (interventional) for assessment of soil pollution according to Appendix 1 of the Methodic instruction of the Ministry of Environment (Official bulletin of the Ministry of Environment, No. 3/1996). Levels of indicatory PCBs usually settled and assessed were not included in the supplied materials and levels of HCBs are lower than it is usual in various types of soil in the Czech Republic (see Table VI in Annex 1)
- It is not possible to evaluate possible impacts on environment and human health on the base of the supplied chemical analyses without assessing the leachability of the given material and without assessing toxicity of leaches, eventually contact tests of toxicity on original samples. But it is possible to recommend monitoring the area around localities where the material was used. (see the Methodic instruction of the Ministry of Environment, limit B).
- Bioavailability of the assessed contaminants is a base for assessment of environmental risks in real natural ecosystems. Real bioavailability of hydrophobic substances of POPs types is undermined by absorption capacity of assessed matrix, really bioaccessible factions of these chemicals are many times lower than levels of absolute concentrations settled by particular adequate procedures of separation and analysis.
- Contribution of fly ash in a mixture with slag to the total POPs content can be assessed only with orientation value on the base of the materials we have (materials about one-time analyses from 2000 and 2005), because these materials do not show clearly what partiuclar mixture sample represents, what is a relation of fly ash and slag mixture towards the mixture sample, and in which way the mixture sample was created. If we consider the weight ratio 1:9, the content of PCDDs/Fs in result mixture is approximately 1/6 of initial content in the fly ash.
- It must be said that from the point of view of fly ash treatment in other countries it is not suitable to use these materials (either fly ash from production or other product) for road construction and powdering without detoxication preceding the utilization. Otherwise it is not possible to exclude a risk of gradual, though very slow, fly ashing

out of POPs by humic acids or by convergents and of contamination of environmental compounds.

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