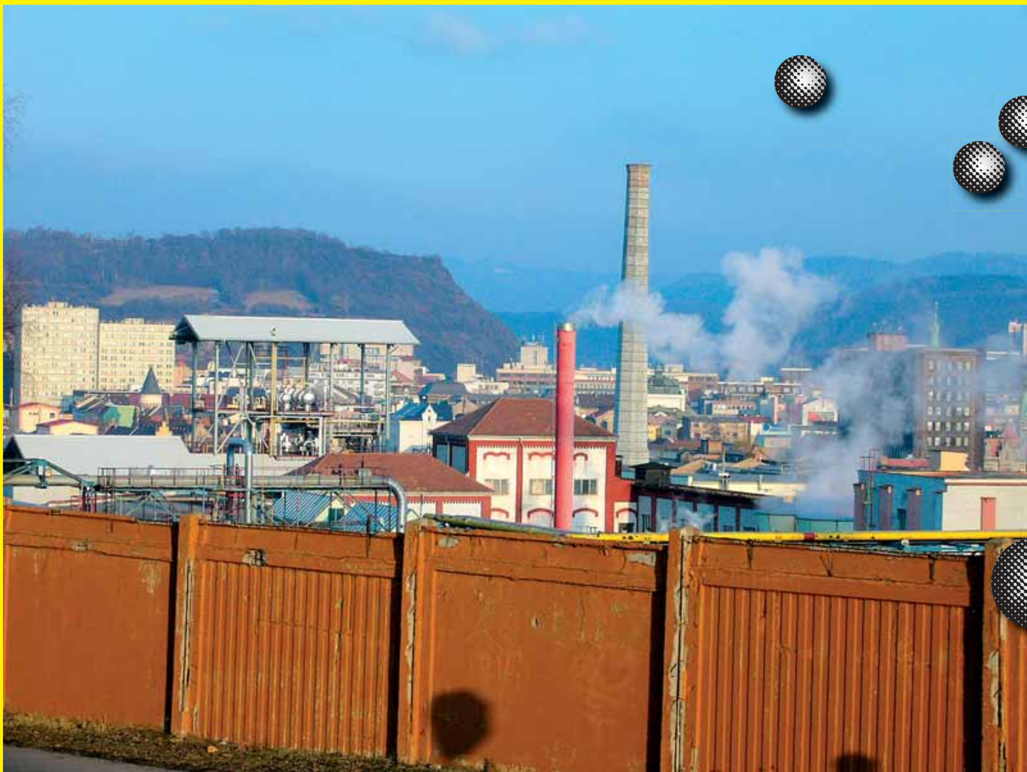
# Chlorine Production – a Large Source of Mercury Releases

## The Czech Republic Case Study



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# Chlorine Production – a Large Source of Mercury Releases (The Czech Republic Case Study)

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**Prepared by Arnika Association as a member NGO of the Zero Mercury Working Group**

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## Contents:



**Prepared by Arnika Association as a member NGO of the Zero Mercury Working Group[a]**

[a] Arnika is also a member of the Zero Mercury Working Group. The Zero Mercury Working Group, is an international coalition of over 55 public-interest non-governmental organisations from around the world formed in 2005 by the European Environmental Bureau and the Mercury Policy Project/Ban Mercury Working Group. The group's aim is to reach 'zero' emissions, demand and supply of mercury, from all sources we can control, towards eliminating mercury in the environment, at EU level and globally., www.zeromercury.org

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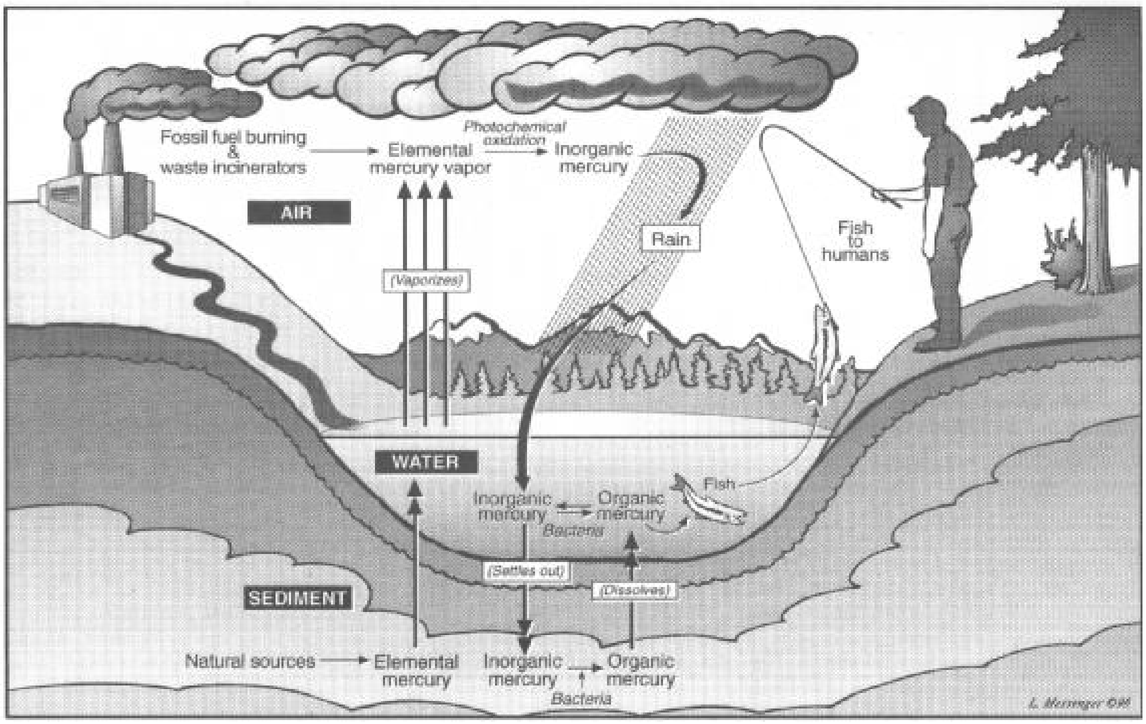
# 1. Introduction

As one of the most important pollutants mercury has a considerable impact on the contamination of the environment. It occurs in numerous natural materials and parts of the biosphere as well as in fabricated raw materials, products and waste. Its movement in the lithosphere, atmosphere and hydrosphere influences natural processes, and the mercury cycle is nowadays considerably supported by human activities (Picture 1).

**Picture 1**: Hg movement in the environment. Source: Shettler T. and et al. 1999.[1]




The sources of mercury releases into the atmosphere are natural and also caused by human activities. Natural sources involve wind erosion, ocean aerosols, river erosion, weathering of rocks, vaporization of metallic mercury from focal accumulations, volcanic activity etc. Activities which cause mercury releases are chemical industry (production of chlorine and caustic soda by amalgam electrolysis or production of organic and inorganic mercury compounds), incinerators, cement factories, sewage works, electrical industry (production of dry batteries, mercury lamps, regulators, mercury thermometers and other machines), thermal power plants etc. Mercury is also used in pharmaceutical industry – in dentistry, antiseptics, dermatology, textile industry etc.

Due to the increasing concentration of mercury in the environment and its global contamination the international community has started to consider the possibilities of how to prevent further releases of the toxic heavy metal and its compounds. Our study, in the framework of the Zero Mercury Campaign[b], documents the contamination of the environment caused by the following human activity – production of chlorine and caustic soda in the Czech Republic. The best way to prevent the contamination of the environment is replacing mercury in chlorine production. However, chemical plants are postponing the date to the time allowed

[b] The Zero Mercury Campaign, coordinated by the European Environmental Bureau, has been contributing and supporting Arnika's work on mercury, www.zeromercury.org

by legislators. We hope that an international agreement will accelerate the end of mercury use not only in the chemical industry. We are convinced it is the only way to prevent further contamination by mercury.

### 1.1 Impacts of mercury on human health

Mercury occurs in the form of elementary, inorganic and organic mercury. The form influences not only the movement of mercury among the individual parts of the environment (water – soil – air), but also the toxic effects of the metal and its compounds on living organisms. [2]

As soon as mercury is released into the environment with the help of bacteria it starts to change into an organic form, e.g. methyl mercury, especially in the water environment. Mercury accumulates in animals' and human bodies. [3] Then it is transported further in the food chain. Higher levels of food chain are typical for higher concentrations of mercury.

As soon as mercury enters the human organism it becomes a neurotoxin, i.e. it has a negative impact on the nervous system. It poses a danger especially to pregnant women and babies. With developing foetuses and children, long-term exposure to higher doses of mercury leads to mental retardation, cerebral palsy, deafness, blindness, retarded development of the ability to speak and walk, learning disorders. [4, 5, 6, 7].

Exposure to undesirable effects of mercury depends on the form of mercury and the length and the concentration of mercury an individual has been exposed to. Acute toxication varies with the inorganic and organic form of mercury; it leads to irreversible harm to the nervous system, collapse or death. Acute fatal toxication is caused by 0.15 – 0.2 g Hg.[8, 9]

The International Agency for Research on Cancer (IARC) regards methyl mercury and its compounds (organic forms of mercury) as carcinogens for humans (group 2B)[10], whereas elementary mercury and its inorganic compounds are not classified as carcinogens (group 3).[11]

Mercury is secreted by urine, faeces, saliva, perspiration, and has been found in the milk of nursing mothers. The secretion of mercury is very slow and lasts several months or years after the end of exposure.

## 2. Mercury releases from large sources in the Czech Republic – data from PRTR

Releases of mercury and its compounds from large sources into all parts of the environment are in the Czech Republic – with exceptions – very well documented on the data from Pollutant Release and Transfer Register (PRTR) which already involves three reports from 2004 to 2006. The register contains the information about mercury amounts for the particular year from those factories which exceeded the so called reporting thresholds. They are determined in the following way: releases into the air – 10 kg, into water 1 kg, into soil 1 kg; transfer in waste and waste water at standby time 5 kg. The development of total sums for individual parts of the environment according to PRTR-data is shown in Table 1.
The Table shows that mercury enters the environment mainly through waste and, secondly, air. The amounts of mercury in waste are significantly influenced by chlor-alkali plants. There

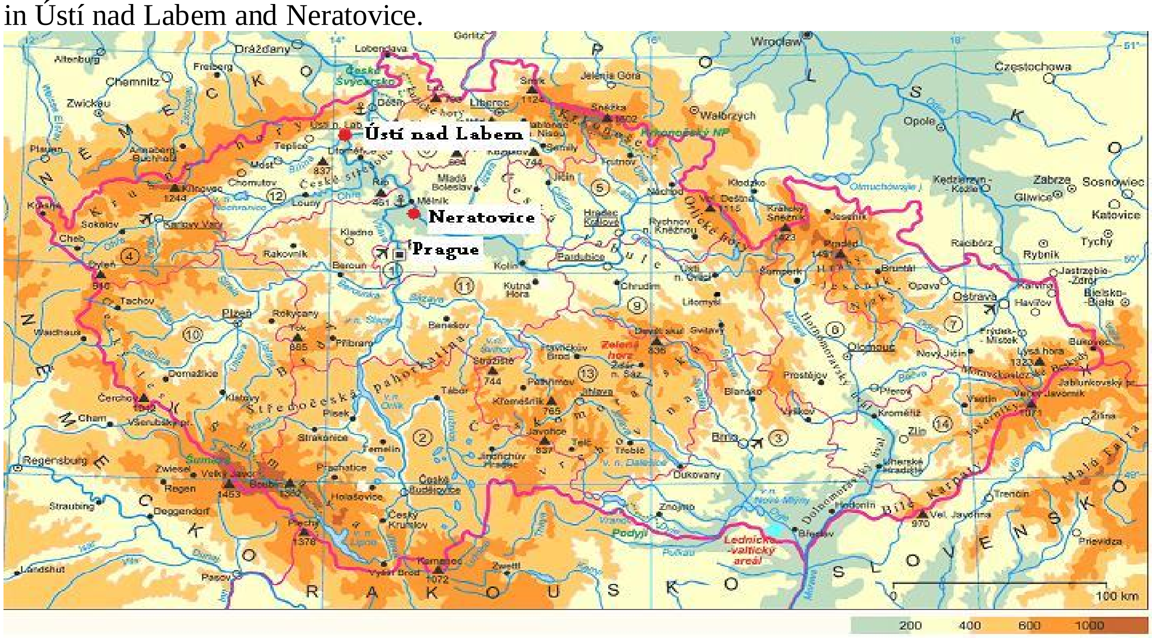
are two in the Czech Republic: Spolana in Neratovice and Spolchemie in Ústí nad Labem (see Picture 2). It can be documented in the differences of mercury contents in waste in individual years. The drop in mercury in 2004 and 2005 was mainly influenced by Spolchemie in Ústí nad Labem which reduced the amounts of mercury in waste from 2,080 to 353. On the other hand, the increase in 2005 and 2006 was considerably influenced by Spolana Neratovice – the amounts of mercury in waste increased from 5.91 kg in 2005 to 1,446 kg in 2006.

**Table 1:** Trends in reported sums of total mercury releases and transfers into individual parts of the environment in PRTR 2004-2006.

| **Releases/transfers** | | **2004** | **2005** | **2006** |
|---|---|---|---|---|
| **Releases to:** | air | 3,140.9 | 2,970.9 | 2,843.0 |
| (kg/year) | water | 73.2 | 86.7 | 189.2 |
| | soil | 8.7 | 2.6 | 0.0 |
| | | | | |
| **Transfers in:** | waste | 5,463.6 | 2,558.0 | 5,707.5 |
| (kg/year) | waste waters | 88.3 | 67.7 | 44.8 |
| | | | | |
| **Total reported** | | 8,774.7 | 5,685.9 | 8,784.5 |

In total sum chlor-alkali plants are the largest individual sources of mercury entering the environment in the Czech Republic. Therefore the study concentrates on them. The details of flows of mercury are documented in the examples of Spolana Neratovice, which produces mainly PVC, and at the end it is compared with Spolchemie in Ústí nad Labem.

**Picture 2:** Map of the Czech Republic highlighting the location of the two chlor-alkali plants in Ústí nad Labem and Neratovice.




## 3. Mercury in chlor-alkali plant – case study Spolana Neratovice

### 3.1 Brief history of production

The beginnings of heavy chemical industry in Spolana Neratovice dates back to 1939 and it is connected with World War II. German I. G. Farben initiated the establishment of a chemical plant.

The old production of chlorine in the buildings of the so called amalgam electrolysis ended in 1975. In the 1960s Spolana also produced chlorine pesticides: 2,4,5T, hexachlorbenzen, DDT, hexachlorcyclohexan and lindan and for a long period of time also pentachlorfenol.

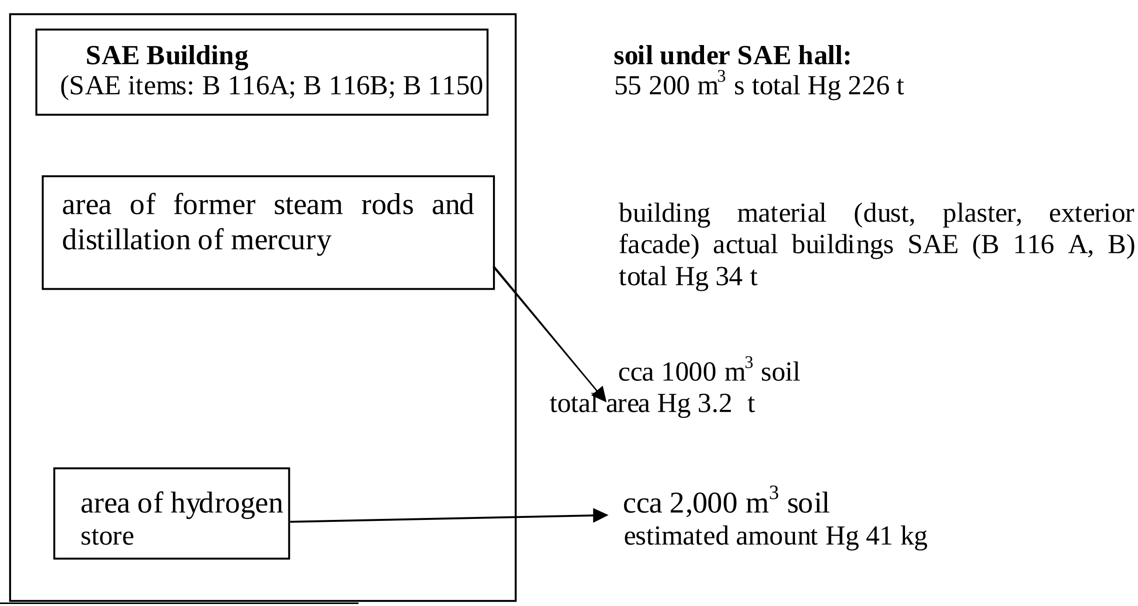
In the 80s and 90s Spolana also produced viscose staple. Nowadays the plant concentrates mainly on the production of PVC, caprolactam and inorganic compounds: caustic soda, chlorine, hydrochloride and sulphuric acid and other acids.

According to Spolana's data the annual production of chlorine is increasing. It reports the following data: 2003 – 74,125 t Cl; 2004 – 82,143 t Cl; 2005 – 94,865 t Cl.[12]

### 3.2 Contamination by mercury in old amalgam electrolysis

Old amalgam electrolysis was used in Spolana from the beginning of the 1950s and it was used to produce soda hydroxide and chlorine. In the 70s it was replaced by a new production capacity and put out of service. Nowadays it presents one of the biggest problems on the premises of Spolana Neratovice. It is a part of the plant which is highly contaminated by mercury and also polychlorinated dibenzodioxin and dibenzofuran [c] (PCDD/F).
The documentation EIA from 2001 contains the construction description of individual buildings of old amalgam electrolysis and their state. Buildings B 116A and 116B have been out of service for a long period of time and since 1975 they have become run down without any maintenance. However, the part marked as building B 1150 was still in service in 2001. [13]
The total amounts of mercury in the most contaminated part of Spolana plant are shown in Picture 3.

**Picture 3:** Specification and amounts of materials contaminated by mercury from old amalgam electrolysis (SAE). Source: Vurm, K. et al. 2001. [14]




[c] Abbreviation dioxins is used for these two groups of substances. It is also used in the text in this sense.

High concentrations of mercury are measured especially in the places where mercury is used (buildings SAE B 116A and 116B, area of auxiliary plants of electrolysis – steam rods and mercury distillation in Picture 3).

The prevailing form of mercury in abandoned barracks is elementary, characteristic with volatility, low water solubility, limited horizontal migration and a high potential for vertical migration. Another form of mercury is diatomic inorganic mercury ($Hg^{2+}$) in the form of water-soluble salts with a higher capability of horizontal migration and inorganic mercury in the form of complexes. Its presence is rather exceptional.

### 3.3 Current production and releases to all environment media

#### 3.3.1 Inputs

The total capacity of electrolysis in Spolana is 230 t of mercury.[15] The annual consumption of mercury for this production tripled in the period from 2003 to 2005. The exact data taken from the documentation for the issue of an integrated permission is shown in Table 2.

**Table 2:** Consumption of mercury in plant Electrolysis of Spolana a.s. Neratovice from 2003 to 2005 as stated in the request for the issue of an integrated permission.[16]

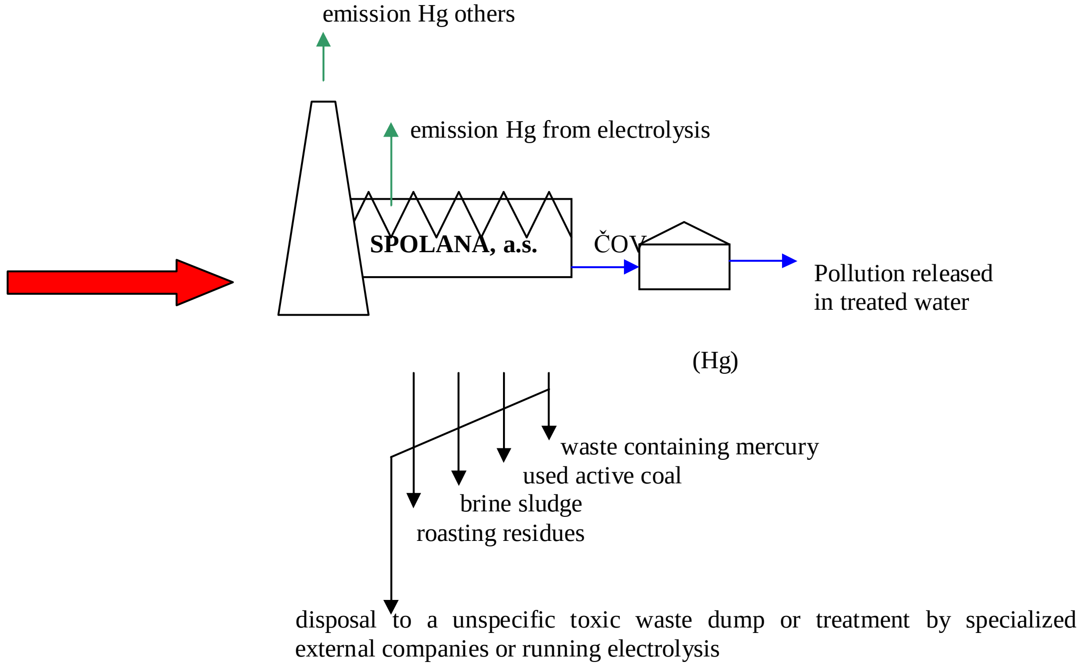
| Year | | 2003 | 2004 | 2005 |
|---|---|---|---|---|
| Volume of chlorine per year (tonnes) | | 74,125 | 82,143 | 94,865 |
| Annual usage mercury | total (kg) | 170 | 345 | 515 |
| | per tonne of produced chlorine (g) | 2.3 | 4.2 | 5.4 |

#### 3.2.2 Outputs

Plant Electrolysis in Spolana, a.s. Neratovice is the source of the occurrence of gaseous and liquid releases and solid waste containing mercury. Picture 4 gives a rough insight into their origin and types.

Most information about mercury releases into the air and water, amounts of waste containing mercury and the way it is disposed of, has been collected from materials obtained from state administrative agencies, Municipal Office Neratovice (report about waste production and disposal), Czech Environmental Inspectorate (CIZP),[17] Mělník District Authority (OkÚ Mělník) (when it existed), and also from reports issued by Spolana, a.s. Neratovice,[18, 19] the request to issue an integrated permission from 2006[20] and the Integrated register of contamination (http://www.irz.cz).

**Picture 4:** Scheme of flows (inputs and outputs) containing mercury in Spolana, a.s. Neratovice in plant Electrolysis during chlorine production.




**Key:**

gaseous emissions; liquid emissions; solid waste;
ČOV – waste water treatment.

### 3.3.2.1 Gaseous mercury releases

Air ventilated from factory buildings is, together with electrolyses, one of the main sources of mercury releases into the air during chlorine production with the use of mercury, [21] which is obvious in Table 3 with the values of mercury releases into the air from production plants of Spolana, a.s. Neratovice from 1997 to 2005. In the last monitored years (from 2003 to 2005) they decreased by more than a third; however, as it had been seen in the previous years, the total releases of the plant varied considerably. Further sources, especially the energoblock must be added to the total releases of mercury into the air by Spolana Neratovice.

**Table 3:** Mercury amounts released into the air from 1997 to 2005 by the electrolysis plant in Spolana Neratovice. Sources: see summary at the beginning of chapter 3.3.2.

| Year | | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|
| Emission from electrolyte hall (kg/year) | | 138 | 128 | 102 | 101 | 123 | 51 | 130 | 105 | 83 |
| Other emissions of mercury from electrolyte from Spolana | | | 12.6 | 26.3 | 26.4 | 28.4 | | 0.116 | 3.16 | 4.24 |
| Measurable emission (g/t chlorine) | total capacity | | | | | | | 0.966 | 0.801 | 0.616 |
| | produced | | | | | | | 1.755 | 1.317 | 0.920 |

In 2005 Spolana managed to reduce specific mercury releases into the air under 1 g per year; however, it is not enough compared with the best European plants which use comparable technology.[d]

[d] See also chapter 4. Mercury measurements in the exterior air in the surroundings of the chlorine producing plants

#### 3.3.2.2 Releases into water

Mercury amounts in waste water released into the Labe in kg/year are described in Table 4. The overall trend is decreasing; however, the amount of mercury released in 2006 is higher than in the previous two years.

**Table 4:** Mercury amounts released by Spolana Neratovice from 1996 to 2006 in treated water. Sources: see summary at the beginning of chapter 3.3.2.

| Year | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mercury amounts (kg/year) | 17.6 | 24.0 | 24.0 | 17.0 | 10.4 | 19.5 | 10.7 | 14.9 | 7.7 | 5.4 | 8.2 |

#### 3.3.2.3 Mercury in waste

The data about mercury content in waste are least accessible. In the case of Spolana Neratovice the situation is worse than in the case of Association for chemical and metallurgical production, a.s. (Spolek pro chemickou a hutní výrobu, a.s.) in Ústí nad Labem. The following Tables 5-8 show different scenarios of mercury amounts in waste.

Spolana's report is the basis for the data of mercury amounts in waste per one tonne of installed chlorine capacity in years: 2003 – 4.09g; 2004 – 4.87g; 2005 – 4.63g. [22] However, we do not have the data for this calculation, and it is not clear whether all waste containing mercury has been included in it. To estimate it, we have therefore used the average values of mercury contents in waste per tonne of produced chlorine from the study of A. B. Mukherjee et al. (2004). [23] According to this the average values in fifteen EU member states varied between 10 to 17 g per tonne of produced chlorine. The calculations of all estimations are shown in Table 5. The Table shows the increasing trend of mercury amounts in waste and considerable value dispersion.

Table 6 shows values based on the data of Spolana Neratovice. However, it does not contain all kinds of waste containing mercury**. For the year 2006 Spolana reported a very high value of mercury content – 1,446 kg – in waste disposed at standby time.** However, this number may also involve waste coming from the elimination of old ecological damage etc. The authors of this study do not have the supporting evidence which may give more information about the origin of mercury in waste.

Tables 7-8 give an overview of waste amounts containing mercury produced by Spolana Neratovice.

**Table 5**: Calculations of mercury volume in waste from Spolana Neratovice according to Spolana's data in the formulation of 'competent person' in process IPPC, and according to average values for European plants of chlorine chemistry in the study of A. B. Mukherjee et al. (2004).

| Year | | 2003 | 2004 | 2005 |
|---|---|---|---|---|
| Volume of chlorine production in t / year | | 74,125 | 82,143 | 94,865 |
| Mercury estimation in waste (kg/year) | according to the data of Spoalana Neratovice | 552.2 | 657.5 | 625.1 |
| | minimal value according to Mukherjee, A. B. et al. 2004 | 741.3 | 821.4 | 948.7 |
| | maximal value according to Mukherjee, A. B. et al. 2004 | 1,260.1 | 1,396.4 | 1,612.7 |

**Table 6**: Calculations of mercury volume in waste handed by Spolana Neratovice, a.s. after negotiation on the issue of an integrated permission based on the measurements of mercury content in waste. The documentation protocols have not been published yet.

| Year | **2003** | **2004** | **2005** |
|---|---|---|---|
| Waste amounts (t/year) | **30.75** | **89.94** | **82.38** |
| Mercury contents in waste (kg/year) | 382.77 | 138.83 | 134.10 |
| Measurable mercury emissions into waste (per gram of mercury /1t $Cl_2$) | 2.835 | 1.028 | 0.99 |

**Table 7:** Waste amounts containing mercury produced by Spolana Neratovice in connection with chlorine production. Sources: Spolana, a.s. [24, 25, 26, 27, 28, 29], Mělník District Authority [30], Municipal Office Neratovice [31, 32]

| Catalogue no. | Title | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 60404 | waste containing mercury | | 9.8 | | 9.94 | | | 10 | 35.4 | 34.78 | 35.26 |
| 61302 | Used active coal | | 9.94 | 28.1 | | 3.1 | 8.3 | 6.23 | 2.22 | 1.82 | 7.88 |
| 160709 | waste containing other dangerous substances (brine sludge)* | | 24.1 | 27.04 | 13.58 | 16.28 | 5.24 | 7.12 | 46.58 | 27.9 | 43.26 |
| 170503 | soil and stones containing dangerous substances** | | | | | | | | | 10.42 | |
| 170603 | Other sealing materials which are or contain dangerous substances | | | | | | 10.76 | | | 2.72 | 2.46 |
| 170901 | construction and demolition waste containing mercury | | | | | | | | | 11.18 | |
| 190211 | Other waste containing dangerous substances (roasting residues)*** | | 19.64 | 11.68 | 6.82 | 5.54 | 7.66 | 7.4 | 5.74 | 12.66 | 10.14 |
| | **Sum of waste containing mercury** | **121.76** | **63.48** | **66.82** | **30.34** | **24.92** | **31.96** | **30.75** | **89.94** | **101.48** | **99.00** |

Notes:

* - in years 1998, 1999 and 2000 rated among no. 160705 – waste from treated storage tanks containing chemicals

** - for 2002 Spolana reported 1805.85 tonnes of such waste, apparently due to floods, however, it is not clear if it was waste containing mercury or not

*** - in the years 1998, 1999 and 2000 rated among no. 190101 - ashes, slag, cinder; in the report about waste for year 1998 reported 40.3 t, data in the table comes from a letter from OkÚ Mělník

**Table 8:** Other waste which contains or may contain mercury produced by Spolana Neratovice, a.s. Overviews for those years in which these catalogue numbers of waste were reported. Sources: Spolana, a.s. [33, 34], Municipal Office Neratovice [35]

| Catalogue no. | Title | 2002 | 2005 | 2006 |
|---|---|---|---|---|
| 70211 | Sludge coming from the treatment of waste waters in places of its origin containing dangerous substances | 92.9 | 132.1 | 78.9 |
| 190813 | Sludge coming from other ways of treatment of industrial waste waters containing dangerous substances | | 28.08 | 5.1 |
| 200121 | Fluorescent tubes and other waste containing mercury | | 0.05 | 0.13 |
| | **sum of waste** | **92.9** | **160.23** | **84.13** |

Mercury content in waste from Spolana Neratovice is definitely very high and some data show that the content has probably been growing over the past years, which is also supported by the data from the last report for PRTR. It is necessary to carefully monitor how waste containing mercury is disposed of.

### 3.4 Comparison of chlorine production in Spolana with the best obtainable technologies

Mercury emissions released by European chlorine chemical plants into the air, water and in other products are – according to the data of Eurochlor – decreasing. However there are concerns that emissions to air from the EU chlor-alkali plants might be underreported.[e] Equally, emissions produced by Spolana are also decreasing and in 2006 they sank under 1 g/t of chlorine (in 2005 – 1.0476 g/t of chlorine). A more detailed overview is given in Table 9. The commitment to Eurochlor promises to fulfill the limit by the end of 2007. Spolana fulfilled it in the year 2006 (0.86 g Hg per tonne of chlorine); however, the consumption of mercury per tonne of produced chlorine is increasing (see Table 2). Mercury content in waste is probably increasing as well (see Table 5).

In the request for the issue of an integrated permission the authors claimed that "the total loss of mercury into the air, water and into products in the facilities using the best equipment which were included in the pilot programme of the minimisation of mercury loss during amalgam production of chlorine is within the range of 0.2-0.5 g Hg per tonne of chlorine capacity. In the case of Spolana Neratovice it was two to five times as much comparing to those facilities in 2005.

[e] Status Report: Mercury Cell Chlor-alkali Plants in Europe, , Peter Maxson, Concorde East/West , October 2006, http://www.zeromercury.org/EU_developments/Final_Report_CA_31Oct2006.pdf

**Table 9:** Balance of mercury emission from plant Electrolysis according to the request to IPPC.[36]

| Mercury emissions (g/t $Cl_2$) | 2003 | 2004 | 2005 |
|---|---|---|---|
| Products (NaOH, $H_2$) | 0.0934 | 0.0726 | 0.0541 |
| Waste waters | 0.7259 | 0.5850 | 0.3757 |
| Process gaseous waste | 0.0020 | 0.0014 | 0.0045 |
| Ventilation of hall | 0.9640 | 0.7780 | 0.6130 |
| **Total** | **1.7852** | **1.4370** | **1.0473** |

### 3.5 Summarizing comparison of mercury loss and transfers in two chlorine producing plants in the Czech Republic

There are two large plants in the Czech Republic which produce chlorine by so called amalgam electrolysis: Spolana, a.s. Neratovice and Spolek pro chemickou a hutní výrobu, a.s. Ústí nad Labem (also known as 'Spolchemie'). Both plants are located near the biggest Czech river – the Labe.

Chlorine in both chemical plants presents the input material for further production. Chlorine amounts produced in these chemical plants vary and depend on their projected capacity. Spolana's projected capacity is 135,000 t of chlorine; Spolana is able to produce up to 61,276 t of chlorine per year. Spolana produces more chlorine per year than Spolchemie. Spolana produced 94,865 t of chlorine in 2005.

**Spolana** – Chlorine functions as input material mainly for the production of PVC and also for the production of inorganic compounds, e.g. HCL and caustic hypochloride.

**Spolchemie** - Chlorine functions as input material mainly for the production of epichlorhydrine (1-chlor-2,3-epoxypropan) which is the main material for the production of epoxide resin. $Cl_2$ is also used to produce inorganic and organic compounds such as HCl, caustic hypochlorite, perchlorethylene and allylchloride.

The comparison of mercury amounts in emissions and waste produced by both chemical plants is reported in Table 10. It is difficult to compare mercury amounts in waste, because the source data for Spolana, a.s. Neratovice is not accessible. Nevertheless it is obvious that Spolana's emissions into the air are a lot higher. On the other hand, mercury amounts in waste water produced by Spolchemie are several fold higher than in Spolana. Despite the difficulties when comparing the data about waste, the difference in 2005 roughly corresponds with the difference in the capacities of both these plants.

**Table 10:** Emissions into the air and water and mercury amounts in waste in kg/year from Spolana, a.s. Neratovice and Spolek pro chemickou a hutní výrobu, a.s. Ústí nad Labem (Spolchemie). Sources: http://www.irz.cz and Table 5 in this study.

| Year | Plant | Emissions into the air | Emissions into water or transfers in waste waters | Transfers in waste |
|---|---|---|---|---|
| 2004 | Spolana | 154 | 7.7 | 658 [*] |
| | Spolchemie | 55 | 70.2 | 2,080 |
| 2005 | Spolana | 104 | 5.4 | 625 [*] |
| | Spolchemie | 38 | 54.8 | 353 |
| 2006 | Spolana | 85 | 8.2 | 1,446 |
| | Spolchemie | 33 | 29.7 | 380 |

Note: [*] – sum based on the data obtained from Spolana, a. s. Neratovice (for example, it is not clear if it covers all waste containing mercury).

## 4. Mercury measurements in the exterior air in the surroundings of the chlorine producing plants

The measurements of mercury concentrations in the surroundings of the chemical plants carried out in 2006 financed by European Environment Bureau (EEB) in the framework of the Zero Mercury Campaign, also confirmed the fact that chlorine producing plants are still important sources of contamination by mercury. In the Czech Republic, they were carried out by Arnika.[37] The total results are reported in Table 11. The automatic analyzer (Lumex RA-915+) was used to determine the concentrations.

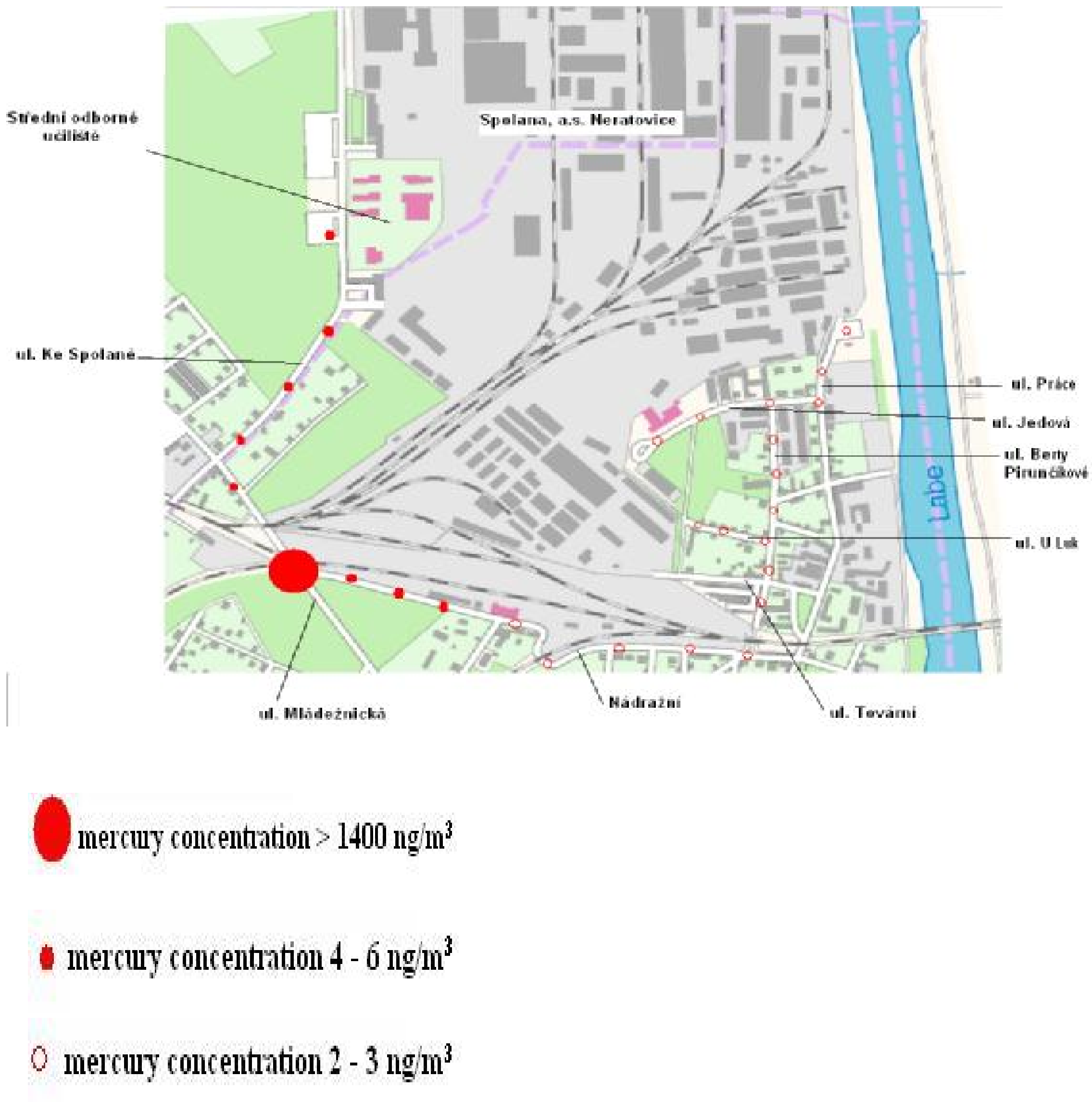
Mercury concentrations in the surroundings of Spolana Neratovice (not on the premises of the plant) reached up to 1,441.63 ng/m$^3$. See Picture 7 and 8.[38]

**Table 11**: Measured immission in the surroundings of the chemical plants which produce chlorine using mercury.[f]

| Country | Location of measurements | Max. concentration of Hg outside the plant (ng/m$^3$) |
|---|---|---|
| Italy | Porto Maghera | 1493 |
| | Pieve Verg. | cca 750 |
| | Torviscosa | 1208 |
| | Rosignano | 1211 |
| | Bussi | 7696 |
| | Priolo | 50-60 |
| Spain | Torrelavega | 510 |
| | Želva | 1954 |
| | Monzun | 19650 |
| Czech Republic | Neratovice a Libiš | 989 (1442) |
| | Ústí nad Labem | 412 |

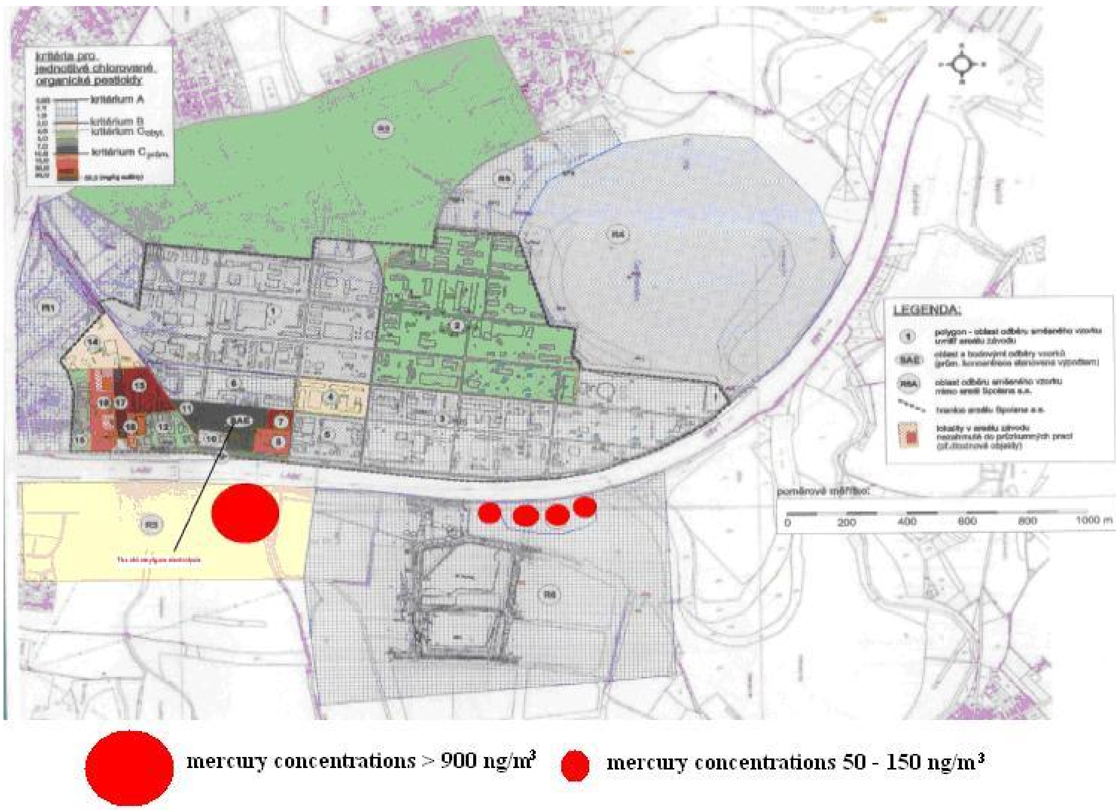
[f] EEB Special Report, Risky Business! No need for mercury in the chlorine industry, p. 13

**Picture 5**: Locations where the highest concentrations of mercury in the air near the premises of Spolana were measured – the same river bank where production plants and old ecological damage are located (red points).




The measurements done for mercury concentrations show that Spolana is in some cases – depending on weather conditions, wind and mercury releases during production and from the plant – responsible for higher mercury concentrations in its surroundings. The concentrations in some areas out of the premises of Spolana (especially near the toxic waste dump of the company) reached during measurement up to thousands of $ng/m^3$ mercury. Mercury concentrations in the air out of the premises of Spolana were in some places within the range of detection limit (2 $ng/m^3$) up to max. 989.18 $ng/m^3$. High concentrations of mercury were also measured on the railway crossing between Neratovice and Libiš.

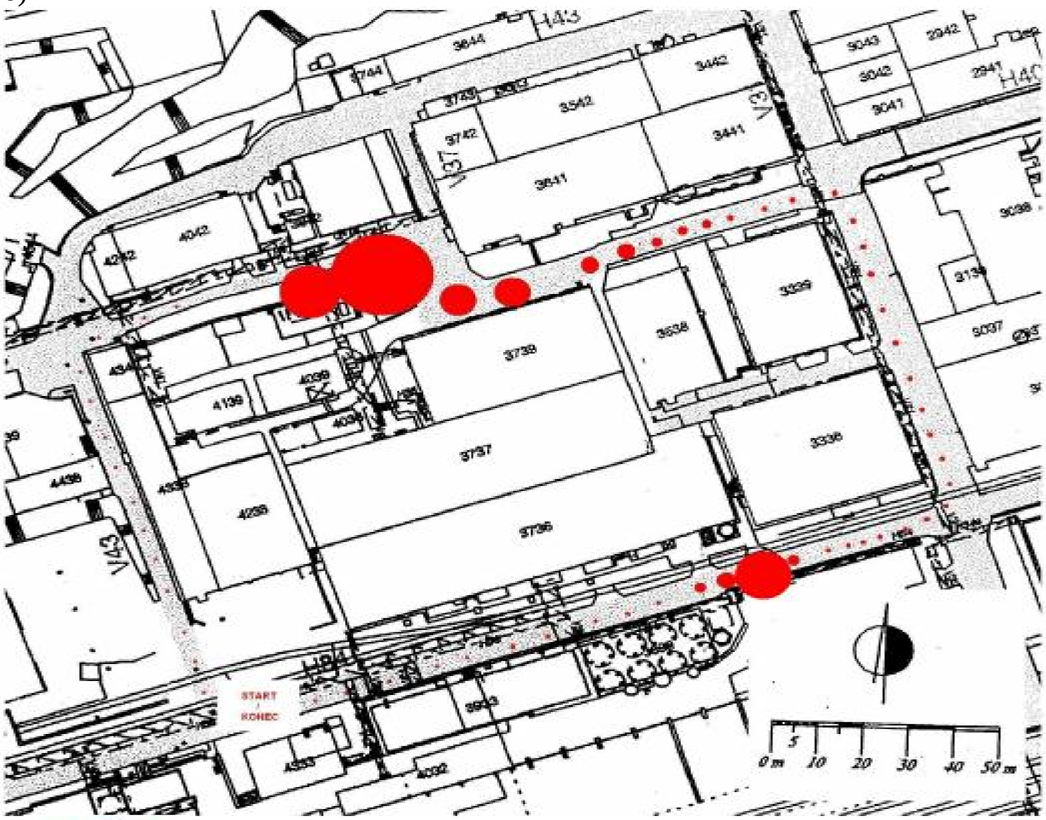
**Picture 6**: Locations where the highest mercury concentrations in the air in the surroundings of Spolana were measured – the opposite bank to the one where production plants are located (red points).




We were not able to measure mercury concentrations in the open air on the premises of Spolana, because the managers did not allow us to enter it. However, the results are known from the measurement which was carried out by M. Suchánek from Vysoká škola chemicko-technologická (VŠCHT) in Prague in 2003. High concentrations of mercury were measured four years ago in the air in the surroundings of the halls of the contemporary amalgam electrolysis, but also inside and near the former amalgam electrolysis which is nowadays regarded as ecological damage.

The experts from VŠCHT measured concentrations >50,000 ng/$m^3$ in the surroundings of the electrolyte hall of the new electrolysis or 1 m above the ground of the electrolyte underhall of the new electrolysis. Equally high maximum concentrations were measured in the surroundings of the old amalgam electrolysis. These concentrations were equal or even exceeded the limit for the working environment which was set by the Czech law at 50,000 ng/$m^3$.[39]

**Picture 7**: The concentrations of mercury which were measured in the area surrounding the premises of Electrolytes in Spolchemie.(Source: Spolchemie, the request of integrated permission for set of device for production of alkalic lyes, chlorine and hydrochloric acid, 2006)




concentration > 9,000 ng/m$^3$, concentration > 5,000 ng/m$^3$,

concentration > 3,500 ng/m$^3$, concentration > 2,000 ng/m$^3$,
concentration > 1,000 ng/m$^3$, concentration 400 - 600 ng/m$^3$,
concentration 70 - > 300 ng/m$^3$

The concentrations of mercury measured in the area of Spolchemie varied from 11 ng/m$^3$ to 9,631 ng/m$^3$ (the average amount in 20 minutes was 970ng/m$^3$). During the first measurement, we recorded two places with increased concentration of mercury: the first one on the corner of building no. 3736 in front of the container for NaOH and the second one in the area of unit for demercurization of waste water (in the area of transport bridge for sewage water) (Picture 7).

The measurements at both places took 5 minutes. At the first place, mercury concentration varried from 127 ng/m$^3$ to 5,333 ng/m$^3$ (average amount over 5 mins was 1,493 ng/m$^3$). At the second place (area of unit for demercurization of sewage water) varied from 912 ng/m$^3$ to 7,816 ng/m$^3$ (average amount over 5 mins was 3,145 ng/m$^3$). The measurements in surrounding area of Spolchemie were taken on two different days – 23.6.2006 and 26.6.2006. The measurements around all the grounds were taken firstly from a slow moving car (identifying the places with the highest concentrations) and afterwards in the selected places, where the higher concentrations of mercury in the air were found.

The highest concentrations of mercury during both days were measured in Solvayova Street. It is a place located above the building for current amalgam electrolyte. The amount of 412 ng/m$^3$ measured on July 23 2006 exceeded the level of 300 ng/m$^3$, which is the level of protection concentrations of mercury in air defined by the EPA in the USA.

## 5. Measuring mercury in the other parts of the environment

Across the whole of the Czech Republic a range of measurements showing presence of mercury in the natural environment is available. It is monitored systematically in soil and water, including the analysis of biota.

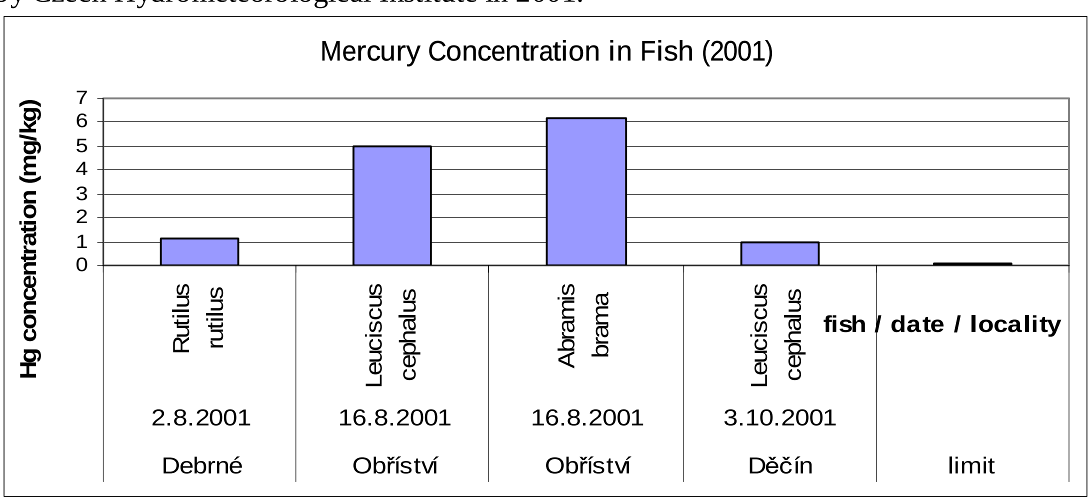
The annual hydrological publication for 2004 on contamination of alluvium and sediments states that "mercury, and polyaromatic hydrocarbons, from which benzo(a)pyren is the most significant constant pollutant, occur especially in solid matrixes in the whole area.**"**

The state of water environment contamination by mercury is best documented in the analysis of water animals. In 2004, the maximum amounts of mercury were registered in Obříství in the Labe in biofilm (1.2 mg/kg), while in benthic organisms and lamellibranchiata the amounts varied in all profiles of CR from 0.1 to 0.4 mg/kg. Obříství is very close to Spolana Neratovice, lower on the river Elbe. The older works in this location had already shown increased concentration of mercury in fish. However, it's necessary to mention that this isn't the only hot-spot in the Czech Republic.

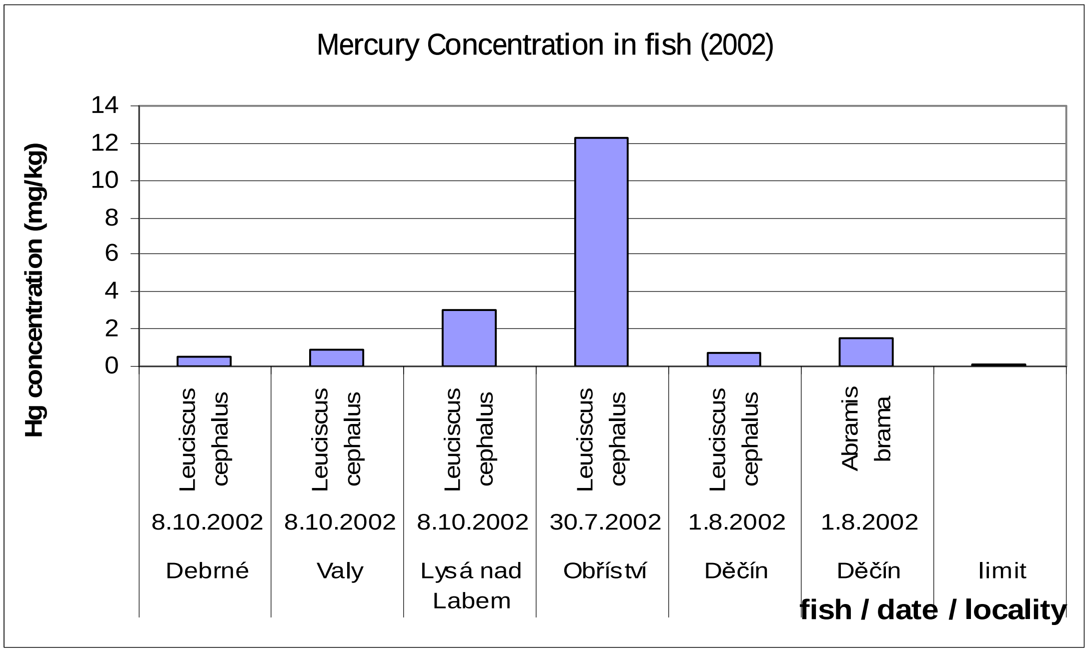
The previously mentioned annual publication states elsewhere: **"**The constantly high pollution of mainly heavy metals, and the most serious condition in the view of the whole country, was monitored last year in the sediments at Bílina in Ústí nad Labem. It was pollution by mercury (up to 13.9 mg/kg) and especially arsenic." Profile of measurement on the river Bílina in Ústí nad Labem is below an outlet and a small water stream coming out from the premises of Spolchemie. There are other industrial areas around the country which cause damage, for example the area polluted by waste with mercury in the derelict glass factory on the upper reaches of Vltava near the village of Lenora.

The results of measurements of mercury in fish caught from river Elbe in various years are documented in the graphs in Pictures 8 –10.

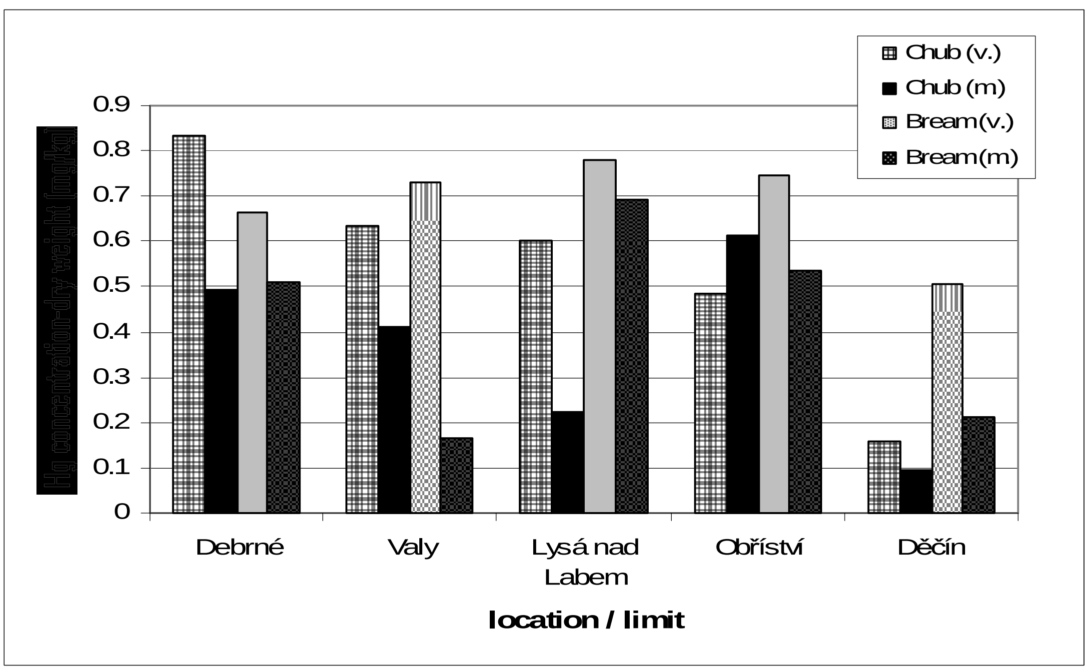
**Picture 8:** The results of analysis of fish from various locations on the river Elbe, carried out by Czech Hydrometeorological Institute in 2001.



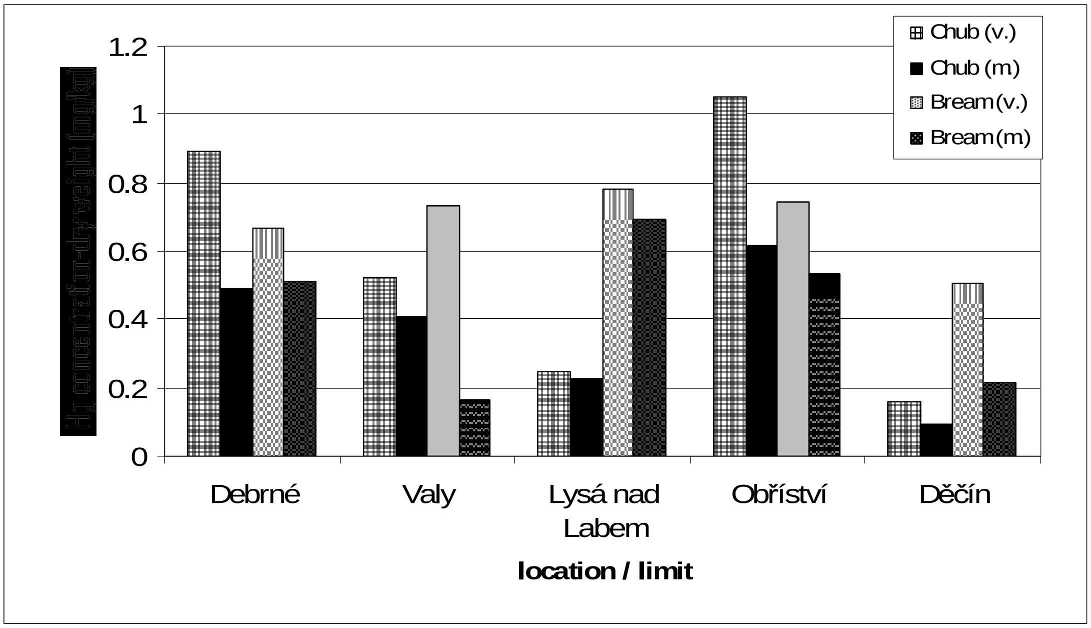
**Picture 9:** The results of analysis of fish from various locations on the river Elbe, carried out by Czech Hydrometeorological Institute in 2002.




**Picture 10:** The results of measurements of mercury in different fish, requested by Spolana Neratovice in 2004.



**Picture 11:** The results of measurements of mercury in different fish in the same profiles of flow on river Elbe, which were requested again by Spolana Neratovice in year 2005.

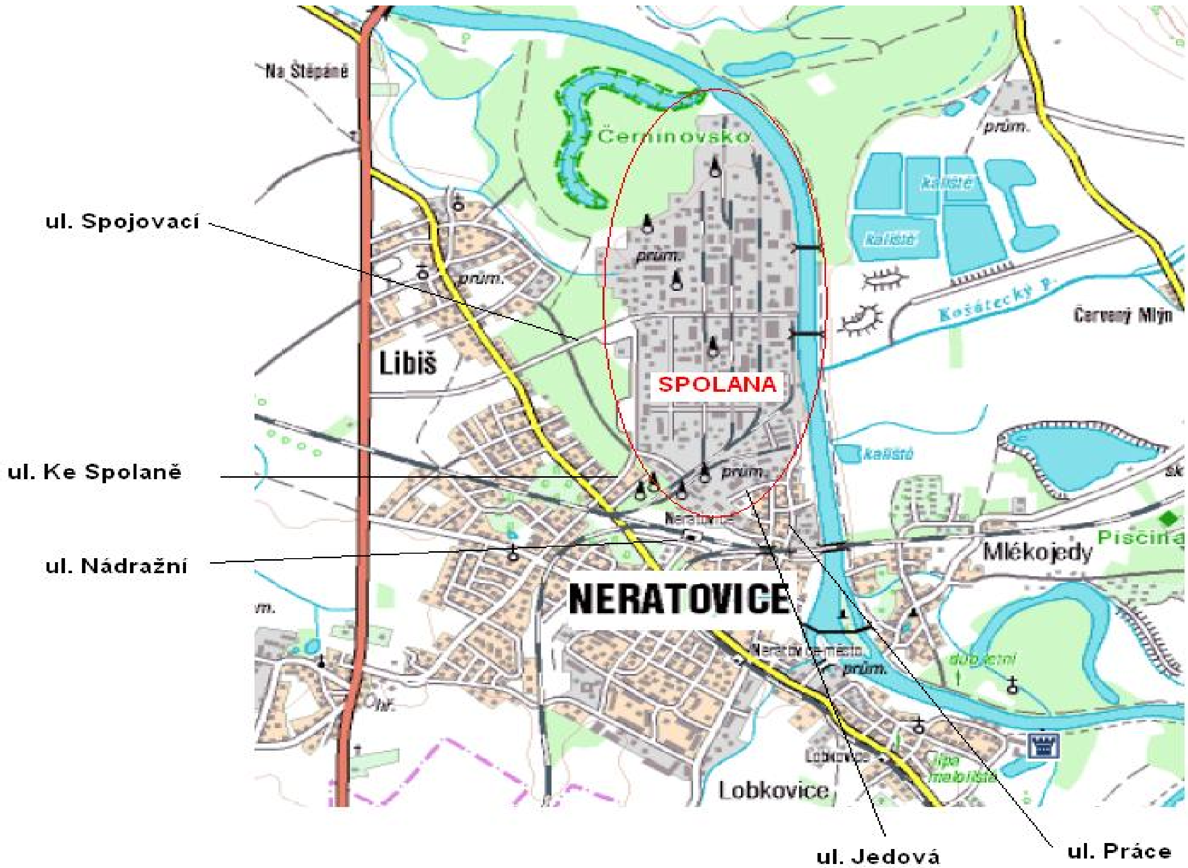



It is evident from all the above graphs, which include results of the research requested by Spolana Neratovice, that the location below this chlor-alcali plant shows higher concentrations of mercury in fish than in other locations on river Elbe.

T. Randák describes the results of research into stress in fish carried out in 2003: "Mercury was unambiguously the most significant contaminant from the range of toxic metals in the locations monitored in 2003. The content value of this metal in muscles of non-predatory fish exceeded the standing hygienic limit in almost all cases, in some locations (Obříství) by even twenty-five times." The final summary of the research from the 2003 was as follows: "From all locations monitored on river Elbe, the most stressed area regarding all monitored parameters is the location Elbe – Obříství (below Spolana Neratovice). The primary fact of not succeeding in catching enough fish in general, especially the requested amount of chub (only 2 males out of 8 chub caught) cannot conclusively prove stress in fish population in this location, especially of male population of European chub**.** During macroscopic and histological examination of their state of health, the fish caught in this location showed serious pathological changes which were found in almost all fish caught." In terms of being responsible for patological changes, the research states the wider group of pollutants also released from Spolana: PAH, NPAH, PCB, dioxins, etc. In the muscles of the fish the highest concentrations found were: Hg, PCB, HCB, DDT and alkylphenols."

In 2002, based on the analysis carried out by State veterinary administration, eating fish, specifically carp caught in the flooded gravel-pit near Spolana Neratovice near Mlekojedy (see map 12), was banned due to excessive content of mercury (between 0.124 – 0.711 mg/kg).

**Picture 12:** Spolana Neratovice and surroundings.




Measurements of mercury concentration in human tissues in the area surrounding Spolana Neratovice were carried out after the disastrous floods in 2002, during which the chemical plant was also flooded. A team from the State health institute in Prague measured the level of mercury in blood in three locations in the area surrounding Spolana Neratovice (see map in picture 12) as well as in the town of Benesov, which was chosen as the back up location. The measurement of mercury was carried out on 20 individuals from each location. The results are summarized in Table 12.

Compared to Benesov, slightly increased concentrations were found in people living directly in Neratovice, whereas they were comparable or slightly lower in two villages from the area surrounding Spolana. It was later found that the location chosen as the back up could have been affected by emissions of mercury from the sanitary waste incineration plant. Neither location exceeded the limit of mercury in blood recommended by scientists- 5 µg/l. In was seen only at maximum rates in Neratovice and Benesov.

[a] 1) Emissions from incinerator of dangerous waste in Benešov in 2002 (Source: Plan for decreasing emmisions from incinerator of waste PL-10-200, Rudolfa and Stefanie Benešov Hospital)

| Emission | 2002 – concentration in smoke fumes | 2002 - estimated possible amount of total emissions per year |
|---|---|---|
| Cd + Ti + Hg | 0.6353 mg/m$^3$ | 8.44 – 16.87 kg |

**Table 12:** Levels of mercury in blood of monitored population groups – descriptive statistics. Source: Černá, M. et al. 2003.[xliv]. The amounts are in μg/l.

| Locality | **Neratovice** | **Libiš** | **Tišice** | **Benešov** |
|---|---|---|---|---|
| Units | v μg/l | | | |
| Median | 2.0 | 1,4 | 1,5 | 1,5 |
| Range Kv 10-90 | 0.8 – 5.3 | 0.8 – 2.1 | 1.0 – 2.5 | 1.2 – 2.6 |
| Min-max | 0.6 – 8.4 | 0.6 – 4.2 | 0.6 – 4.2 | 0.9 – 6.4 |

## 6. Participation of public in decision-making process

The production of chlorine with the use of mercury and old ecological pollutants where the contamination by mercury accompanied with dioxins presents the main problem, has been dealt with in several permitting processes over the past three years: the issue of integrated permissions according to law IPPC (= Integrated Pollution Prevention Control) for the contemporary amalgam electrolyses in both chemical plants (in Spolana and Spolchemie), assessing the impacts on the environment (EIA = Environment Impact Assessment) and the issue of an integrated permission with the intention of cleaning the area of the old amalgam electrolysis in Spolchemie in Ústí nad Labem.

The public in the Czech Republic has the possibility of taking active part in the processes either directly (in the process EIA) or through civic societies (in the process IPPC). Thanks to this possibility, civic association Arnika has managed to enforce earlier dates for the termination of chlorine production with the use of mercury than had been planned, in Ústí nad Labem by the end of 2012 and in Spolana Neratovice by the end of 2014, where both companies had proposed 2015. In both cases, there are also schedules of particular steps leading to the preparation for the transition to mercury-free chlorine production. It also succeeded in enforcing, for example, the monitoring of mercury in the open air around Spolana Neratovice and the analysis of waste for the presence of POPs.

Originally we intended to enforce the termination of chlorine production by the end of 2009; nevertheless, we regard this result as a partial success, because without our participation the conditions for both plants would have had a negative impact on the environment due to further tonnes of mercury coming from releases and waste. Therefore, we regard the participation of public and NNO in decision-making processes as an important instrument for reducing the negative impact on the environment caused by mercury coming from chlorine-producing plants.

As we have found, apart from the EIA and IPPC processes, there are other similar instruments in the Czech Republic (including Pollutant Release and Transfer Register with free-accessible data on the Internet) which gives the public the opportunity to check the amounts of harmful substances which are released into the environment by industrial enterprises and it can exert pressure in order to reduce the releases of substances into the air, water and soil and substance transfers in waste and waste water.

## 7. Conclusion and recommendations

Chlorine production with the use of amalgam electrolysis in the Czech Republic has served as an example to show that the consequence of using mercury is its release into the environment to the total of hundreds of kilograms per tonne of the toxic metal per year. What is more, if we consider the complexity of mercury flows within the plant, it is obvious that it is not easy to measure the releases exactly and express them in exact numbers.

Chlorine production with the use of amalgam electrolysis is not – according to the document BREF[g] – the best available technique [40], especially due to the high amounts of mercury released into the air, water or in waste coming from the plants. The amount of mercury in waste from Spolana Neratovice is undoubtedly very high and the calculations show that it has probably been increasing in the past years. It is necessary to monitor carefully how waste containing mercury is disposed of.

Monitoring the surroundings of the plants producing chlorine with the use of mercury in the Czech Republic has shown increased values of the metal in various parts of the environment. They are also connected with old ecological damage caused by mercury. Therefore, it is not enough only to remove mercury from the contemporary chlorine production, it has to be eliminated it in the whole area of the chemical plants and their surroundings as well.

All this supports the elimination of chlorine production with the use of mercury. The IPPC process in the Czech Republic helped to determine an earlier date to eliminate mercury from chlorine production, but it is not itself sufficient to avoid the unnecessary prolonging of the life span of the processes which use this toxic metal.

As it is documented in this case study, international agreements about mercury and the determination of a date as early as possible of mercury elimination from chlorine production may prevent high releases of mercury and its compounds into the environment.

[g] BREF = Best Available Technique Reference Document

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