HELSINKI COMMISSION
Baltic Marine Environment Protection Commission

Implementing the HELCOM Objective with regard to Hazardous Substances

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"Implementation of the HELCOM Objective with regard to Hazardous Substances" – Project funded by European Communities (Subv 99/79391), Sweden and HELCOM.

Guidance Document on
Mercury and Mercury Compounds

Presented by Poland

October 2002

Guidance for policy makers to select and apply appropriate instruments in order to achieve cessation of emission, losses and discharges of certain hazardous substances in the Baltic Sea Area.

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0. BACKGROUND

Hazardous substances are substances or groups of substances that are persistent and liable to bioaccumulate and toxic or other substances or groups of substances, which are agreed by the Helsinki Commission as requiring a similar approach even if they do not meet all the criteria for toxicity, persistence and bioaccumulation, but which also give grounds for concern. These could for example be endocrine disrupters and substances that can damage immune systems.

The HELCOM Objective with regard to Hazardous Substances, as adopted in 1998 within HELCOM Recommendation 19/5, is to prevent pollution of the Convention Area by continuously reducing discharges, emissions and losses of hazardous substances towards the target of their cessation by the year 2020, with the ultimate aim of achieving concentrations in the marine environment near background values for naturally occurring substances and close to zero for man-made synthetic substances.

Based on a list of numerous potential substances of concern, 43 were selected for immediate priority action, among them e.g. mercury and its compounds, cadmium and its compounds, short-chained chlorinated paraffins (SCCP), nonylphenol and nonylphenolethoxylates (NP/NPE), and dioxins (HELCOM Recommendation 19/5, ATTACHMENT, Appendix 3).

A Project Team for the implementation of the HELCOM Objective with regard to Hazardous Substances held its 1st meeting in October 1998 and since then meets twice a year in Helsinki. It consists of members from all Contracting Parties (Denmark, Estonia, European Community, Finland, Germany, Latvia, Lithuania, Poland, Russia, Sweden) and representatives of NGOs (e.g. CEFIC, EuroChlor, WWF).

The Project Team decided on a pilot programme for a subset of the hazardous substances for immediate priority action to

- identify sources (incl. stockpiles), pathways and fate
- survey the legislative and the market situation
- initiate and promote development of policy instruments and measures aiming at cessation of emissions, losses and discharges, e.g. by substitution and/or minimised use.

The Contracting Parties with the help of a questionnaire submitted available information on the occurrence and regulation of those substances. This information is used to assess the exposure situation and thus to assess the risk. After these assessments relevant measures have to be identified and applied.

The Extraordinary Meeting of the Project Team for the Implementation of the HELCOM Objective with regard to Hazardous Substances, held in May 2001, in Berlin/Germany, decided to prepare guidance documents on certain substances, which should take into account the available information from EU, OSPAR, HELCOM (e.g. 4th PA), CEFIC and EuroChlor. In case no data are available realistic assumptions/estimations of application areas and amount of uses should be made. Risk reduction measures should be identified.

The presented guidance document contains available information on production and use of mercury and its compounds, sources of emissions and discharges, possible pathways to the marine environment, and monitoring data. It assesses the extent of the problem caused by mercury and its compounds, identifies possible measures to reach reduction and cessation of emissions, discharges and losses and instruments to implement these measures. Finally, proposals for possible HELCOM actions are discussed.

The document aims to provide guidance to policy makers with regard to

- Identification of relevant sources of release
- Prioritisation among sources
- Identification of appropriate measures to cease these releases
- Identification of appropriate policy instruments to implement these measures
- Making the choice among the available instruments and measures aiming to get the best outcome for the efforts taken

1. IDENTIFICATION AND QUANTIFICATION OF SOURCES

Mercury is a natural element, heavy metal. Due to its high toxicity to man and biota it is one of the substances of concern.

Significant amount of research indicates that the natural and human activities can redistribute mercury in the air, water and soil through a complex combination of transport and transformations.

1.1 Production and Use

The most important source of mercury production is cinnabar (HgS). It can also be by-product from the process of zinc, lead, copper and gold ores melting, processing of phosphate rocks, and the extraction of natural gas. The secondary production from recovered mercury and mercury products becomes more and more important, due to world wide efforts to prevent this element form entering the environment.

The present annual world primary and secondary mercury production amounts to 3,000 tonnes. About 1/3 of this comes from Spain, where the only EU mercury mine is located [Vonkeman 2000]. Other significant European mercury producers are Finland, Russia, Ukraine, Slovakia, and Slovenia.

The main fields of application are: dentistry, measuring and control equipment, batteries, light sources, chlor-alkali industry (Table 1).

Table 1. Average relative use volumes of mercury

Application	OECD 1988–1992 (%)*	USA 1993 (%)**	USA 1997 (%)**	Sweden 1997 ***
Chlor-alkali industry	28	33	46	15
Dentistry	7	6	12	41
Batteries	25			34
Electrical equipment	16			1.3
Light sources		7	8	6
Measuring devices		12	7	< 0.5
Wiring and switches		15	17	
Paints	10			
Others	14	27	10	2

** Haskoning*
*** Vonkeman*
**** questionnaire*

Consumption patterns are changing nowadays in many countries: mercury technologies are phased–out from chlor-alkali industry, Hg-containing batteries as well as biocides, anti-fouling agents and wood preservatives are phased out. In some countries dentistry consumes up to 50 (the Netherlands) or even 80 % (Nordic countries) of total mercury [Haskoning].

Some of the Helsinki Convention Contracting Parties have provided consumption data on mercury (Table 2). Nevertheless, the estimation of the mercury flow in the total Baltic Sea Area is not possible due to lack of comparable information from other CPs.

Table 2. Import/export and use of mercury within HELCOM CPs.

CP (year reported)	Import	Export	Consumption/Use
	t/y		
Denmark (1992-1993)	6.9-9.6 *(1.2 *)*	7.3-8.2 *(4.8 *)*	6.4-9.5
Finland (1991)	*4.7 **	*138.7 **	10-12.5
Germany (1998)	*77.7 **	*95.6 **	250
Sweden (1997)	*38.5 **	*0.0 **	2

**Haskoning (reported year 1997)*

1.1.1 Contracting Parties

Comprehensive data on the production, and on use to some extent, among HELCOM CPs is lacking. The following information has been submitted in the questionnaire elaborated by the Project Team on Hazardous substances [HELCOM 2001a]:

<u>Denmark</u>: There is no production. The annual consumption in early 90's was about 6.4-9.5 tonnes, mainly for electrolysis and dental purposes.

<u>Finland</u>: In early 90's production was about 1 t/a. The production in late 80's was about 9-25 t/a, however decreased by about 50 % in early 90's.

<u>Sweden</u>: Total annual sale of mercury in goods was about 2 tonnes in 1997. This is approx. 25 % of the sale in 1991/1992 and 60 % of the sale in 1995,

<u>Estonia, Germany, Latvia, Lithuania, Poland, Russia</u>: No information on production and consumption levels.

1.2 Sources of emissions and discharges

Mercury can be released to the environment both from natural and anthropogenic sources. The former ones are of special importance for atmospheric emissions, while the latter ones contribute both, to the discharges to water and soil.

Global anthropogenic discharges to water are estimated at 4,600 tonnes and to soil at 8,300 tonnes (including atmosphere fall-out, but excluding disposal of mine tailings, smelter slags and waste) [EuroChlor 2001]. The average global emission to the atmosphere from both types of sources have been estimated (Table 3).

Table 3. Comparison of annual average mercury emission from natural and anthropogenic sources [OSPAR 2000 on the basis of estimations from 1989].

Natural sources (t/y)		**Anthropogenic sources (t/y)**	
Windblown dust	50	Coal combustion	2,100
Seasalt spray	20	Lead production	10
Volcanoes	1,000	Copper/nickel production	120
Forest fires	20	Waste incineration	1,200
Continental particulates	20	Fuel wood combustion	180
Continental volatiles	610	Chlor-alkali industry	7
Marine sources	770		
Total	**2,500**	**Total**	**3,600**

According to other estimations the emission from natural sources could be even up to 2 times higher, reaching 5,000 tonnes annually [Vonkeman 2000].

As indicated from the table above, significant part of anthropogenic emission comes from the impurity of the material processed. Natural fuels such as coal, oil and natural gas are still an important source of energy production. All of them contain various concentrations of mercury but the average value of 0.21 mg/kg has been determined [Vonkeman 2000].

The emission patterns may differ from country to country. In Poland, for example, major part of energy produced comes from coal incineration. The share of renewable resources as water or wind is still very low and the nuclear energy is not used at all. As a consequence, out of total emission of 33 tonnes of mercury in 1997, about 60 % (20 tonnes) came from industrial heating and power plants and individual heating plants and another 35 % (11.5 tonnes) came from other combustion processes in the industry.

Chlor-alkali industry is the main contributor to mercury air emission as regards the intentional use of this substance (excluding the emission deriving from the contamination of raw materials used elsewhere, as described above). Western Europe is the world's second largest chlor-alkali producer after North America. In 1997 the share of mercury-based technology in chlorine production amounted to 62.4 % of total capacity in EU-member countries and 33.8 % in the rest of Western European countries. At the same time this value for East Europe (mostly accession countries) amounted to 66.9 %. Former USSR and Northeast Asia (China, Japan and Korea) produced practically mercury-free (6.4 and 0.4 % of mercury-based production, respectively). The world's average was at that time on the level of 23.5 %. [Vonkeman 2000].

In Western European countries some improvement took place during the last 25 years. Although the share of mercury-based production still remains on a high level (60 % of plants, 55 % of capacity), mercury emission was reduced by over 95 % from 1977 to 1999 [EuroChlor 2001] and reached the level of 1.3 Hg/t chlorine capacity with an aim to go below 1 g/tonne by 2010. The total emission from the EU industry was estimated at 10 tonnes in 1997 [Haskoning]. The mercury-based production will decline within the next years, as this production route is not considered to be best available technique (BAT). This leads again to a reduction of emissions from this industrial sector, however problems with the mercury from closed-down chlor-alkali plants may then arise.

Chlor-alkali industry may discharge mercury to all environment compartments, but the mayor part is discharged with solid wastes. If not disposed of properly, it may further contribute to water and air contamination.

According to the Swedish Product Register there are several other industrial sectors or activities where mercury may appear (Table 4).

Table 4. Industrial sectors and product types with a potential mercury content (NACE industrial code and EU use/function categories).

	Sectors		Products
Use		Use	
D24.13	Basic chemical, inorganic	55	Others
Minor use		Minor use	
EXP	Export	10	Colouring agents
N	Public health care and veterinary clinics	17	Electroplating agents
Very small use		33	Intermediates
D15	Food	34	Laboratory chemicals
D17	Textile	43	Process regulators
D21	Pulp and paper	55	Others
D24.61	Explosives	61	Surface treatment
D25.2	Plastic and articles		
D31	Electronics		
G51.55	Chemical products		
O90	Solid waste, scavenging and waste water treatment		

Apart from the main sources of emission indicated in Table 3 and sectors with intentional uses of mercury (Table 4) there are other industries still representing minor sources of mercury emission to the environment, mainly due to contamination of the material processed. These are:

- Fuel oil combustion;
- Petroleum refining;
- Cement manufacture;
- Iron-and steel production;
- Lime manufacture;
- Phosphate production.

Very significant stream of mercury enters the environment with the intentionally used man-made products. Among them the main are:

- dental fillings (amalgam);
- batteries;
- biocides, pesticides and fertilisers;
- industrial and control devices;
- laboratory and medical instruments;
- lightning equipment.

In most cases, the main problem with products, although containing very small amounts of mercury, is that they are broadly used and spread all over the society. This created very high costs of collection, transport and recovery of the recycled product. Due to this the real collection and recovery system could be developed only if supported by country administration (legal or financial measures). If those products are not collected in an appropriate way, they end up in a waste stream, where they are either landfilled or incinerated (and by that introduced to the environment).

To compare the influence of various products on the environment pollution with mercury, the emission factors for the product manufacture and use have been estimated in Table 5 [Haskoning]. As mentioned above, waste incineration, including households waste, is one of the main sources of anthropogenic mercury emission.

Table 5. Estimated emission factors for mercury product manufacture and use.

Product	Hg emission from the product manufacture (g/kg)			Hg emission to air from the product use (g/kg)
	to air	to wastewater	to solid waste	
Switches and relays	0.0003	0.03	5	negligible
Vapour tubes and arc rectifiers	0.0003	0.03	5	negligible
Measuring equipment	0.0003	0.03	140	50
Fluorescent tubes/HID lightning	22	0.03	140	80

Due to the fact that large amounts of Hg-containing products are used in households, discharges from households in EU–Member Countries have been estimated in Table 6 [Haskoning]. Comparable data for the remaining HELCOM CP's (EU-accession countries and Russia) are not available.

Table 6. Calculated total discharge of mercury from households after treatment.

Country	1985 (kg)	1995 (kg)
Denmark	265	104
Germany	4,270	1,647*
Finland	241	99
Sweden	366	170
EU 15 in total	19,463	8,501

* thereof 25 kg directly into the Baltic Sea, 5 kg into rivers draining into the Baltic Sea

Although mercury containing pesticides are banned within the HELCOM area, they remain a matter of concern due to large stocks of obsolete plant protection products. According to countries data [HELCOM 2001b] the existing stocks are estimated for 77 tonnes in Estonia, 43 tonnes in Latvia, 1.9 tonne in Lithuania (amounts of products containing 1,2-2 % of active substance as an average) and 0.2 tonne in Poland (amount of active substances).

2. PATHWAYS TO THE MARINE ENVIRONMENT, MONITORING DATA, AND ASSESSMENT OF THE EXTENT OF PROBLEMS

2.1 Pathways to the marine environment

Mercury may reach the marine environment via the rivers or the atmosphere. To the atmosphere mercury is emitted in three main forms (elemental, gaseous divalent and particulate). Further transformations and transport conditions depend a lot on these forms. Elemental mercury is a relatively inert chemical. Once released to the atmosphere it can be transported for long distances even in the global scale before being deposited.

Entering the marine environment, either directly from the sources with discharged wastewater or deposited from the atmosphere, inorganic mercury may be transformed into methylmercury, which is the most toxic and bioavailable form of this element for biota. It is also easily bioaccumulated along the food web causing increasing risk for fish-eating animals, and for human. Mercury in inorganic form can also be accumulated in the sediments.

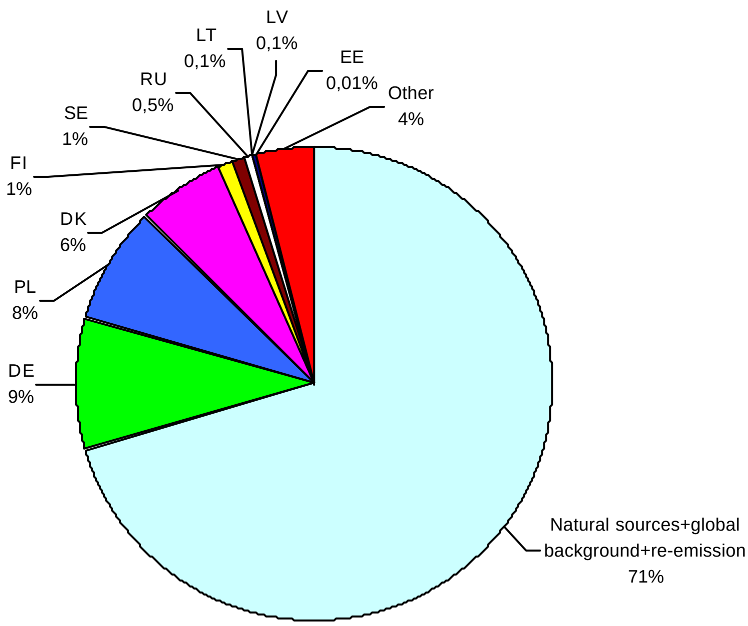
Municipal and industrial waste deposits may have their influence both for the atmosphere and water mercury concentrations, due to either evaporation or dilution.

2.2 Monitoring data

The highest mercury concentrations in the atmosphere are measured in central Europe, where they may reach 2.5 nm/m^3. The values in urban areas usually are higher and vary between 5 and 15 nm/m^3, or even higher in very industrialised areas. The average for the open areas of Northeast Atlantic are estimated at 1.6 ng/m^3.

Anthropogenic mercury air emission in the Baltic Sea region in 1996 was estimated for 78 tonnes from HELCOM Contracting Parties and 195 from other European countries, totalling at 273 tonnes. At the same time emission from natural sources reached 220 tonnes. The main contributors were Poland and Germany (33 and 31 tonnes, respectively). As regards the deposition of mercury in Baltic Sea Region, it accounted for 1.4 tonnes in the Baltic Sea and 17.7 tonnes in its catchment in 1996 [Bartnicki 2000]. Natural sources and re-emission cannot be neglected as important contributors, cause they are responsible for about 70 and 64 % of total deposition in the Baltic and its catchment respectively. Among the Contracting Parties, Poland, Germany and Denmark share the main responsibility for the deposition in the Baltic Sea (Fig 1).

Fig 1. Contributions to the mercury depositions in the Baltic Sea [Bartnicki 2000].



The only available data on riverine and point source mercury discharges from the whole Convention Area are available for 1995, the reference year of 3rd Pollution Load Compilation (Table 7). Due to very incomplete data, a full picture of mercury load going to the Baltic Sea could not be given. However total riverine and direct load was about 13.330 tonnes. Of this amount direct discharges from municipalities and industry were 1.14 and 0.610 tonnes, respectively, while 11.580 tonnes were discharged via rivers. Total as well as specific load varied a lot among the different subregions. The highest total load was discharged to the Baltic Proper (9.9 tonnes). The specific load to the Gulf of Riga was as low as 0.0009 kg/km^2 drainage area, while for the Sound reached 0.0389 kg Hg/km^2. It should be noted that these data do not include Denmark at all and Latvia and Russia as regards riverine input [HELCOM 1998]. Quite high mercury load from Estonia is due to one river, Narva River, shared with Russia (720 kg/a), however the actual concentration of mercury there is less than 0.1 ì /dm^3.

Table 7. Riverine and direct point source mercury discharges [HELCOM 1998].

Contracting Party	Total Hg load (t/a)
Denmark	0.324[1)]
Estonia	1.003[2)]
Finland	0.807
Germany	0.107
Latvia	n.r.
Lithuania	n.r.
Poland	9.765
Russia	0.771[1)]
Sweden	0.558

n.r. not reported

[1)] data incomplete

[2)] data from 1994

The information submitted by the CPs in the questionnaire elaborated by the Project Team on Hazardous substances is compiled in the Table 8 [HELCOM 2001c]. However, this information is not very comparable due to a lot of missing data and different years reported.

Table 8. Discharges and emissions from HELCOM CPs.

Contracting Party	Emission (t/a)				Reported year
	to air	to soil	to water	Total	
Denmark	1.9-2.5	0.2-0.3	0.5		1992-1993
Estonia	0.664	n.r.	n.r.		1998
Finland	2	3.7	0.150	6	1992
Germany	*31**	n.r	n.r		*1995*
Latvia	*0.12**	n.r	n.r		*1998*
Lithuania	0.472	n.r	n.r		1998
Poland	29.5	n.r	0.489**		1998
Russia	*9.4**	n.r	n.r		*1998*
Sweden	0.88	n.r	n.r		1995

* Vestreng 2002

** from chemical industry only, no data for other sectors available

Within the whole HELCOM area no comprehensive data on mercury concentration in environmental samples exist. Within the 3rd Periodic Assessment water samples were not analysed for mercury [HELCOM 1996]. Nevertheless it was done during 4th Periodic Assessment, which covered the period 1994–1998. The mean total Hg concentrations, which did not show significant regional differences were 0.008 nmol/l and 0.012 nmol/l in 1997 and 1998, respectively [HELCOM 2002].

Mercury concentration in biota varied a lot among the Baltic sub-basins and species examined, as concluded in 3rd Periodic Assessment, where monitoring data from 1980 till 1994 were analysed. The general conclusion is that lower mercury levels were observed in the Baltic Proper and in the Kattegat, while higher concentrations prevails in the Sound, Bothnian Sea and Bothnian Bay. The mercury contents in the soft body of blue mussel collected from Kattegat were approximately constant over the period (0.01-0.015 mg/kg wet weight) and slightly lower than the ones from Swedish west coast (0.01-0.025 mg/kg w.w.). The level of Hg from the Baltic Proper and from the Kattegat was low, varying between 0.01 and 0.04 mg/kg w.w. with significant upwards trend, while the level in fish from Bothnian Sea was higher (0.04-0.095 mg/kg w.w.), however the sampling site may have been influenced by the point source and not representative for the sub-region [HELCOM 1996].

Slightly different conclusions come from the 4th Periodic Assessment (1994-1998), where no systematic spatial variation in mercury concentrations were found from south to north and from east to west. The concentration of mercury in muscle tissue of herring varied from 0.016 to 0.083 mg/kg w.w., but both the lowest and the highest values were found in sampling sites in the Gulf of Bothnia. The average concentrations found in blue mussel was 0.011 mg/kg w.w. and 0.023 mg/kg w.w. in perch in central Baltic Proper. [HELCOM 2002].

2.3 Assessment of the extent of problems

There are the unique properties of mercury which make them a special issue of concern. First, it is easily transported for long-range distances. Due to this fact, measures aimed at reduction of atmospheric emission should be agreed and taken globally. This relates to combustion activities mainly. However, diffuse appliances in different products cannot be neglected, as those products often end their lives in the waste incineration plants. Secondly, mercury can be accumulated along the food web, this relates especially to the form of methylmercury. The process is even more important in the marine ecosystems, as they usually have more predatory levels than terrestrial ones. This makes the fish-eating birds and marine mammals heavily endangered due to high concentration of mercury. As a matter of fact, a decrease of fish-eating birds population as a result of eggshell thinning was one of the consequences of mercury pollution noted as early as in 1950s.

Although a lot of measures were taken during the years, there is no a clear evidence that the state of environment is improving. The long term temporal trends for mercury are varying and thus difficult to explain. Concentration in muscle tissue of herring increases significantly by about 4 % annually in northern Baltic Proper along the Swedish coast, from about 0.01 mg/kg in early 1980s to 0.04 mg/kg in 1998. At the same time, in the south-western Gulf of Bothnia the concentrations were fairly high in the beginning of the 1980s (0.17 mg/kg) with a negative trend up to 1996 (0.02 mg/kg) when the levels raised again to reach 0.08 mg/kg. However, the trend is significantly decreasing in perch muscle in central Baltic Proper by 6.3 % per year (from over 0.06 in 1980s mg/kg d.w. down to approx. 0.02 mg/kg in 1998) as well as in guillemot eggs from the central Baltic proper by 2.3 % per year (from over 0.5 mg/kg in early 1970s down to 0.26 mg/kg in 1998). No obvious difference in mercury concentrations in fish muscle was found among investigated species and all varied between 0.016 and 0.091 mg/kg w.w. [HELCOM 2002].

Basing on the guidelines elaborated by US EPA in 2001 it could be stated that Baltic fish consumption does not pose significant threat for human health. According to those guidelines, if mercury level ranges between 0.08 and 0.12 mg/kg w.w. the number of fish meals should not exceed 8 times per month (16 if concentrations are up to 0.06 mg/kg) [UNEP 2002]. However it should be noted that US EPA refers only to methylmercury concentrations, while in HELCOM data total mercury concentration is given.

According to the conclusions of Swedish Environment Protection Agency [SEPA 2002] 0.01 mg/kg w.w. of herring tissue could be regarded as a reference value, the estimated concentration which may be expected to occur in areas that have not been significantly affected by human activities, while the concentration exceeding 0.09 indicates the significant anthropopression. The reference value for blue mussel from the Baltic Sea is 0.2 mg/kg dry weight and from Kattegat 0.5 mg/kg.

3. IDENTIFICATION OF POSSIBLE MEASURES AND INSTRUMENTS

3.1 Measures required by EU legislation or international agreements

3.1.1. EU requirements

Mercury is referred to in many legal instruments of the European Commission, both as a substance intentionally or unintentionally used and contained in products as well as contamination discharged to the environment with various streams of pollution.

Collection, recovery and disposal of mercury–containing batteries is regulated by Directive 91/157/EEC. Moreover in 1998 (Directive 98/101/EC) concentration limits for marketed batteries have been set (ban of batteries containing more than 0.0005 % mercury and button cells containing more than 2 % Hg).

According to Directive 94/62/EC the amount of mercury and other heavy metals in packaging and packaging waste has to be reduced (sum of Hg, Pb, Cd and Cr(VI) below 100 mg/kg by weight).

Council Directive 79/117/EEC (further amended) prohibits the marketing and use of plant protection products containing certain active substances, including mercury compounds.

To solve the problem of used vehicles and enable to reuse their components the Council Directive 2000/53/EC prohibits the use of mercury in materials and components of vehicles. This ban, however, refers to vehicles put on the market after 1 July 2003.

According to Council Directive 89/677/EEC marketing and use of certain dangerous substances and preparations is subject of restrictions. As regards mercury, it cannot be used as a constituent of anti-fouling paints/preparations, wood preservatives, impregnates of heavy-duty industrial textiles. It can neither be used in treatment of industrial waters.

The issue of mercury discharges from point sources is regulated at present by the EU Water Framework Directive (2000/60/EC). This legal act integrates in practice a set of earlier directives, which had referred to specific type of sources (e.g. Council Directive 82/176/EEC on the mercury discharges by the chlor-alkali industry) or hazardous substances in general (e.g. Council Directive 76/464/EEC on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community). According to the WFD mercury is regarded as a priority hazardous substance and is subjected to the cessation goal to be reached within 20 years.

The very useful tool to reduce the emissions and discharges of mercury is provided by Council Directive 96/61/EC on integrated pollution prevention and control (IPPC), which concerns many important branches of industry (*i.a.* energy production, chemical industry, metal production and processing, pulp and paper industry), as well as intense livestock farming. It lays down requirements (further supported by elaboration of BAT reference documents) to prevent or at least reduce pollution (including mercury) from those activities.

The very useful tool to reduce the emissions and discharges of mercury is provided by Council Directive 96/61/EC on integrated pollution prevention and control (IPPC), which concerns most of the relevant industrial sources of mercury emissions to air and water (e.g. combustion, chlor-alkali production, cement and lime production, metal production and processing, waste incineration). It lays down requirements to prevent or at least reduce pollution (including mercury) from these activities. The technical information for the sectors to prevent and reduce emissions according to best available techniques (BAT) is described within the BREFs (BAT reference documents). They are available on the internet (http://eippcb.jrc.es/pages/FActivities.htm).

Waste incineration is another important source of mercury emission. It is regulated by Council Directive 2000/76/EC on the incineration of waste, which specifies, *i.a.* air emission limit values from waste incineration or co-incineration, as well as limit values for mercury discharges in wastewater from exhaust gases cleaning. However, this Directive has not been implemented yet (it applies to new installations as from the end of 2002, while to existing ones as from the end of 2005).

Large combustion plants are the major source of mercury air emissions. The Large Combustion Plant Directive 2001/80/EC specifies not directly mercury emission limit values, but due to restrictions to dust and sulphur dioxide emissions it effects mercury emissions as well. Abatement techniques to reduce dust and sulphur dioxide reduce mercury emissions in parallel to a certain extent. This Directive has also not been implemented yet, it will apply to new installations by end of 2002, for existing installations by 2008.

The concentration of mercury in drinking water is regulated within the Community as well (Council Directive 98/83/EEC). The maximum acceptable value is 1.0 ì g/l.

3.1.2. HELCOM requirements

The most important regulation regarding mercury and its compounds within HELCOM is the Helsinki Convention itself. All heavy metals are classified as priority harmful substances (Annex I, Part 1, Paragraph 1.2), which should be eliminated and prevented from introduction to the marine environment (Article 5). Mercury containing pesticides and biocides, which are mentioned separately, should also be avoided or even banned, whenever possible (Annex I, Part 3).

Among all the Recommendations concerning mercury, the most important and strategic one is Recommendation 19/5 defining the overall HELCOM objective with regard to hazardous substances.

There is a set of more specific Recommendations referring to product control measures or particular branches of industry:

- HELCOM Recommendation 6/4 (adopted 13 March 1985, having regard to Article 13, Paragraph b) of the Helsinki Convention): Measures aimed at the reduction of mercury resulting from dentistry. In order to reduce losses of mercury from this source Contracting Parties should establish collection of mercury-containing waste from dental clinics, laboratories and surgeries, and promote the research on mercury-free tooth fillings and, if possible, to stop using mercury-containing materials.
- HELCOM Recommendation 13/4 (adopted 5 February 1992, having regard to Article 13, Paragraph b) of the Helsinki Convention): Atmospheric pollution related to the use of scrap materials in the iron and steel industry. To reduce the atmospheric pollution CPs are requested to take measures to avoid mercury in all products that can end up as scrap as well as to conduct further research to achieve suitable technologies for reducing emissions of mercury.

- HELCOM Recommendation 14/5 (adopted 3 February 1993 having regard to Article 13, Paragraph b) of the Helsinki Convention): Reduction of diffuse emissions from used batteries containing heavy metals (mercury, cadmium, lead). Batteries containing heavy metals should be labelled and collected after use, however with the focus on the substitution and reduction of use with an aim at total ban.
- HELCOM Recommendation 16/8 (adopted 15 March 1995 having regard to Article 13, Paragraph b) of the Helsinki Convention): Limitation of emissions into atmosphere and discharges into water from incineration of household waste. In order to reduce emissions and discharges of heavy metals and dioxins CPs are recommended to use BAT and BEP and further development of treatment technologies. Limit values for Hg concentration in discharged effluents and air emission are established.
- HELCOM Recommendation 17/6 (adopted 12 March 1996 having regard to Article 13, Paragraph b) of the Helsinki Convention): Reduction of pollution from discharges into water, emissions into the atmosphere and phosphogypsum out of the production of fertilizers. CPs are recommended to use raw materials with the lowest possible content of heavy metals, including mercury.
- HELCOM Recommendation 18/2 (adopted 12 March 1997 having regard to Article 13, Paragraph b) of the Helsinki Convention) on offshore activities states that discharge of drilling cuttings containing *i.a.* mercury should be prohibited in the specifically sensitive parts of the Baltic Sea (confined or shallow areas with the limited water exchange and areas characterised by rare, valuable or particularly fragile ecosystems).
- HELCOM Recommendation 23/4 (adopted 6 March 2002 having regard to Article 20, Paragraph 1 b) of the Helsinki Convention, superseding Rec. 18/5): Measures aimed at the reduction of mercury pollution resulting from light sources and electrical equipment. According to this Recommendation mercury containing light sources and equipment should be substituted with mercury-free ones if technically and economically feasible, but if not, the mercury content should be reduced together with development of collection and recovery systems.
- HELCOM Recommendation 23/6 (adopted 6 March 2002 having regard to Article 20, Paragraph 1 b) of the Helsinki Convention, superseding Rec. 6/3): Reduction of emissions and discharges of mercury from chloralkali industry. It defines the limit values for mercury discharges, however indicating that mercury-free chlorine production is available and considered as BAT.
- HELCOM Recommendation 23/7 (adopted 6 March 2002 having regard to Article 20, Paragraph 1 b) of the Helsinki Convention, superseding Rec. 16/6): Reduction of discharges and emissions from the metal surface treatment. Sets general requirements for the technology used together with the limit values for wastewater discharges.
- HELCOM Recommendation 23/11 (adopted 6 March 2002 having regard to Article 20, Paragraph 1 b) of the Helsinki Convention, superseding Rec. 20E/6): Requirements for discharging of waste water from the chemical industry. Sets general requirements for the technology used together with the limit values for wastewater discharges.
- HELCOM Recommendation 23/12 (adopted 6 March 2002 having regard to Article 20, Paragraph 1 b) of the Helsinki Convention, superseding Rec. 16/10): Reduction of discharges and emissions from production of textiles. It states that mercury and its compounds should not be used as biocides in the production of textiles.

3.2 Other existing or new measures and instruments

Apart from regional initiatives related to the reduction of anthropogenic pressure on the environment related to mercury pollution there are a lot of international instruments on this issue.
Among them there are:

- The UN/ECE Protocol to the Convention on Long-Range Transboundary Air Pollution on heavy metals (CLRTAP-HM) adopted in Aarhus (Denmark) in 1998. It targets three particularly harmful metals: mercury, cadmium and lead. According to one of the basic obligations, Parties will have to reduce their emissions for these three metals below their levels in 1990 (or any alternative year between 1985 and 1995). The Protocol aims to cut emissions from industrial sources (iron and steel industry, non-ferrous metal industry), combustion processes (power generation, road transport) and waste incineration. It lays down stringent limit values for emissions from stationary sources and suggests BAT for these sources, such as special filters or scrubbers for combustion sources or mercury-free processes. The Protocol requires Parties to phase out leaded petrol. It also introduces measures to lower heavy metal emissions from other products, such as mercury in batteries, and the introduction of management measures for other mercury-containing products, such as electrical components (thermostats, switches), measuring devices (thermometers, manometers, barometers), fluorescent lamps, dental amalgam, pesticides and paint. The Protocol comes into force after 16 countries ratify it. As of 1 March 2002 it has been ratified by 10 countries, among them Denmark, Finland and the European Commission. The remaining HELCOM CPs, except the Russian Federation, have signed it [UN/ECE 2002].
- The Basel Convention on the control of transboundary movements of hazardous waste and their disposal. The central goal of the Convention is “environmentally sound management“ (ESM) the aim of which is to protect human health and the environment by minimising hazardous waste production whenever possible. ESM means addressing the issue through an “integrated life-cycle approach”, which involves strong controls from the generation of a hazardous waste to its storage, transport, treatment, reuse, recycling, recovery and final disposal. An integral part of implementing the Basel Convention is building the capability to manage and dispose of hazardous waste. Through training and technology transfer, developing countries and countries with economies in transition gain the skills and tools necessary to properly manage their hazardous waste. To this end Regional Centres for Training and Technology Transfer have been established in *i.a.* Slovak Republic and Russian Federation. In 1999 the Ministers of the CPs set out guidelines for the next decade (2000-2010) recognising that the long-term solution to the stockpiling of hazardous waste is reduction in the generation of those, which includes *i.a.* active promotion and use of cleaner technologies, further reduction of movement of hazardous and other waste, prevention and monitoring of illegal traffic [Basel 2002].
- The Convention for the Protection of the Marine Environment of the North-East Atlantic. The OSPAR Commission (the executive body of this Convention) has adopted a number of Decisions and Recommendations concerning mercury. They are related to the reduction of discharges of mercury from chlor-alkali industry, as well as other sectors. There are also measures taken to control releases from the use of mercury in products (*e.g.* thermometers, batteries, dental fillings).

4. PROPOSALS FOR POSSIBLE HELCOM ACTIONS

4.1 Evaluation of the need for actions at HELCOM level

As stated in chapter 1.2 large parts of annual emissions of mercury to the environment come from natural sources and thus cannot be controlled. The remaining parts arise mostly from the combustion activities, e.g. combustion of fuels as well as waste. This creates the possibility for further measures.

The emissions arising from fuel combustion are caused by the impurities of the material. The reduction of emissions may be obtained by:

- Reduction of consumption of contaminated fuel, or
- Use of cleaner/mercury-free alternative materials, or
- End-of-pipe measures.

The possibility of implementation of the first two measures highly depends on the economic condition of the plant and country concerned (it may be assumed that alternatives or *e.g.* mercury-free coal are more expensive). Due to this the third option seems to be easier to introduce. There are many available techniques commonly considered as effective for mercury removal, *e.g.* adsorption measures (wet or with activated carbon). However, many other available techniques allow the reduction of emission not only of mercury, but SO_2 and NO_x as well, *e.g.* selective catalytic reduction combined with wet scrubber may result in 50 - 80 % Hg, 90 % SO_2 and 90 % NO_x reduction, making the technology more effective for particular pollutants [UNEP 2002]. It should be noted yet, that end-of-pipe techniques do not deal with the cause of the problem since mercury is only transferred from gas to solid phase. If applied, greater concern should be given to proper management/disposal of solid waste produced.

Although many product-related decisions have already been taken by HELCOM, there are still some applications requiring further action. One possibility is regulation concerning mercury-containing thermometers. In France thermometers were not only prohibited for future marketing, but users had to return them to the pharmacies. It was estimated that this application was responsible for 20 % of annual mercury consumption. Taking into account both the mercury reprocessing costs and costs of new thermometers purchasing the operation is expected to be cost-effective. For example, the period of use of mercury-free thermometers (e.g. digital thermometers) is much longer. Experience showed that mercury thermometers used in hospitals are broken after only one month of use [IAE 1999]. Alternative measuring equipment can also be used in applications other than medical. They are usually more expensive, but have a lot of advantages as well – they can be adjusted to different measuring spans, and record the measurements. It also allows the elimination of errors caused by the human factor [Gustafsson 1997].

The use of mercury thermometers as well as other instruments and electronic equipment was also successfully phased out in Sweden. It was estimated that this will result in the drop of annual mercury consumption in these applications from 2,665 kg in 1993 to approx.14 kg in 1999 [KEMI 1994].

Other widely used products, as light sources, batteries and pesticides, which may contain mercury have already been regulated by HELCOM.

Emission from waste incineration depend highly on the composition of waste and the content of mercury-containing or polluted products. The emissions should be prevented or reduced in a two-fold approach: on the market and use side by enhancing the phase out of mercury containing products from the markets; and on the emission sides by using efficient abatement techniques, following the provisions in HELCOM Recommendation 16/8 and the EC Directive 2000/76/EC on waste incineration and regarding the information on BAT by the EC information provided in the respective EC BREF.

4.2 Proposals for such HELCOM actions

HELCOM Recommendation 19/5, aiming at the cessation of *inter alia* mercury discharges, emissions and losses, provides a general frame for the CPs' joint and individual actions and measures. The adoption of more specific Recommendations may be, however, helpful for the Contracting Parties. It may give to the Commission a greater possibility to monitor the work and the progress being done, as well.

Most CPs will become European Union Members and be bound by EU regulations. It may be expected that this process will enhance the full implementation of HELCOM Recommendations, especially with regard to discharges and emissions from industrial and municipal point sources. Nevertheless, there will remain enough room for future HELCOM actions, e.g.:

- All CPs should put efforts to implement those provisions of HELCOM instruments, which result from the specific conditions of the Baltic Sea and go beyond the EU legislation requirements.
- Although mercury-containing pesticides are banned within the Baltic Sea Region there are still considerable amounts of stockpiled products. HELCOM may consider and discuss with the countries concerned whether there is a possibility and need for assistance from other CPs to solve the problem.
- HELCOM should consider whether there is a need for a Recommendation concerning the mercury emission from the natural fuel combustion (e.g. heating plants) and elaborate a draft, if appropriate.
- HELCOM should consider whether there is a need for a Recommendation concerning the mercury use in thermometers and other measuring equipment and elaborate a draft, if appropriate.

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6. ABBREVIATIONS

BAT	Best Available Technology
CEFIC	European Chemical Industry Council
CPs	Contracting Parties
CLRTAP-HM	Convention on Long-range Transboundary Air Pollution, Protocol on Heavy Metals
DE	Germany
DK	Denmark
EC	European Community
EE	Estonia
EEC	The European Economic Communities
e.g.	exempli gratia / for example
EMEP	European Monitoring and Evaluation Programme
ESM	Environmentally Sound Management
EU	European Union
EuroChlor	European Chlor-Alkali Industry
FI	Finnland
g	Gram
HELCOM	Helsinki Commission (Baltic Marine Environment Protection Commission)
Hg	Mercury
i.a.	inter alia
IAE	Institute for Applied Ecology
IPPC	Integrated Pollution Prevention and Control
KEMI	Kemikalieinspektionen – Swedish National Chemicals Inspectorate
kg	Kilogram
LT	Lithuania
LV	Latvia
mg	Milligram
nmol	Nanomol
OECD	Organisation for Economic Cooperation and Development
OSPAR	Oslo and Paris Commissions
PL	Poland
PLC	Pollution Load Compilation
RU	Russia
SE	Sweden
SEPA	Swedish Environmental Protection Agency
UBA	Umweltbundesamt (German Federal Environmental Agency)
UN/ECE	United Nations Economic Commission for Europe
UNECE/LRTAP	Convention on Long-range Transboundary Air Pollution
UNEP	United Nations Environment Programme
WHO	World Health Organisation
ww	Wet weight
WWF	World Wide Fund for Nature
y	year