HELSINKI COMMISSION
Baltic Marine Environment Protection Commission

Implementing the HELCOM Objective with regard to Hazardous Substances

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Guidance Document on Cadmium and its Compounds

Presented by Denmark

June 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 cadmium 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 cadmium, 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

Pure cadmium is a soft, silver-white metal. Cadmium is not usually present in the environment as a pure metal, but as a mineral combined with other elements such as oxygen, chlorine, or sulfur. Cadmium is most often present in nature as complex oxides, sulfides, and carbonates in zinc, lead, and copper ores. It is rarely present in large quantities as the chlorides and sulfates. The melting point of cadmium is 321^{o} C and its boiling point is 778^{o} C, a relatively "volatile" metal, although less volatile than mercury.

Soils and rocks naturally contain varying amounts of cadmium, generally in small amounts (for example in some fossil fuels or fertilizers). Most cadmium is extracted as a by-product during the production of other metals such as zinc, lead, or copper. Cadmium has a number of uses in industry and consumer products, mainly in batteries, pigments, metal coatings, plastics, and some metal alloys.

It is estimated that about 25,000 to 30,000 tons of cadmium are released to the environment globally each year, about half from the weathering of rocks into river water and then to the oceans. Forest fires and volcanoes also release some cadmium to the air. Release of cadmium from human activities is estimated at 4,000 to 13,000 t/a, with major contributions from mining activities, and burning of fossil fuels. Cadmium can enter the air from the burning of fossil fuels (e.g. coal fired electrical plants) and from the burning of household waste. In countries with comprehensive regulation of cadmium, only smaller amounts currently enter water from the disposal of wastewater from households or industries. Fertilizers often contain some cadmium that will enter the soil when fertilizers are applied to crops; this quantity has also been reduced in some countries due to regulation. Cadmium can also enter the soil or water from spills or leaks at hazardous waste sites if large amounts of dissolved cadmium are present at the site. The form of cadmium at these sites is important since many forms do not easily dissolve in water. New and old mine tailings and wastes leach cadmium into the environment.

Cadmium that is in or attached to small particles can enter the air and travel a long way before coming down to earth as dust, or in rain or snow. Cadmium, being an element, does not break down in the environment, but it can change into different forms. Most forms of cadmium stay for a long time in the same place where they first entered the environment. Some forms of cadmium that go into the water will bind to particles, but some will remain dissolved in the water. Some forms of cadmium in soil can enter water or be taken up by plants. Fish, plants, and animals can take up some forms of cadmium into their bodies from air, water, or food. Cadmium stays in the body for a very long time (years).

Food and cigarette smoke are the biggest sources of cadmium exposure for people in the general population. Smokers may double their daily intake of cadmium compared with nonsmokers (USATSDR, 2001).

Cadmium and its compounds can have acute toxic effects on humans, but particularly its accumulation in human tissues and subsequent effects (in the kidneys among others) at higher concentrations are of concern.

1.1 Production and Use

1.1.1 Production

Production of cadmium has declined slightly during the last decade, especially in the HELCOM area. Cadmium prices have also fallen. Some cadmium is also produced from recycling, but the low market price does not encourage this. Commercial cadmium is obtained mainly as an impurity in zinc ores: approximately 3 g of cadmium are produced for every ton of primary zinc produced, and cadmium production is more closely related to the demand for zinc than to the demand for cadmium itself (EUPHEMET 2000). Some cadmium is also produced from the recycling of scrap metals, industrial wastes, dusts and fly ash etc. containing cadmium impurities. Primary cadmium production has slightly decreased since 1990, while secondary production has increased.

OSPAR (2001) has compiled data on European cadmium production as listed in table 1.

Table 1: Cadmium production in different years in OSPAR countries (in tons).

Country	1985	1990	1993	1998
Belgium	1293	1750-1958	1573	1145-1318
Finland	564	591-568	785	550
France	365	188	139	177
Germany	1095	973	1069	1150
Netherlands	598	590	526	739
Norway	164	286	213	270
Spain	268	262-344*	329	320
United Kingdom	370	438	458	440
Total	4717	5263	5092	4964
Price ($/pound)	1,21	7,90**-3,38	0,45	0,28

(*) 1991 data; (**) 1998 data.

World production in the period 1996 – 2000 has been slightly under 20,000 t/a (USGS 2001). Of the HELCOM Contracting Parties, only Sweden reported production of cadmium ore (520 tons in 1993; in Haskoning 2001), and only Finland reports production of cadmium metal in the Baltic Sea catchment area (HELCOM 2001F). Germany produced 1150 tons of refined cadmium in 1998 (Haskoning), presumably outside the HELCOM catchment area. Poland's production of refined cadmium, averaging around 600 t/a in the 1980's, has declined after 1990 and has now ceased.

For environmental reasons, the use of cadmium has been increasingly restricted or banned, and the main demand for cadmium now arises from its use in rechargeable Nickel-Cadmium batteries (OECD 1994). Cadmium prices have fallen steeply since 1990, and in 1998 the price was one tenth of the 1990 price (USGS 2001). It is doubtful whether primary or secondary production of cadmium is economic at the current low prices. EUPHEMET (2000) notes that "very low cadmium prices do not encourage genuine interest for recycling".

EUPHEMET (2000) notes that battery recycling schemes have not been particularly effective so far, but if these systems eventually manage to collect and reuse a considerable part of the accumulated cadmium in the market (estimated to several hundreds of tons), then the market will not be able to absorb more cadmium extracted as by-product from the production of zinc, copper and lead. EUPHEMET concludes that inevitably a lot of cadmium will end as controlled waste, and, irrespective of any regulations imposed on cadmium products, the zinc industry should be prepared technologically and economically to handle cadmium properly in the medium and long term, not as a by-product but as a hazardous waste.

1.1.2 Use

For environmental and health reasons many historical uses of cadmium have been increasingly restricted or phased out, so the usage pattern has shown considerable changes over the last ten years. Cadmium is now mainly used in rechargeable batteries (NiCd batteries for which alternatives are readily available).

Usage patterns of cadmium in Western Europe have changed during the last two decades as a result of increasingly strict restrictions and a marked increase in NiCd consumption in the mid 1990s. This is reflected in table 2.

Table 2: Cadmium consumption in the Western World by application (EUPHEMET 2000)

Application	% total consumption, 1980	% total consumption, 1993
NiCd batteries	15	61
Cadmium pigments	25	20
Cadmium-based stabilizers	15	10
Cadmium coatings	33	8
Cadmium-containing alloys	8	3
Miscellaneous uses	4	4

Nickel-Cadmium (NiCd) rechargeable batteries now represent the largest single cadmium application, constituting for example over 90 % of the total cadmium consumption in Sweden (HELCOM 2001E). Consumption is thought to be declining at the close of the 1990s due to the massive introduction of NiMH and Li-ion batteries instead of NiCd batteries in equipment.

In addition to NiCd batteries, the following major uses/sources are considered relevant to cadmium pollution in the Baltic area (Baltic Environmental Forum, 2000 and HELCOM 2001F):

Intentional uses:

- Electroplating industry (cadmiation of electrical contact surfaces etc.)
- Stabilizer in plastic
- Pigment in paints and plastic

Mobilization of cadmium impurities:

- Fossil fuel combustion
- Ferrous and non-ferrous metal production

Indirectly from both categories:

- Waste incineration

As the large point sources of cadmium pollution are dealt with, other uses which lead to more diffuse releases to the environment become relatively more important. The Swedish Product Register (2001) reports that cadmium is used in very small quantities in a number of industrial sectors/activities. A number of product types are also identified as having a potential (but very small) cadmium component (terminology as in Swedish Product Registry 2001). These are listed in table 3.

Table 3: Product types with potential cadmium content (Swedish Product Registry)

Sectors (code and description)		Products (code and description)	
"Minor" use:			
Code	Description		
D24.30 D28.5	Paint Metal surface treatment		
"Very small" use:		"Very small" use:	
Code	Description	Code	Description
D17 D24.42 D25.1 D26.1 D26.2 D26.3 D28 D35 EXP G51.55 G52.462 I	Textile Drugs Rubber articles, tires Glass and articles Ceramics Ceramic floor and wall articles Metal articles Boats, bikes, aeroplane and rai vehicles Export Chemical products Colourmans shop Transport business	2 10 12 15 20 26 35 43 54 55 59 61	Adhesives, binding agents Colouring agents Conductive agents Dustbinding agents Fixing agents Food/feedstuff flavourings anc nutrients Lubricants and additives Process regulators Welding and soldering agents Others Paints, lacquers and varnishes Surface treatment.

Another potential growth sector for use of cadmium is in the electronics industry, where cadmium sulfide and telluride are used in solar cells and photodetectors. The quantities used are relatively small, but large-volume usage is expected to increase, for example for production of electricity in remote areas. OSPAR (2001) comments that it is important to ensure that this growing usage for "clean energy" is carefully planned to prevent any risk of cadmium pollution.

Cadmium is also used as an additive (0.025 – 0.070 %) in zinc sacrificial anodes protecting steel structures (ships, harbour pilings, offshore installations and pipelines) against corrosion in marine environments. In Denmark, sacrificial anodes release 0.6 t of cadmium to the marine environment yearly. Cadmium-free aluminium electrodes are available as an alternative to zinc/cadmium anodes (COWI 2000, EPE 2001).

There have been distinct differences in the cadmium usage patterns in different HELCOM countries, partly due to historical differences in economic systems, different import/export patterns, and differences in the rate at which restrictions took effect and specific cadmium uses have been phased out.

For example, a substance flow study for cadmium in Denmark and Estonia in 1992 (CASA 1994) and Denmark 1996 (COWI 2000) showed marked differences. Automobile imports to Estonia contained significant quantities (22 t) of cadmium in 1992, whereas in Denmark this source had declined from 20 t in 1980 to only 2 t in 1990. In Estonia, oil-shale fuel consumption contributed 21.5 t out of the total cadmium consumption of 54 t, whereas NiCd batteries contributed only 3.8 t, about 7 % of the total (although the report considers that this figure is probably underestimated due to a "concealed" import of batteries mounted in finished products). In Denmark, NiCd batteries (including batteries mounted in finished products) contributed more than 50 – 60 % of the total cadmium use. The report notes that 1992 was not a "normal" year for Estonia, since the economy was in transition from the old planned economy, which no longer worked, to a new market economy, which was still very weak at that time.

Oil-shale production, which was already declining in Estonia in 1992, has continued to decline as a result of the increased access to oil and natural gas fuels (Dyni 2000).

The differences in usage patterns can be expected to diminish in the future as economic systems and technologies are converging. In the last few years, the consumption of particularly electronics has increased in many of the HELCOM countries, and the majority of these products are deemed to be of types traded internationally. At the same time most of the HELCOM countries not currently EU members but accession countries are working fast to approximate their legislation and related procedures to EU standard, which also influences the usage pattern as well as the types and sizes of emissions and discharges. Still, the individual countries industrial profiles will vary, and this is also expected to continue to be reflected in the cadmium release patterns.

A newer substance flow analysis was made for 1996 in Denmark (COWI 2000). A summary of the results is shown in table 4. Also in Denmark NiCd batteries was by far the dominant use of cadmium. The remainder of the cadmium consumption consisted mainly of internationally traded products like toys and jewellery, alloys (for sacrificial anodes etc.) and cadmium impurities in bulk materials like zinc, lime, fertilizers and cement.

The cadmium usage data from Contracting Parties (HELCOM 2001F) and some supplementary data are summarized in the table 5. A transcription of the Contracting Parties' replies is included as Annex 1. As seen, the amount of available data varies considerably among the Parties.

Table 4: Cadmium balance for Denmark in 1996. All figures are tons Cd/year (COWI 2000; the notation "follow substances" refers to natural and anthropogenic Cd impurities in consumed bulk materials like fuels, minerals etc.).

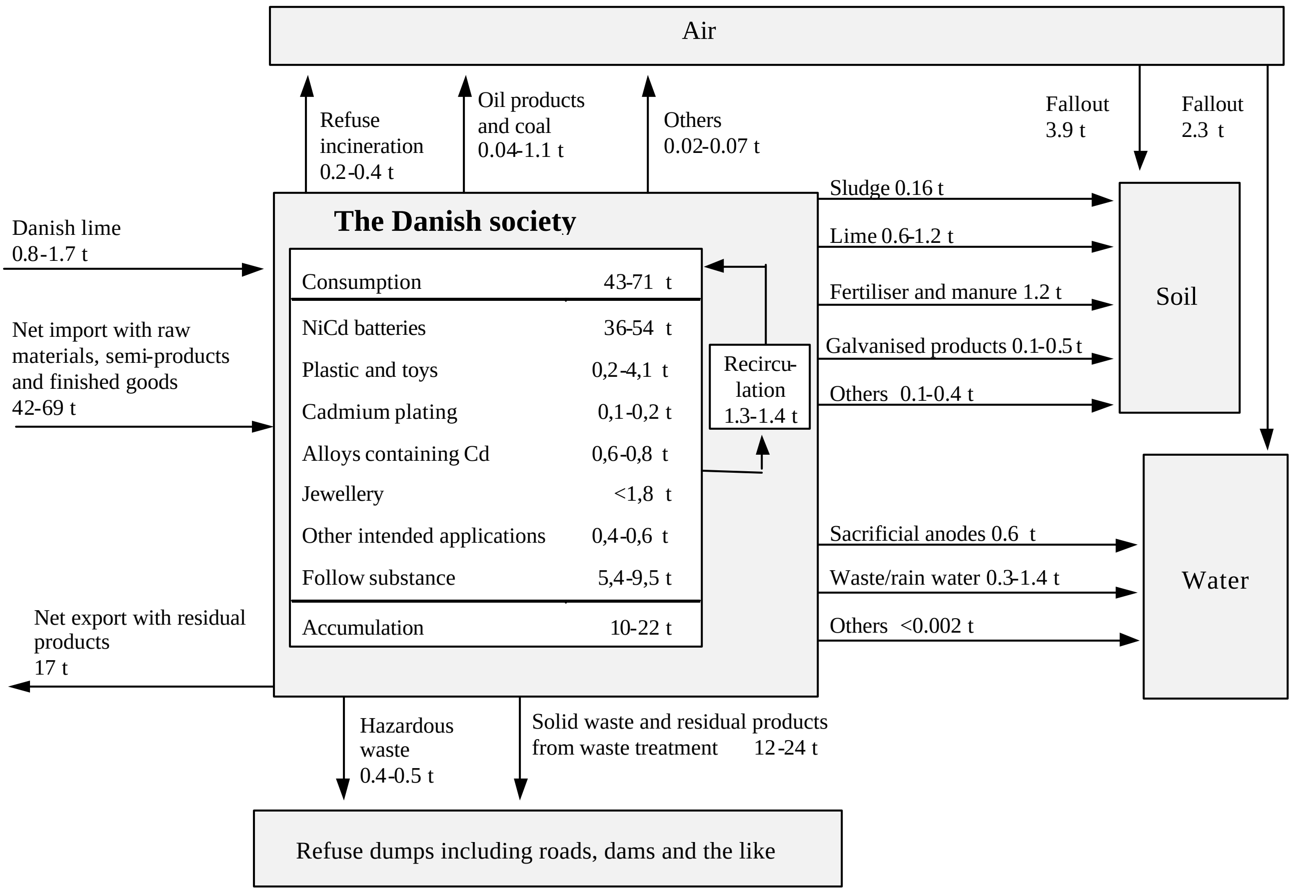

Table 5: Cadmium usage data (in tons) reported from HELCOM Contracting Party countries.

	DK	EE*	FI	DE	LV	LT	PL	RU	SE
Usage	40 – 70	54	> 50		>0.6	**	> 84		> 94
To waste deposit	12 – 24	23	<110						
Import	42 – 69	38	50						94
Export	17	20	570-639						
Own production	1 – 2	22	519						
Accumulation	10 – 22	13			0.6				

* reported data was for industrial usage only. These figures for cadmium are 1992 data, from CASA (1994)

** reported data was total consumption of products and materials, not cadmium consumption, therefore not shown here.

1.1.2.1 Particulars on NiCd rechargeable batteries

As NiCd batteries are by far the most dominant potential source of cadmium to the environment, particular attention is paid to them in this section. A distinction should be made between the larger "open" type NiCd accumulators, which look and work somewhat like the traditional lead accumulators, and the "closed" or sealed type, referred to as NiCd batteries (or rechargeables etc.), usually looking like ordinary primary cellular batteries. NiCds (of the sealed type) have played an important economic role in society as a prerequisite for the use of portable, wireless equipment. Today, however, alternative battery types with less potential impact to the environment are commercially available for all ordinary uses. The alternatives have been developed partly because of their technical superiority to NiCds and partly due to environmental concerns related to cadmium.

The largest volumes of NiCd batteries have been used in cellular phones (mobile phones – large in numbers) and wireless hand tools (particularly drilling/screwing machines – large in Cd weight). Also other consumer electronics like lap-top computers, video cameras and walkie talkies have – and may still – utilize NiCd batteries. Also individually sold NiCds cells have been – and are still – available for the same uses as primary (non-rechargeable) battery uses, i.e. portable stereos, torches etc.

The substitutes for NiCd batteries appeared first for lap-top computers and cellular phones (driven by the search for high performance and low weight), and last for hand tools. Today, consumer electronics are often powered by nickel-metalhydride (NiMH) or lithium-ion rechargeable batteries. The more expensive brands of handtools adopted NiMH cells in about 1997, and today low cost machines can also be bought with NiMH batteries.

The consumption pattern for rechargeable cells has been changing rapidly over the last years, and no recent, publicly available overview of the relationship between NiCd cells and their substitutes on the markets in the HELCOM area appear to exist. The situation may thus span from dominance of the substitutes to sustained or increased consumption of NiCd cells. In Denmark, sales campaigns for cellular phones at very low prices (in 1995-96) resulted in increased NiCd consumption, because NiCd cells were cheaper than the substitutes at that time.

Irrespective of the current supply situation, a large volume of NiCds have been spread in society in most or all of the HELCOM countries, and only a fraction of these has been recovered through collection schemes for environmentally safe handling. These un-recovered NiCd batteries are distributed amongst the following fates:

- still in active use in society
- spent but still kept by users
- lost in the general waste stream (deposited on waste dumps and emitted from – or deposited after – waste incineration), and
- lost diffusely in the environment due to un-controlled waste disposal.

This situation underlines the need to ensure efficient and safe collection and handling of spent NiCd batteries in order to reduce releases of these substantial amounts of cadmium to the environment over the next decades. Based on experience, such systems should not rely too strongly on the will and ability of the consumers, but should be as simple as possible while still meeting the requirements. Such systems are expensive to run and it is recommended that appropriate collection should preferably be financed by the users in order not to burden the general tax payers.

In the light of the availability of adequate substitutes, bans on the closed type of NiCd batteries should be considered in the future. The economic burden of NiCd substitution for society and the general consumer is deemed negligible today.

A general ban on the larger “open” type of NiCd accumulator (for instance used in some electric cars) may prove less crucial, as they are used in much more limited and controllable compartments in society, where efficient collection and treatment may be easier to achieve, judging from experience with ordinary lead accumulators for cars etc.

In the environment we have not yet seen the full consequences of the widespread and extensive NiCd use. Emissions from waste incineration are evident today, but long-term releases of cadmium from deposited NiCds will occur over decades and maybe even centuries, unless adequate measures are applied.

1.2 Sources of emissions and discharges

In addition to emissions and discharges in connection with production and planned use of cadmium, emissions and discharges also arise from activities in which cadmium is unintentionally mobilized, for example in the burning of fossil fuels, the production and application of phosphate fertilizers, the use of galvanized products, etc.

1.2.1 General

Inputs of cadmium to the environment have declined considerably in Europe over the last 20 years. Phosphate fertilizers and rechargeable batteries are now the most significant sources along with cadmium impurities in zink and other metals, lime and cement.

The sources of emissions of cadmium to the biosphere can be grouped in three categories:

- Emissions due to natural mobilization of cadmium from the Earth's crust. Volcanic activity and weathering are some of the emission mechanisms
- Anthropogenic (associated with human activity) emissions from the mobilization of cadmium impurities in fossil fuels, other minerals (phosphate fertilizer, metal ores), and materials (galvanized iron, zinc products)
- Anthropogenic emissions from cadmium used intentionally in products and processes.

The relative importance of the two last categories of sources varies between countries and regions, particularly depending on:

- state of substitution/phase-out of intentional uses (products and processes)
- collection setup and efficiency for spent NiCd-batteries and other wastes containing cadmium
- extent of reliance on fossil fuels for energy production, particularly oil-shale, coal and oil
- extent of mining and mineral extraction industry
- waste disposal pattern – incineration/landfilling
- ability of waste deposits to prevent release of percolate to the environment
- state of implementation of emission control technology in power production, industry and waste incineration.

According to the Draft EU Risk Assessment Document for Cadmium (EU 2001), estimated total Cd inputs to the EU environment from Cd producing- and processing plants have declined over the last 20 years as shown in table 6.

Table 6: Total, direct emissions in the EU (T y^{-1}). (Comparison of different studies)

	to Air (T y^{-1})		to Water (T y^{-1})	
	Cd-producing plants	Cd-processing plants	Cd-producing plants	Cd-processing plants
Hutton, 1982	19.5	8.8	50	107
Jensen & Bro-Rasmussen 1992	22.8	12.2	17.3	45
OECD, 1994	/	4.05	/	1.6
RAR-Cd, 1998	3.9	0.8	1.2	0.4

Data in the Hutton report are based on estimated emission data from the late 1970s. Data in Jensen & Bro-Rasmussen (1992) are based on estimated emission data from the late 1980s. The emission results reported in OECD (1994) are based on the same production data (late 1980s), but emission factors have been updated with more recent estimates.

The table reveals a general decrease in emissions from the cadmium-producing and processing industry over the last 20 years. Since the late 1970's, emissions to air decreased more than 80 %, while emission to water decreased more than 97 %. This trend, based on measured data, confirms earlier estimates. The trend is interpreted as the consequence of increasing regulatory pressure on Cd-emitting industry and the consequent implementation of waste water treatment plants in the seventies.

EUPHEMET (2000) points out that apart from batteries (for which a series of measures have been taken with various, rather poor degrees of efficiency, until now) another major input of cadmium to the European environment is through phosphate fertilizers. Generally phosphate rocks of volcanic origin have very low cadmium content, compared to sedimentary rock phosphates, which contain much more cadmium. Most phosphate is converted to phosphoric acid, from which a number of products such as Triple Super Phosphate (TSP), Mono-ammonium phosphate (MAP) and Di-ammonium Phosphate (DAP) are made. During the conversion of rock to acid, gypsum is produced as a by-product, which contains a proportion of the original cadmium. Approximately 30 % of the Cd contained in the raw material passes to the gypsum waste whilst the remainder passes to the phosphoric acid product. According to an earlier estimate (1990), EU-11 imported annually 409 t of cadmium in phosphate rocks, 126 t of which pass to gypsum and 283 t through fertilizers to soils. Despite the introduction of maximum concentrations of Cd allowed in phosphate fertilizers by most EU states and a major trend in fertilizer manufacture towards use of low cadmium content phosphate rocks, the overall cadmium input via this route to European soils is still deemed quite significant.

The cadmium balance for Denmark (table 4) reveals that under conditions like those in Denmark, other major sources of cadmium to the environment are:

- combustion of fossil fuels (to air),
- corrosion of zinc gutters, plating and galvanized items (zinc contains small traces of cadmium, highest concentrations in old zinc items; released to water and soil recipients),
- lime spread on agricultural soil
- sacrificial zinc anodes on boats and marine constructions

It should be added that there is a much more widespread tradition (than in Denmark) of zinc plated roofs on buildings in some other countries in the Baltic catchment area. Formerly zinc contained much larger amounts of cadmium than today and because of high lifetimes (60-70 years depending of acidification and other local conditions) zinc roofs may prove to be a more important source of cadmium discharges in such locations than in Denmark. This is a source, which will only diminish very slowly as old zinc plated roofs, and gutters are gradually replaced by newer zinc with lower cadmium content (and other materials like aluminium plating, for instance).

1.2.2 HELCOM area

Inputs to the Baltic Sea Area are believed to have declined by over 50 % in the last decade, although total usage of cadmium remains unchanged. A comprehensive picture of the total input requires more consistent data from the Contracting Parties.

Although a lot of information is available, a comprehensive picture of the total Cd emissions and discharges in the Baltic catchment area cannot be produced due to lack of consistent data. Data submitted in response to the cadmium questionnaire (HELCOM 2001F) reflect differences between the different Contracting Parties in recorded usage patterns and in their adoption of either a source-orientated approach or a load-orientated approach to the problem. More information is therefore needed. However, it is clear that the total inputs to the Baltic Sea Area have declined considerably over the past 10 – 15 years.

HELCOM (2001B) has concluded that the 50 % reduction goal of cadmium emissions to water has been fulfilled due to decreasing deposition from the air (quantities from production of iron and steel, scrap shredding, and direct deposition have all decreased), cessation of phosphoric acid production, lower cadmium impurity levels in zinc, partial substitution of zinc guttering by PVC and steel guttering, significant reduction of emissions from waste incineration plants, effective legislation on the maximum permitted content of cadmium in fertilizers, and bans on the use of cadmium in certain applications and products. However, total cadmium consumption has not declined, due to a significantly increased usage of closed nickel-cadmium batteries (based on 1996 data). Consumption is thought to be declining at the close of the 1990s due to the massive introduction of NiMH and Li-ion batteries instead of Ni-Cd batteries in equipment.

In general the current atmospheric emissions of heavy metals in the Baltic States are comparatively low. The per capita emission of cadmium due to emissions from large combustion plants range from 0.27 grams per capita per year in Lithuania[1] in 1997 compared to 0.16 grams per capita per year in Denmark and 0.07 grams per capita per year in Estonia. The cadmium emission in Poland is high (2.26 grams per capita per year). The basis for these comparisons is not explained in the report (Baltic Environmental Forum, 2000). Local industrial emissions of cadmium occur at the Liepäja smelter (Latvia) and the Naujoji Akmene cement plant (Lithuania).

[1] Original figure of 0.58 has been corrected by Lithuania cf. HELCOM document HAZSUB 7/2002 3.3/3 Com 1.

The cadmium emissions data submitted from Contracting Parties (HELCOM 2001F) and some supplementary data are summarized in table 7. A transcription of the Contracting Party replies is included in Annex 2.

Table 7: Cadmium emission data submitted from HELCOM Contracting Party countries (all figures in tons).

<table>
<tr><th></th><th>DK</th><th>EE</th><th>FI</th><th>DE</th><th>LV</th><th>LT</th><th>PL</th><th>RU***</th><th>SE</th></tr>
<tr><td>To air</td><td><1</td><td>5.4</td><td>1.1</td><td></td><td></td><td>2.4</td><td>85</td><td></td><td></td></tr>
<tr><td>To water</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>-Municipal discharges</td><td rowspan="3"><2</td><td rowspan="3"><0.1</td><td rowspan="3"><0.2</td><td rowspan="2">0.017</td><td></td><td>0.009</td><td></td><td rowspan="3">0.32</td><td>2.9</td></tr>
<tr><td>-Industrial discharges</td><td></td><td></td><td>3.3</td><td>5.5</td></tr>
<tr><td>-River transport</td><td>2.7</td><td></td><td>9.4</td><td>5.6</td><td>46</td></tr>
<tr><td>To Soil</td><td><3</td><td>0.1</td><td></td><td></td><td></td><td>1.4- 51**</td><td></td><td></td><td></td></tr>
<tr><td>Deposition from air to water and soil</td><td>6*</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>53</td></tr>
</table>

* Additional 4 t to soil and 2 t to water (includes non-Danish sources)
** Cadmium in sewage sludge
*** See additional information from Russia in Annex 3

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

Considerable quantities of cadmium are in use in industrialized societies and a certain percentage escapes to the external environment each year. For instance it is estimated that Denmark has an annual cadmium consumption of about 50 tons, from which about 1 ton is released to the atmosphere, 2 tons is discharged to water, and 3 tons are added to the soil. In addition, about 20 tons are deposited in landfill (COWI 2000, data for 1996). Thus at least 10 % of the annual consumption escapes directly to the environment and 40 % goes to landfill, from which large- or small-scale release can potentially take place at a later date. Another 6 tons of cadmium are “imported” to Denmark as transboundary atmospheric pollution and deposited on land and water.

Similar patterns can be expected in other countries, although the balance will be altered by such factors as local cadmium production, large-scale metal industry, preferred waste disposal options, or unusual fuel consumption patterns.

Elevated levels of cadmium in the mosses (above 0.3 µg/g dry weight) occur in Polish, Estonian, and Russian parts of the Baltic Sea drainage area (Baltic Environmental Forum 2000, Map 5.B.I). The cadmium content of agricultural soil is still increasing slowly in European countries, but reductions in the permitted maximum cadmium content in fertilizers in Sweden, Finland and Denmark have reduced the rate of increase considerably in these countries.

2.1 Pathways to the marine environment

2.1.1 General

Cadmium is relatively mobile in the aquatic environment. Levels in European rivers and lakes have been falling during the last twenty years. Estimates are given of “natural” cadmium levels in the environment.

Cadmium can reach the marine environment by way of the atmosphere or through aquatic discharges and natural runoff. Cadmium is relatively immobile in the soil, but transfer of cadmium from the soil compartment to the aquatic compartment can occur through suspended particles in surface runoff (OECD 1994).

Efforts have been made to limit the amounts of cadmium deposited on agricultural land as a trace constituent in phosphate fertilizer, lime, and sewage sludge. EUPHEMET (2000) notes that one of the characteristics of cadmium is the relatively high solubility and mobility of its species in the aquatic environment, including the marine one, where ionic and very labile forms prevail over the less labile colloidal ones. The behaviour of cadmium in fresh water is complex and it is not easy to predict cadmium loads entering the marine environment on the basis of the inputs to the rivers concerned. The mobility is cadmium is amongst others depending on pH and salinity values. For pH values up till 8 Cd^{++} is the dominant species, while as the salinity increases the dominant species is found as chlorocomplexes, e.g. $CdCl^{+}$ in brackish water and $CdCl_2$ in oceanic water.

OSPAR (2000) stresses that reductions of regional cadmium inputs will not necessarily lead to a corresponding reduction in concentrations in the marine environment in the short term. Such trends have been found in the environment and indicated in models. Possible reasons may be underestimation (in the specific assessments) of diffuse sources and a delayed release of contaminants from soil and sediments to the marine environment. The latter indicates that actions to reduce emissions should not be delayed unnecessarily as consequent reductions in the impact from cadmium may only be observed after long time.

On the basis of a broad literature survey, the draft EU Risk Assessment for Cadmium (EU 2001) concludes that the lowest concentrations of cadmium in freshwater lakes and rivers are found in northern Sweden, ranging between 0.005 and 0.01 µg/L. Large European rivers generally have concentrations above this range. The report notes that most dissolved cadmium concentrations in freshwater are below 0.1 µg/L, but the “natural” background level is almost impossible to determine, since all European surface waters probably contain some Cd arising from human activity. Weathering from minerals varies between regions; this is also influenced by acid rain, which increases the solubility of cadmium. The Risk Assessment Document (EU 2001) therefore recommends 0.05 µg/L as a general natural background level for (dissolved) Cd in freshwater.

The dissolved fraction Cd ranges 10 – 40 % of total Cd in the rivers Rhine, Meuse and Schelde, about 50 % in the rivers Rhine and Arno and 30 - 40 % in Tiber and Elbe. In lakes Constance and Zurich, the percentage dissolved Cd is 80 and 84 % respectively. Hgh dissolved fractions are found in acid waters, in which total concentrations are also elevated. In Swedish oligotrophic lakes, about 60 – 100 % of the Cd is dissolved (physical size < 2.4 nm) at pH 4.5 - 6.0 and about 10 – 60 % at pH 6 - 7 (EU 2001).

An important fraction of total Cd in freshwater is adsorbed on suspended matter. The Cd concentrations in suspended matter typically range between 1 and 10 mg kg^{-1}_{dw}. Higher values are recorded in rivers like the Maas that carry Zn ore particles. In German rivers the background Cd concentration in suspended matter is 0.15 - 0.6 mg Cd kg^{-1} (EU 2001).

The surface sediments in EU lakes are cadmium-enriched by a factor of up to 30 compared with deeper sediments. This indicates the extent of the cadmium burden added through human activities in recent times (EU 2001).

The Cd concentrations in EU freshwater generally have decreased since the end of the 1970s. Ros and Slooff (1990, quoted in EU 2001) demonstrated that Cd concentrations in Dutch rivers (total and dissolved and on suspended matter) decreased 4-fold from 1983 to 1986. The total Cd concentration in the Schelde on the Belgium-Netherlands border decreased from 3.5 $\mu g\ L^{-1}$ in 1975 to about 0.4 $\mu g\ L^{-1}$ in 1988 (no further trend).

Seasonal changes in Cd concentrations occur in lakes. Borg (1987, quoted in EU2001) investigated 59 forest lakes in northern Sweden. Cadmium concentrations are 2.4 fold higher in winter than in summer. During summer, there is higher production of phytoplankton and a higher input of particulate matter from the watershed. Therefore, more metal becomes particle-bound and settles to the lake sediment.

A correlation between Cd concentrations and acidity is observed in Swedish rivers and in lakes. Cadmium concentrations in Swedish surface waters increase from north to south along with acidification and air-borne Cd (Parkman et al., 1998, quoted in EU 2001).

2.1.2 HELCOM area

The total input of cadmium from external sources to the Baltic Marine Area is estimated at 30 tonnes per year based on values found in 1995 and 1997. About 80 % of the cadmium input to the Baltic Sea Area originates from aquatic sources: direct discharges and riverine input. Information for heavy metals as regards the riverine and direct loads are very uncertain. It has been estimated that for the North Sea in 1996 riverine inputs and direct discharges accounted for 38.6 tonnes whilst the atmospheric input was 22 tonnes (OSPAR, 1998 and 2000). In addition to this comes the water-borne exchange of cadmium with the adjacent sea areas.

The Baltic Sea catchment area rivers in Estonia, Latvia and Lithuania show no signs of cadmium contamination (Baltic Environmental Forum 2000), whereas the Odra river displays elevated cadmium levels (2.3 – 2.8 ug/l) in its higher reaches (Czech republic). Further down (Hohenwutzen) the levels are lower (< 0.2 – 0.39 µg/l) (EU 2001), although the total cadmium load has increased from 1.7 to 2.67 t/a (see chapter 1.2.2). This could indicate that although a legislative set-up for limiting discharges is in place in many countries, a potential exists to lower such releases further.

Compared with the rest of Europe, atmospheric Cd deposition data are lowest in the Scandinavian countries (EU 2001). The HELCOM 4th Assessment (HELCOM 2001C, HELCOM 2001E) notes that one fifth of the cadmium input to the Baltic Sea Area comes from atmospheric deposition. The deposition rates are highest in the southwestern part of the Baltic Sea, indicating that much of the atmospheric cadmium is carried to the area by the prevailing south westerly winds. Germany and Poland are mentioned as important emitters of heavy metals (HELCOM 2001E). Cadmium deposition from the atmosphere to the Baltic Sea Area was lower in the 1990s than previously, but there was no clear trend in deposition during the assessment period 1994-98 (HELCOM 2001E).

Like a number of other environmental pollutants, cadmium is spread over relatively long distances with air movements in the atmosphere, once emitted from combustion sources. Cadmium is transported with dust particles, which are mainly deposited within a few hundred kilometres from the source. This means that the deposition in the Baltic area is expected to be influenced primarily by emissions from the HELCOM countries themselves. However, deposition of cadmium from non-HELCOM countries is most likely also occurring.

Within the marine environment, considerable redistribution of the cadmium inputs takes place. The final sink for cadmium in the Baltic Sea Area appears to be the sediments in the deep anoxic parts of the Baltic; the HELCOM 4th Assessment comments that "the data indicate that cadmium is effectively transported to and entrapped in areas where the bottom waters are anoxic" (HELCOM 2001C).

In conclusion, the current important pathways for cadmium to the marine environment in the HELCOM area appear to be:

- atmospheric deposition (originating from industrial sources, fuel combustion, and waste incineration of Ni-Cd batteries and other cadmium-containing wastes)
- direct discharges from industry and other human activity
- sacrifical anodes on fixed and mobile steel structures including shipping (direct input to the marine environment)
- loss of recyclable Ni-Cd batteries through the waste disposal system with consequent release of cadmium to the environment
- run-off containing cadmium from a number of diffuse sources (for example galvanized guttering) and
- runoff from agricultural areas treated with phosphate fertilizers.

2.2 Monitoring data

Monitoring data show that concentrations in marine environments no longer seem to be rising, although there are areas with raised concentration levels, particularly in the deeper parts of the Baltic Sea. Cadmium levels in some Baltic fish species and mussels are rising. The reason for this is not fully understood.

2.2.1 General European background levels

Table 8 list proposals for typical ambient cadmium concentrations in the environment as presented in the EU Draft Risk Assessment Document for Cadmium (EU 2001.

Table 8: Typical measured European Cd concentrations (Measured away from point sources = ambient Cd concentrations) with regional and continental predicted environmental concentrations (PEC's).

Compartment	Measured Cd		Natural background	Predicted environmental concentration	
	typical range	typical conc.		continental	regional
Freshwater µg L^{-1} (dissolved fraction)	0.02-0.35	<0.1	<0.05	0.062	0.121
aq. Sediment mg $kg^{-1}{}_{ww}$	0.38-3.8	0.77	0.04-0.3	1.38	4.33
Soil mg $kg^{-1}{}_{ww}$	0.1-1.6	0.26	unknown	0.29-0.50	0.36
Air ng Cd m^{-3}	0.1-0.5	~0.5	~0	0.2	0.7

Ambient air cadmium concentrations are usually in the range 0.1 - 5 ng/m^3 in rural areas, 2 - 15 ng/m^3 in urban areas, and 5 - 150 ng/m^3 in industrialized areas although even much higher concentrations have been recorded near point sources. In certain industrial installations, considered as occupational environments, concentrations may exceed 1 mg/m^3, exceeding by far the former occupational standards of 100 and 200 ng/m^3. The new specified exposure standards are even lower (2 to 50 ng/m^3) but there are no systematic surveys available showing to what extend industrial settings have adapted their technologies to fulfill these standards (EUPHEMET 2000).

OSPAR's Quality Status Report 2000 (OSPAR 2000) establishes a background reference concentration of cadmium in marine sediment of 0.007 – 0.04 x 10^{-4} (cadmium to aluminium ratio*). The background reference concentration in seawater is 5 – 25 ng/l, and the reference concentration for biota (common mussel) is 0.07 – 0.11 mg/kg (wet weight). Additional figures for background/reference concentrations in various environmental compartments are given in the OSPAR Cadmium background document (OSPAR 2001) and are presented in table 9.

Table 9: Range in background/reference concentrations of cadmium for fine-grained marine sediments, seawater and blue mussel within the OSPAR area.

Compartment	**Location**	**Concentration**	**Reference**
Sea water			
Average in sea water	Natural ocurrence	≤ 0.1 µg/l	Korte, 1983 (WHO)
Sea water		5-25 (ng/l)	QSR, 2000
Atlantic sea water (µg/l)		0.004±0,009	Laane, 1992
Sediments			
Marine seds. (metal (Al(x10^{-4}) ratio)		0.007-0,04*	QSR, 2000
Marine sediments (mg/kg)	Natural occurrence	0.03-1	Korte, 1983 (WHO)
Wadden Sea (mg/kg)		0.5 ±0,01	Laane, 1992
Norwegian coast (mg/kg)		0.08±0,02	Laane, 1992
River and lake sediments	Natural occurrence	Up to 5 mg/kg	Korte, 1983 (WHO)
Atmospheric			
Air	Inhabited areas	1 ng/m^3	WHO, 1992
Air		0.2 ng/m^3	Laane, 1992
	Rural areas	0.1 – 0.5 ng/m^3	(Jensen and Bro-Rasmussen, 1992
Soil			
Soil	No known polluted areas	0.2-0.4 mg/kg	WHO, 1992
Soil (median concentration)	Non-volcanic	0.1 to 1 mg/kg	OECD, 1994
Biota			
Blue mussel (mg/kg ww)		0.07-0.11	QSR, 2000
Mussels (mg/kg DW)		<0.2	Laane, 1992

* see footnote

2.2.2 HELCOM area

Monitoring data studied by the HELCOM 4th Assessment (HELCOM 2001C) indicate that cadmium concentrations in seawater have declined above the halocline and are no longer increasing below the halocline. There are high cadmium concentrations in the sediments of the deepest parts of the Baltic Sea: the Gotland Basin (7.16 mg/kg), Fårö Deep (6.20 mg/kg) and

* OSPAR has adopted metal/aluminium ratios as the basis for its background/reference concentrations for fine-grained sediments. This normalizes the measurements and permits variability in naturally occurring amounts of trace metals to be taken into account, so that sediments from different regions can then be compared. Trace metals associate preferentially with fine-grained material (clay/silt) in the sediment. (OSPAR 2000, page 50).

West Gotland Deep (4.12 mg/kg). Sediment levels in the Gulf of Finland have declined since the early 1980's but remain slightly elevated (2.24 mg/kg); the northern central basin (2.70 mg/kg) and southern Bothnian Bay (2.15 mg/kg) also show slightly elevated levels. The data is interpreted as showing that cadmium is effectively transported to areas where the bottom waters are anoxic, and remains trapped there.

In several sediment cores, for example for cadmium in cores from the Gulf of Finland, it has been found that the heavy metal concentrations decrease in the upper few centimeters (2 – 10 cm.), indicating a general decrease in concentration levels since the early 1980s. (HELCOM 2001C). Cadmium concentrations are generally lower in the Kattegat than in the Baltic Proper. Concentrations in some fish species and mussels are increasing. Herring liver cadmium concentrations range from 0.16 µg/g ww in Kattegat to 0.91 µg/g ww in the central Bothnian Sea, and have shown an increase of as much as 6 % annually over an 18-year period in the Swedish Baltic proper and southern Bothnian Sea. Levels in flounder (Øresund) have risen by about 5 % annually in a time series extending from 1969 to 1999, and Swedish coastal perch and mussel have shown even greater (> 10 %) annual increases over a shorter time period (4 - 5 years). Mussel tissue concentrations range from 0.25 – 0.8 µg/g (ww), exceeding the OSPAR background reference concentrations (0.07 – 0.11 µg/g (wet weight)). However, concentrations in cod liver (range 0.021 – 0.043 µg/g ww) have shown a decline over the same period (HELCOM 2001C). No satisfactory explanation has yet been given for these changes (see chapter 2.3.2). Apart from the general Kattegat – Baltic Proper gradient, there is no obvious spatial pattern in the recorded biota concentrations.

In the North Sea, no trends of increasing cadmium concentrations in biota have been detected in 65 data sets. Declining biota concentrations have been detected at several sites (OSPAR 2000).

2.3 Assessment of the extent of problems

The principal cadmium problem in the Baltic Sea Area is the continued increase in cadmium levels in some fish species and mussels, despite the recent reductions in inputs.

2.3.1 European

For Europe as a whole, EUPHEMET (2000) concludes that two major inputs of cadmium to the environment today arise from the use of batteries and application of phosphate fertilizer. According to an earlier (1990) estimate, EU-11 imported annually 409 t of cadmium in phosphate rocks, 126 t of which pass to gypsum and 283 t through fertilizers to soils. Despite the introduction of maximum concentrations of Cd allowed in phosphate fertilizers by most EU states and a major trend in fertilizer manufacture towards use of low cadmium content phosphate rocks, the overall cadmium input via this route to the European soils is still quite significant.

In 1988 a resolution was adopted by the European Commission, which outlined an action programme aiming at reducing the input of cadmium in soil from fertilizers (ERM 2001), and the Commission was committed to review before 31 December 2001 the need for establishing provisions at Community level concerning the cadmium content of fertilizers (see chapters 3.1 and 3.2.1).

National measures have already been taken by some HELCOM Contracting Parties (see below). Despite these initiatives, Sweden points out that cadmium levels in agricultural soils are still increasing, although at a lower rate (Swedish comment to the EC draft Risk Assessment (EU 2001)).

Ten EU member States (including Finland, Sweden, Denmark and Germany) have implemented national regulations limiting the maximum cadmium concentrations in fertilizers, the annual cadmium input on agricultural land and/or maximum permitted cadmium concentrations in agricultural soils. As table 10 (ERM 2001) shows the current average fertilizer cadmium concentrations reported by the EU Member States in the EU Cadmium Risk Assessment (EU 2001) lies below these limit values.

Table 10: Limit values for cadmium in fertilizers and in soil in the Member States (Oosterhuis et al., 2000, cited in ERM 2001).

Member State	Limit for Cd in fertilizers (mg/kg P_2O_5)	Limit for Cd input to agricultural soil (g/ha/a)	Limit for Cd in agricultural soils (mg/kg dry soil)
Austria	75	10 (1)/5 (2)	1.0
Belgium/Lux	90	150	1.0 - 3.0
Denmark	47		0.5
Finland	21.5	3	0.5
Germany	40-90 (7)	16.7 (3)	1.0
Netherlands	(8)		0.5 - 1.0
Portugal	40-70 (9)		
Sweden	43 (10)	1.75 (4)	
UK		0.15 (5)	3.0 (6)

Notes:
(1) arable land
(2) grassland and vegetables
(3) average over a period of 3 years.
(4) average for 7 years; will lower to 0.75 g ha-1 year -1 as from 2000.
(5) with sewage sludge only.
(6) soils with a pH of 5 and above, treated with sewage sludge.
(7) based on a voluntary agreement between government and industry.
OECD (1994) mentions a limit of 40 mg/kg phosphorus (17 mg/kg P_2O_5). According to a spokesman of VKP, there is no limit for the Cd content in P fertilizers in the Netherlands. Instead a voluntary agreement is in preparation.
mentioned in OECD (1994); probably not a legal limit.
(10) a voluntary limit of 21.5 mg/kg P_2O_5 has been introduced by the SLR.

The OSPAR background document on Cadmium (OSPAR 2001) identifies a new potential threat to the environment from cadmium and other heavy metals in storage lakes used for separation and treatment of ores at zinc and copper mines. These lakes contain acid water, mine tailings and sludges with mixtures of heavy metals including cadmium. In 1998 a supporting wall of a reservoir holding toxic wastes from the Aznalcollar mine (Sierra Morena, Southern Spain) collapsed, releasing 5 million cubic metres of toxic mud and acidic water to the Guadiana river, heavily polluting the downstream areas including a World Heritage nature reserve (Cota Doñana) and the Huelva Bay. The document proposes regulation of such acid reservoirs in order to improve environmental security, and also proposes to strengthen regulations concerning the dumping of contaminated dredged sludges in the sea or in near-coastal land sites.

2.3.2 HELCOM Area

Although the inputs of cadmium to the Baltic Sea Area have declined (see chapter 2.2.2), and concentrations in seawater are stable or declining, the cadmium concentrations in some fish species and mussels are still increasing (HELCOM 2001C). No conclusive explanation has yet been given for this “remarkable difference” in trends between seawater and biota, but some theories have been advanced for consideration, suggesting an influence from changing salinity, from acidification, or from the effects of environmentally influenced hormonal changes on organism metallothionin concentrations.

These increasing cadmium concentrations in some fish species and mussels constitute one of the most significant environmental problems in the Baltic Sea Area today (HELCOM press release, Febr. 2001). Reductions in inputs do not yet appear to have made an impact on the environmental situation. It must be borne in mind that there is a large pool of cadmium already discharged into the Baltic Sea Area, where it is mainly found in the deepwater sediments. Under the right conditions (for example anoxia), release can occur from the sediment to the water column, from which it can enter the biota after uptake by phytoplankton (OECD 1994).

Because the reactions and mobilization of heavy metals take place in the uppermost zone of the sediment, heavy metals are subject to variable conditions until they become “buried” deeper in the sediment, where environmental conditions are more stable and the metal concentrations no longer change. With time, heavy metal contaminated sediment will be buried under new layers of sediment, and the heavy metals in the deeper sediment will therefore no longer be available for release (HELCOM 2001C). It can be expected that if cadmium inputs are reduced, cadmium concentrations in newly deposited sediment will fall, and recycling of cadmium from the sediment will slowly decline over time.

The need for continued action to restrict cadmium use and further reduce inputs to the environment therefore appears to be clear.

3. IDENTIFICATION OF POSSIBLE MEASURES AND INSTRUMENTS

3.1 Measures required by EU legislation or international agreements

Annex 4 lists and describes the existing measures adopted by the EU, as well as HELCOM and OSPAR initiatives, aiming at protection of the environment from pollution by cadmium.

Historically, the focus was initially placed on major point sources of cadmium emissions to air and water, with attention then moving to activities, which cause more diffuse emissions, such as energy production, waste disposal, and agricultural use of phosphate fertilizer.

Table 11 shows the measures currently in force in HELCOM Contracting Party countries and EU generally, giving an indication of the types of measures used up to now.

Table 11: Types of measures already adopted and currently in force in HELCOM Contracting Party countries (as indicated in Contracting Party questionnaire replies (HELCOM 2001F); some Parties have not submitted information on these issues).

	EU	DK	EE	FI	DE	LV	LT	PL	RU	SE
Ban on Cadmium and compounds in:										
- pigment in plastics, ceramic glazes etc.	X	X		X	X		X			X
- stabiliser in plastics	X	X		X	X		X			X
- surface coatings (cadmiation)		X		X	X		X			X
Ban on use/marketing of Cadmium metal		X		X	X	X		X		
Limit on Cd in fertilizer		X		X						X
Tax on Cd in fertilizer										X
Limit on Cd in sewage sludge		X		X	X		X	X		X
Limit on Cd in discharge to water	X	X		X			X			X?
Tax on Cd in discharge to water			X		X	X	X			
Limit on emissions to atmosphere:										
- from incinerators	X	X		X	X					X?
- from industrial processes	X	X								X?
Tax on Ni/Cd batteries		X								X
Bonus on collected Ni/Cd batteries		X								X?

Note: The designation X? is used where the given information was not included in the Contracting Party questionnaire replies, but the authors believe that such regulation exists in the mentioned country – this information has not been confirmed.

3.2 Other existing or new measures and instruments

3.2.1 Ongoing activities within the European Union

Because of the growing importance of NiCd battery usage in the total cadmium substance flow in European countries, programmes for recycling these batteries have been implemented by a number of countries: Switzerland (1990), Belgium (1993), UK and Ireland (1994), The Netherlands (1995), Denmark (1996), Norway (1997), Germany and Sweden (1998) and France and Spain (1999) (OSPAR 2001).

As already noted, sustained consumption of rechargeable batteries may be expected. Although the rise in NiCd consumption has levelled off in recent years due to introduction of Li-ion and Ni-metalhydride batteries, it is possible that the current low prices for cadmium could make NiCd batteries attractive to users again. Furthermore, larger “open” type NiCd accumulators are technically suitable options for heavy-duty purposes in electrical vehicles, whose use is expected to expand in the future. Although it is theoretically possible to achieve almost 100 % collection of batteries for recycling, minimizing loss to the external environment (apart from minor losses in the recycling process itself), experience so far has shown disappointing results for collection and recycling of small NiCd cells. The Danish battery collection system is currently under reconsideration for this reason. On the basis of experience with collection programs in a number of EU countries, OSPAR (2001) predicts that the collection rate for small batteries is unlikely to exceed 50 – 60 %. Most of the cadmium in the remaining 40 – 50 % of batteries will presumably go to landfill, either directly or after waste incineration. This prospect has led Denmark to propose to the European Commission that Nickel-Cadmium batteries should be phased out completely, since more environmentally acceptable alternative products now exist.

The battery industry is currently arguing against this proposal and claiming that recovery rates will eventually improve. According to industry the recycling percentage is already 60 – 80 %, and the discard rate of NiCd batteries to municipal waste is very low (based on measurements in five member states). The "missing" batteries are assumed to be lying in private homes, from where they will eventually be returned for recycling (ref: letter from "CollectNiCad" to the Danish environment minister Mr. Svend Auken, October 2001, copied to all EU ministers of environment and the EU commission).

OSPAR (2001) notes that recent improvements have been made in cadmium recovery from batteries, due to environmental concerns and collection programmes related to the Directive 91/157/EEC, Community Directive on batteries and accumulators.

In 2000 the European Commission under the IPPC Directive has published so called BREFs on Iron and Steel Industry and on Non Ferrous Metals industries. In these documents the EU Members States and industries have collated all available information on best available techniques (BAT), associated monitoring and developments in these industrial branches. The national competent authorities responsible for issuing permits are required to base these on the best available techniques. Since the best available techniques change over time the BREFs will be reviewed and updated from time to time.

Upcoming legislation:
The Waste Electrical and Electronic Equipment (WEEE) Directive, currently under discussion, will support the collection of rechargeable batteries in general and of NiCd batteries in particular, contributing to establishment of a more closed loop system for NiCd applications. The Directive also aims to phase out the use of cadmium generally in electrical equipment.

The Council was required to review before 31 December 2001 the need for establishing provisions at Community level concerning the cadmium content of fertilizers (see section 3.1, Directive 98/97). A number of studies including ERM (2001) have now been produced as part of the review. EUPHEMET (2000) calls for EU to address this question by using a series of regulatory and economic instruments as part of an integrated EU policy to reduce cadmium in the European environment. The options available for the formulation of EU measures include:

- Limits on Cd concentrations in fertilizers (e.g. 60, 40 or 20 mg Cd/kg P_2O_5).
- Limits on Cd concentrations in agricultural soils.
- Restrictions on phosphate fertilizers applied to agricultural land (kg/ha).
- Charges on Cd in phosphate fertilizers above a certain threshold. (ERM 2000).

As already noted above (chapter 2.3.1), a number of EU member states have already adopted one or more of these types of measures.

3.2.2 National initiatives

The Contracting Party questionnaire responses (HELCOM 2001F) present information about national legislation on cadmium. The replies have been used to elaborate table 11 (chapter 3.1), indicating the types of measures already in use to regulate the use and release of cadmium. A transcription of the text of the replies is found in Annex 3.

3.2.3 Alternative measures

As mentioned, the sources of emissions of cadmium to the biosphere can be grouped in three categories:

- Emissions due to natural mobilization of cadmium from the Earth's crust. Volcanic activity and weathering are some of the emission mechanisms
- Anthropogenic (associated with human activity) emissions from the mobilization of cadmium impurities in fossil fuels, other minerals (phosphate fertilizer, metal ores), and products (galvanized iron, zinc products)
- Anthropogenic emissions from cadmium used intentionally in products and processes.

The first category (natural mobilisation of cadmium) is not considered susceptible to control. Various types of possible control mechanisms can be applied to the second and third categories respectively. Category 3, which includes most point sources of cadmium, has usually been the first to be addressed.

OSPAR (2001) for example proposes:

- Implementation of more stringent environmental restrictions on cadmium in those countries that have not fully implemented the (EU) legislation, i.e. treatment facilities for the removal of pollutants from effluents and atmospheric emissions. General reduction of industrial emissions and a more effective control of run-off and atmospheric deposition are desirable.

- Improvement in data collection about direct cadmium inputs from municipal and industrial outfalls to coastal waters, from offshore activities, and from dumping of dredged materials.

- Imposition of a uniform minimum standard for municipal and industrial wastewater treatment based on the Best Available Technology: source control and treatment of wastes

- Collection of cadmium-containing batteries etc. from portable computers, telecommunications, electric vehicles and solar cells, through effective policies including contractual obligations to return used batteries, participation of the population in collection schemes, improvements to recycling technology, and economic incentives to encourage recycling and reuse of these products.

As mentioned above, Denmark has proposed a phase-out of NiCd rechargeable batteries, since adequate substitutes (NiMH and Li-ion batteries) are now available for all purposes. Alternatively, the economic incentives to return and recycle NiCd batteries should be strengthened.

In addition, Denmark has proposed the replacement of cadmium-containing sacrificial zinc anodes with aluminium/tin/indium anodes. This is expected to reduce the direct cadmium input to the marine environment by 0.6 t annually in Denmark – a significant reduction in the current emissions to the marine environment from this country (more than 50 %).

4. PROPOSALS FOR POSSIBLE HELCOM ACTIONS

4.1 Evaluation of the need for actions at HELCOM level

Despite the actions already taken to reduce and restrict the use of cadmium in many applications, the stock of cadmium in circulation in the HELCOM area states is still increasing. This is primarily due to the large increase in the use of rechargeable NiCd batteries in the period 1985 - 1995. After the mid-1990s the introduction of alternative types of rechargeable battery (Li-ion and Nihydride) appears to have halted this increase, but the dramatic fall in the price of cadmium may alter the balance again in favour of the NiCd battery type.

It is expected that differences between HELCOM Contracting Parties in patterns of cadmium usage and environmental losses (see chapter 1.2) will decline in coming years, partly due to convergences in economic systems and partly in response to convergence in the regulatory initiatives already taken. This is expected to result in general improvement regarding the releases of cadmium to the environment.

One immediate need for action in the HELCOM forum appears to be to strengthen the data creation and retrieval on uses and releases of cadmium in a number of the HELCOM Contracting Parties. As can be seen in the submitted responses to the questionnaire, numerous subsets of data have not been available at this stage, indicating that appropriate data have not yet been aggregated, or maybe in some cases it has not been possible to collect and utilise existing data. Chapter 4.2 presents some options for actions within the HELCOM region.

In addition to the ongoing reduction of direct emissions, it should be ensured that releases from spent NiCd batteries are reduced by effective measures. As mentioned, we have not yet seen the full environmental consequences of the widespread and extensive use of NiCd batteries. Emissions of cadmium from incineration of NiCds in household waste are evident today, but long-term releases of cadmium from deposited NiCds will also occur over decades and maybe even centuries, unless adequate measures are adopted.

4.2 Proposals for HELCOM actions

Sustained and strengthened initiatives against cadmium releases to the environment may be grouped according to the following focal points:

- Reduce the direct emissions and discharges to air, water and soil from industry, power production with fossil fuels, and waste incineration. This could be achieved by adherence – or approximation – to the standards set in EU emission legislation, by all Contracting Parties, regardless of whether they are current or potential members of the EU. Such standards cover *inter alia*:
  - Better combustion technology and flue gas cleaning techniques at power plants.
  - Regulation of car-scrapping, including ban on metal extraction/uncontrolled burning without prior separation of metal and plastic parts.
- Reduce the current and future release of cadmium from NiCd batteries and accumulators.
  - Make use of attained experiences from other nations/locations, in the attempt to sustain or create efficient collection schemes for NiCds already accumulated in society.
  - Consider economic incentives to reduce Ni-Cd battery usage (tax) and to improve collection and recycling of NiCd batteries (a bonus system).
  - Collect open NiCd accumulators in a separate scheme (other user groups).
  - Consider a ban on closed type NiCd batteries including products with built-in NiCds (alternatives are commercially available and widespread already).
- Reduction of other intended cadmium uses over time, and prevention of emergence of new or revived cadmium used, could be obtained by a general ban on cadmium (like for instance in Denmark).
  - Substitution of Cd-containing pigments and stabilizers (probably already addressed).
  - Make campaign to check that imported plastics, ceramics etc. comply with regulations on maximum cadmium content in stabilizers, colourings, fillers and glazes.
- Reduce diffuse releases of cadmium present as impurities in fertilizers, zinc, fossil fuels, cement, lime etc. by optimal choice of raw materials and purification technology (to the

extent available), and by enhanced reduction of releases by emission control technology where possible.

- o The HELCOM Harmonization report (HELCOM 2001G) proposes that the HELCOM Hazardous Substances Group should be requested to elaborate a new Recommendation concerning limitation of diffuse sources of cadmium.
- o Consider regulation of permitted cadmium content in fertilizer, lime and sludge used in agriculture.
- o Replace cadmium-containing sacrificial zinc anodes with (for instance) aluminium/tin/indium anodes to reduce the direct cadmium input to the marine environment (0.6 t annually in Denmark)

- ❑ Identify/locate potential sources of cadmium pollution from historical activities (abandoned mine workings and tailings, abandoned industrial sites, fly ash deposits etc).
  - o Prioritise and carry out remediation/release reductions on such sites.

- ❑ Close data gaps.
  - o To support any proposals for HELCOM actions, better data is needed on significant uses and emissions of cadmium to the Baltic Sea Catchment Area. Substance flow studies by each Contracting Party would form a basis for the planning of specific action programs addressing any general problems that are identified, as well as the specific problems in each country.

Table 12 summarizes briefly the types of actions appropriate at various stages of the cadmium life cycle.

Table 12: Types of actions appropriate at various stages of the cadmium life cycle. (See table 11 for submitted information on existing legislation in HELCOM countries.)

Aim of legislation
Existing national legislation
Production and use phases of lifecycle
Limit the allowable contents of cadmium present as impurities in bulk materials
Prevent or limit the intentional use of cadmium in processes
Limit or prevent cadmium from industrial processes from being released directly to the environment, air, water and soil (industrial point sources, including metallurgic industry etc.)
Limit the emissions of cadmium from combustion of fossil fuels and processing of mineral materials by emission control technology
Prevent or limit the release of cadmium from processes to the wastewater treatment system (in order to limit releases to the water recipient and to permit the use of sludge as fertilizer on agricultural soil)
Prevent products containing cadmium from being marketed nationally (and in exports)
Prevent or limit the use of already purchased cadmium and cadmium-containing products
Disposal phase of lifecycle
Prevent cadmium in products and process waste from being released directly to the environment, by efficient waste collection
Prevent cadmium in products and process waste from being mixed with less hazardous waste in the general waste stream, by separate collection and treatment
Prevent or limit cadmium releases to the environment from treatment of household waste, hazardous waste and medical waste by emission control technology
Set limit values for allowable cadmium contents in sewage sludge spread on agricultural land
Restrict the use of solid incineration residues in roads etc.
Relevant options for additional legislation
Prevent or limit the marketing of virgin cadmium
Control trade of pure cadmium in order to limit its use to pre-defined essentials and secure environmentally safe handling (similar to procedures for hazardous waste)
Limit the allowable contents of cadmium present as impurities in fuels, metals and other bulk mineral materials

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ANNEX 1: CADMIUM USAGE

From the Contracting Party questionnaire responses (HELCOM 2001F) the following information about cadmium use in the individual countries has been extracted. Data sources quoted in the questionnaire responses are not included here but references to additional data sources are indicated:

Denmark:

Production, industrial and consumer uses: The consumption of cadmium in Denmark in 1996 was 40-70 t. The main use was NiCd batteries (36-54 t), plastic and toys (0.2-4.1 t), jewellery (< 1.8 t) and as an impurity in bulk materials (5-9 t).

Import/export, production per year: Net import with raw materials, semi-products and finished goods 42-69 t. Danish lime 1-2 t. Net export with residual products 17 t.

Amount in imported chemical products, articles and goods: Net import with raw materials, semi-products and finished goods 42-69 t, primarily as Ni-Cd batteries (36-54 t), plastic (specially toys) and as an impurity in bulk materials such as zinc, fertilizer, lime, cement components and coal.

Sales per year, per use and mode of application: 1996 data: Ni-Cd batteries (36-54 t, mostly closed batteries (35-50 t) in battery-powered tools and mobile phones). Sale of cadmium with toys (0.2-3.6 t, mainly cadmium as pigment and stabilizer in non-branded toys imported from the Far East). Jewellery (< 1.8 t, partly "Indian silver" from India and Nepal, and partly silver-plated or gilt bijouterie imported from the Far East).

Amount of stockpiling and its treatment: Accumulation in 1996 from all uses in Danish society was 10-22 t. Waste deposits (including roads, dams etc.) receive solid waste/residual products form waste treatment (12-24 t), and controlled deposits receive cadmium-containing hazardous waste (0.5 t).

Estonia:

The following figures were reported for heavy metal usage in industry:

Year	**1995**	**1996**	**1997**	**1998**	**1999**
Use of salts of heavy metal compounds by industrial enterprises (kilograms): Cd	17361	18035	114879	963	3
Residual stock of heavy metals in enterprises (at the end of year, tons): Cd	35,2	82,9	7,5	11,8	13,2
Generation of waste of heavy metals in enterprises (kilograms): Cd	-	0	270	0,2	0,1

Use of heavy metals is reported to be declining. At the same time (1999), 4,154 tons of heavy metals were treated by enterprises treating hazardous waste, which is 23 % less than in the previous year.

The cadmium substance flow analysis for 1992 (CASA 1994) gives the following figures:

Usage: 54 tons	To waste deposits: 23 tons
Import: 38 tons	Export: 20 tons
Own production: 22 tons	Accumulation: 13 tons

NiCd battery consumption is estimated to have been 15 t/a on average in 1996-98 (COWI 1999).

Finland:

Production, industrial and consumer uses: In 1987, some 860 t of cadmium were produced at Kokkola zinc plant (Mukherjee 1989). In 1998, the production was 519 t (Outokumpu 2001). Some 25 t of cadmium were consumed in products in 1987 (of which 18 t were in batteries). In 1995, the cadmium content of batteries sold in Finland was approximately 50 t. Use of sealed NiCd batteries has declined rapidly after 1995. They have been substituted by NiMH and Li-ion batteries in most appliances.

Amount of import/export: From mid 1980s onwards, all cadmium produced in Finland has been exported from the country. Amount of cadmium in imported chemical products, articles and goods:
The Finnish product register contains data on chemical products. There are 3 products that contain 0.3 - 1.0 % cadmium oxide (CdO). These are glass enamel powders used to give colour to glass products, and products used as conductors in the electronics industry. The register also contains data regarding 3 products containing 95 –100 % cadmium sulfide (CdS), which are also used to give colour to other products or used to manufacture electronic components. 3 products mentioned in the register contain 1 to 5 % cadmium chloride (CdCl2). These are laboratory chemicals and fluxes used in soldering. There are 22 other cadmium-containing products in the register. They are used for numerous purposes, ranging from laboratory to industrial uses. One product in the register contains sulphuric acid and cadmium sulphate (1:1). It is used in the metallurgical industry.
Finland exports used NiCd batteries. Assuming a concentration of Cd in unsealed industry batteries to be 7 % and 18 % in sealed batteries, the following amounts of cadmium have been exported:

Year	**Estimated Cd export in used batteries (metric tons)**
1997	1 – 2
1998	5 – 13
1999	11 – 29

Finland imports other cadmium-containing wastes, but the quantity of cadmium in these wastes is unknown. They are mainly cadmium pigment residues and paint wastes. The total quantity of these wastes ranged between 40 and 90 t during 1997-1999. All export and import of cadmium-containing wastes complied with the EU Directive 259/93 and the Basel Convention on Hazardous Waste.

Sales per year, per use and mode of application: The product register contains no information on the amounts of products sold.

Germany:

Production, industrial and consumer uses: Cadmium metal is used in the manufacture of batteries (NiCd batteries) and in the production of protective coatings for electroplating metal parts. The largest quantity of this metal is used in compound form as a pigment and as a stabiliser for plastic production (PVC).

No figures for production and consumption have been submitted by Germany.

Latvia:

Industrial use of cadmium continues in Latvia but restrictions are being increased. Stockpiling takes place, estimated at 0.6 tons/year.

Lithuania:

Production, industrial and consumer uses: Data submitted by Lithuania does not seem to indicate cadmium consumption but the total quantities of materials consumed. The data is therefore not included here. Cadmium as such is not used in the galvanic industry; however, it is assumed to be present as an impurity in zinc.

Import/export data show a net import of cadmium accumulators, iron casts, and glass, all of which have some cadmium content. There is a net export of cement and phosphate fertilizer. The overall cadmium balance cannot be assessed from the submitted figures, due to uncertainty about the units reported.

Poland:

Production, industrial and consumer uses: at least 84,000 kg cadmium is used in industry for (unspecified) production purposes. These are probably mainly NiCd batteries, since a number of international battery companies have production facilities in Poland.

Import/export, production per year: the submission states that no information is available.

Russia:

(no information submitted)

Sweden:

Production, industrial and consumer uses: The submission gives an estimated average content of cadmium per kg P-fertilizer of 25 mg/kg in 1997. The submission gives no information about other types of usage involving cadmium (for example batteries).

Import/export, production per year: Less than 1 ton of cadmium compounds were imported and/or produced in 1998 (source: Kemi Products Register). Other imports of cadmium-containing goods are (quantities in tons):

Use area	Pigments	Stabilizers	Plating	Ni-Cd-batteries
1980	7	30	20	39
1985	0.5	9	2	44
1990	0.5	2	2	101
1995	0.5	0	0.5	93

(tonnes). Source: KemI Report 1/98

Amount of stockpiling and its treatment: All collected Cd-batteries are recycled. Temporary stockpiling is reported to take place. No information is given about plans for final treatment.

ANNEX 2: CADMIUM RELEASES

The Contracting Party questionnaire responses (HELCOM 2001F) present the following information about cadmium releases to the environment:

Denmark:

Discharges, emissions and losses from point and diffuse sources: In 1996 Danish releases of cadmium to air, soil and water were 0.2 -1 t, 2 - 3 t and 1 - 2 t respectively. Probably 80 % of the releases to water will go to HELCOM Convention waters. In addition, soil and water receive approx. 4 t and 2 t respectively from air deposition (includes other sources than the Danish).

Discharges to water/ emissions to air/ losses from production, use, storage, transport and waste treatment within the catchment area of the Baltic Sea: At least 80 % of the above-mentioned emissions to water (2 t) will go to HELCOM Convention waters. The main direct inputs to Danish waters are sacrificial anodes (0.6 t) and waste-/rainwater (0.3-1.4 t). Similar figures were obtained in 1999 (COWI 2001). Wastewater cadmium contributions could here be broken down into municipal wastewater (0.8 t) and small- and medium size enterprise industrial wastewater (0.5 t).

Estonia:

no information submitted.

In the 1992 substance flow study (CASA, 1994) the Estonian emissions to air, soil and water were estimated at 5.4 t, 0.1 t, and < 0.1 t respectively. The amount of atmospheric deposition on land and water (including sources outside Estonia) was not estimated.

Finland:

Discharges, emissions and losses from point and diffuse sources: Atmospheric emissions were about 6.3 t in 1990, mostly from metal industry processes. In 1997, emissions had declined to 1.1 t, and the metal industry share had fallen to 35 %. Other major sources of cadmium emissions in 1997 were fuel burning in industrial power plants (30 %) and other energy production (30 %). These estimates do not include mobile sources such as road traffic. Cadmium discharges to waters from monitored sources varied between 0.4 and 0.6 t/a during the 1980's and 0.09 – 0.18 t/a during the 1990's. Cadmium flux in Finnish municipal solid waste was approximately 15 t/a in 1990 (not including reused or recycled quantities). Most of this was NiCd batteries.

The following table for 1987 also includes industrial cadmium waste:

The total release of cadmium (t/y) into the Finnish environment in 1987.

Source category	Air	Water	Land
Zinc mines	-	0.02	0.7
Zinc plant	0.85	0.13	124*
Copper smelter	1.46	0.28	0.04
Secondary metal industry	0.007	0.004	0.11
Car & other scraps	0	0	8.00
Foundry	0.056	-	-
Iron & steel industry	0.424	0.016	-
Cement industry	0.017	0	-
Tyre wear	0	0	0.243
Electroplating industry	0	0.006	0.004
Fuel combustion	0.38	-	1.39
Phosphate fertilizers and gypsum	0.003	-	0.911
Other chemical plants	0	0.522	0
Household waste	0	0	0.900
Ni-Cd batteries	0	0	9.6
Refuse incineration	0.024	-	0.94
Sludge from waste treatmen plant	0	0.015	0.434
Total	3.22	0.99	23.27+124* = 147.27

*Cd in jarosite "-" = Not Known

Germany:

Discharges, emissions and losses from point and diffuse sources: Atmospheric cadmium is emitted from metal works (as a by-product of zinc extraction), from incinerating plants and from car tyre abrasion. Cadmium is discharged in wastewater from various industrial enterprises (metal and chemical industry) and in urban surface run-off due to the gradual disintegration of galvanised gutters and drainpipes.

Discharges to water/ emissions to air/ losses from production, use, storage, transport and waste treatment within the catchment area of the Baltic Sea: The 3rd HELCOM Pollution Load Compilation, PLC-3 (1995) established that the German pollution loads from direct and diffuse sources, approximately 90 % of which occur via the Baltic inlets, must be quantified in the entire German Baltic Sea catchment area in order to identify the main sources of pollution load. An Emission inventory of the German Baltic Sea catchment area was therefore carried out, registering the point pollution loads in the whole German Baltic Sea catchment area in 1998. To assess the pollution flux from the German Baltic Sea catchment area into the Baltic, sampling was also carried out in different German Baltic inlets (Oder, Lausitz Neisse, Trave and Warnow). Cadmium was only quantified in industrial waste water and the quantified amount was 14 kg/a in 1998.

Table: Cadmium point source discharges in the entire German Baltic Sea Catchment Area (kg/a)

	Discharge industrial plants	Discharge municipal STP*	Discharge i German Balti Sea catchment area	(calculated) Total discharge in the Germar Baltic Sea coastal areas 1)	(calculated) Total discharge i the Germa Oder catchment area 2)	(calculated) Total discharge ii the Germar Baltic Sea catchment area
Cadmium	14	< LQ**	14	0.02	16.8	16.8

*STP = waste water treatment plants
** LQ = limit of quantification
calculated according to method developed by BfG
Point sources in Mecklenburg - Western Pomerania and Schleswig Holstein
Point sources in Brandenburg and Saxony

However the major part of heavy metal loads is carried into the Baltic Sea via the rivers, the load originating from point and diffuse sources throughout the entire respective riverine area. Heavy metal loads only represent emissions upstream of the tested rivers' measurement stations (MS), so the additional municipal and industrial contributions downstream must also be taken into account.

Table: Cadmium loads in rivers (t/a):

	Lausitz/Neisse (Dreiländereck)	Lausitz/Neisse Ratzdorf	Oder Frankfurt	Oder Hohen wautzen	Warnow	Trave
MS no.	27	28	29	30	31	32
Cadmium	0.049	< LQ	1.7	2.67	< LQ	0.006

It should be noted that heavy metal loads are a combination of natural background loads and anthropogenically caused contributions.

Latvia:

(no information submitted)

Lithuania:

Discharges to water/ emissions to air/ losses from production, use, storage, transport and waste treatment within the catchment area of the Baltic Sea:

	1990	1995	1996	1997	1998
Discharges of cadmium into surface water bodies, Cd (in kg/year)	no information	30,0	no information	no information	9,4
Emissions of Cd (in kg/year)		1555,5			1961,98
Stationary Sources	3016,36	1153	1644,05	1559,4	1380,0
Large Combustion plants	2664,0	360	1204,0	1014,6	500,0
Small appliances	184,7	42,5	390	494,4	81,98
Industry	167,5	2,4	50,05	50,4	2,9
cast iron foundries	14,8	24,0	2,2	2,9	31,5
cement production	136,0	8,3	28,0	28,0	33,18
phosphate fertilizer	9,3	7,8	9,8	11,6	14,4
glass production	7,4	522,48	10,05	7,9	619,48

Mobile sources	902,6	443,25	579,95	618,	486,63
Road traffic	749,2	432,5	489,65	499,7	462,15
gasoline	735,0	10,75	476,8	479,3	24,48
diesel fuel	14,2	32,03	12,85	20,4	34,23
light duty vehicle	30,6		35,3	35,5	
(emissions from		41,0			94,15
tyre)(gasoline)	108,6		49,0	78,4	
heavy duty vehicle (emiss.		6,2			4,47
from tyre)(diesel fuel)	14,1	2077,98	6,0	4,6	2581,46
Other traffic	3918,9		2224,0	2177,6	
Total emissions					
Sludge from municipal waste		458000		no	486000
water treatment:	no	3-87	no	informatio	3-106
Total amount (t/year)	informatio		informatio	n	
cadmium content (mg/kg dry	n		n		
substance)					

Poland:

Discharges to water/ emissions to air/ losses from production, use, storage, transport and waste treatment within the catchment area of the Baltic Sea:

total emission to air: 85,000 kg from industry, 100 kg from transport, 100 kg from waste treatment;
discharges to water: 3,319 kg from industry;
total riverine load discharged to the Baltic Sea: 5,600 kg in 1998.

Russia:

Discharges to water/ emissions to air/ losses from production, use, storage, transport and waste treatment within the catchment area of the Baltic Sea: 0,32 t/a (1998).

Cadmium discharge with sewage and storm water from the Russian catchment area of the Gulf of Finland in 2000:	
Water objects *(basin sectional view)*	Cadmium, t
TOTAL on the Gulf of Finland basin	0.76
Including	
The basin of the Nevskaya bay	0.25
The basin of the river Neva	0.35
The basin of the Ladogskoe lake	0.02
The basin of the Il'men' lake	0.01

Cadmium discharge with sewage and storm water from the Russian catchment area of the Gulf of Finland in 2000:	
Branches *(branch sectional view)*	Cadmium, t
TOTAL on the gulf of Finland basin	0.76
Including	
Industrial enterprises	0.06
Municipal stations of sewage treatment	0.70

Development of cadmium discharge (t) with sewage and storm water in water objects of St Petersburg													
1985	88	89	90	91	92	93	94	95	96	97	98	99	2000
0.06	0.08	0.01	2.34	3.43	8.66	4.19	2.28	1.00	0.45	0.69	0.32	0.41	0.62

Cadmium content in bottom sediment of St Petersburg water currents, data for 1987-1995.		
Species	Quant. of samples	Average cadmium content mg|kg
Sand	178	1.9
Aleurite sand	45	1.99
Aleurite	16	2.8
Sand aleurite (sludge)	23	2.4
Clay aleurite (sludge)	15	9.8
Clay	19	1.9
miktit	25	4.2

Riverine cadmium input into the Gulf of Finland from Russian territory (t)*					
waterways	1996	1997	1998	1999	2000
The Bolshaya Neva	8.1	8.0	8.9	10.2	21.9
River arm Bolshaya Nevka	0.3	0.33	0.37	0.42	1.1
River arm Malaya Nevka	1.3	1.3	1.43	1.62	2.8
River arm Malaya Neva	2.6	2.5	2.82	3.21	5.6
The Luga	1.4	3.3	2.98	2.60	2.5
The Narva	-	-	-	7.7	7.4
The Seleznevka	0.03	0.03	0.03	0.03	0.05

*unfiltered samples

Cadmium concentration in smoke fumes of combustion furnace Pirofluid of the central aeration station in St Petersburg is 0.00075 mg/nm^3.

Average cadmium content in soils of St Petersburg - 0.94 mg|kg dry weight.

Sweden:

Discharges to water/ emissions to air/ losses from production, use, storage, transport and waste treatment within the catchment area of the Baltic Sea:

deposition 53 t/y
riverine input 46 t/y
industry discharges 5,5 t/y
municipalities 2,9 t/y (1993). A medium value for a Stockholm municipality is 0.03 ug/l (1999).

ANNEX 3: TRANSCRIPTION OF CONTRACTING PARTY REPLIES CONCERNING CADMIUM LEGISLATION

Denmark:

Legislation on chemical products: Ban on the use in certain applications. Administrative Order no. 1199 of 23.12.92. All Cd containing products are considered as hazardous waste according EU regulation and are treated accordingly.

Legislation on production/use of cadmium: Ban on the use in certain products, where Cd is used as pigment, as stabilizer in plastics or as surface treatment (cadmiation)

Legislation on use/import of the cadmium: Ban on import, sale or production of the products mentioned in above

Economic instruments, voluntary agreements etc.: Collection of NiCd cells (batteries). Tax on NiCd batteries. Bonus system on collection of NiCd batteries. Cadmium is on the indicative list of undesirable substances.

Planned measures and activities: -

Permits/Regulation of industrial installations: Ban on production of above-mentioned products. Cadmium is covered by statutory order 921 of 8. Oct. 1996 regarding quality criteria for point source discharges to aquatic environment.

Effectiveness of legislation/regulations: Effective; only few known violations of the regulations. In 1987-90 a control campaign were performed. Of 215 plastic products 12 % exceeded the limit value. After new regulation (1992) a campaign on hobby products showed no violation above limit value (2 products did contain Cd at 1ppm). In 1999 48 erotic articles were tested and 30 of these did not comply (PVC articles). Max. concentration was 1100 ppm. Products from the Far East had the highest concentrations.

Effectiveness of implemented HELCOM Recommendations: -

Illegal or unidentified uses: Only few known violations of the regulation. See above.

Administrative and financial resources needed for the implementation and supervision of measures: Part of normal control programme on chemicals, therefore difficult to estimate resources for only one substance.

Estonia:

General legislation comprise:

Chemicals Act (06.05.1998), providing the legal basis for organization of the handling of chemicals and for the restriction of economic activities involving the handling of chemicals, and provides the principal safety requirements for the handling of chemicals and the procedure for notification of chemicals.

Waste Act (10.06.1998) providing general requirements for prevention of waste generation, for prevention of health and environmental hazards arising from waste generation and for organization of waste management with the objective to reduce the harmfulness and quantity of waste and liability in the case of violation of the established requirements.

Water Act (11.05.1994), regulating the use and protection of water, relations between landowners and water users in order to guarantee the purity of inland and transboundary water bodies and groundwater as well as ecological balance in water bodies.

For cadmium the following measures have been specifically implemented:

Legislation on chemical products: products, containing Cd-compounds listed as hazardous chemicals, must be packed and labeled as required for hazardous chemicals legislation; products containing Cd are considered as (potential) hazardous waste.

Ban of the production/import/use of a substance (RTL 2000, 116, 1825): banned to use PPPs containing Cd; banned to import/use batteries and accumulators containing >0.025 mass % of Cd; banned in certain paints (ordinary limit value for Cd in paints 0.1 %); banned to use as stabiliser in PVC or as metal surface treatment.

Economic instruments, voluntary agreements etc: voluntary agreements and contracts between Ministry of Environment and enterprises on substitution of pollution fees are used (tailor-made; not concerning only Cd, but more depending on the specific activities of an enterprise or used chemicals).

Planned measures: enforcement of supervision

Regulation on industrial installation (permits): Discharges into environment are regulated through permitting system (see emissions limit values in a table below); issuers of permits are 15 County Environmental Departments of the Ministry of the Environment:

- Water permits – Regulation No 63 (24.12.1996) of the Minister of Environment on issuing and revocation of water permits; a new version of it – No 18 (26.03.2002).
- Waste permit – Regulation No 34 (17.03.1999) of the Minister of Environment on issuing and revocation of waste permits. The handling of hazardous waste is managed through licencing system, issuer of a licence on handling of hazardous waste is the Ministry of the Environment.
- Air permit - Regulation No 47 (28.04.1999) of the Minister of Environment on application and issuing of ambient air pollution permits.
- Integrated environmental permit – relevant Integrated Pollution Prevention and Control Act was adopted in 10.10.2001, will enter into force in 01.05.2002.

Information on discharges, emissions and losses: (also in table 7 and Annex 2:) Cd emissions **into air** from fuel combustion 44042 kg (= 44 tons) in 1998 (data from Estonian Environmental Information Centre). Other data not available.

Limited Cd concentrations in legislative acts:

	Limit value
Soil	5 mg/kg (20 mg/kg in industrial areas)
Groundwater	10 ì g/l
Surface water	0.005 mg/l
Drinking water	5 ì g/l
Waste water	0.2 mg/l (same value for discharges into public sewerage)
Sewage sludge (if used in agriculture, recultivation, urban landscaping etc)	*15 mg/kg (dw); *can be used if Cd-concentration in soil is originally <3 mg/kg (dw), pH>6; *10-years average Cd-load per hectare per year: 0.15 kg/ha/y
Plant protection products	Cd-compounds banned in PPP
Ambient air	3 ì g/m^3/h 1 ì g/m^3/d
Emission to air	0.5 mg/Nm^3 for old oil combustion
*Mineral and Phosphorus fertilizers * Other fertilizers	*100 mg Cd per 1 kg Phosphorus *3 mg Cd per 1 kg dry matter
Pollution fees (in 2001) for heavy metal emissions:	
*into air *waste	2413.7 EEK/t 1897.7 EEK/t of waste containing Hg, Cd, cyanides, PCB, PCT or organic pesticides.
Packaging material	<100 mg/kg

Requirement for ecological farming: the Cd concentration in natural phosphates may be < 90 mg/kg from P2O5. Limits for Cd in animal feed established.

According to the Waste Act and Regulation of the Minister of Environment No 72 (19.07.1999) on the collecting and labelling of batteries and accumulators containing hazardous substances, the old/used batteries and accumulators must be collected and handled separately as hazardous waste, if concentrations of substances are:

- Cd >0.025 mass%;
- Pb >0.4 mass%;
- Hg >0.0005 mass%.

Production, import, export, marketing and use of batteries and accumulators containing abovementioned quantities of Cd, Pb or Hg is banned according to the Governmental Regulation No 99 (16.03.1999).

The quantity of Ni-Cd batteries collected as hazardous waste and exported in 2000/2001 was 18'900 kg, containing 6 % Cd and 8 % Ni as estimated.

International projects concerning hazardous substances management:
The Twinning Project ES98/IB-EN-01(a)-Air Accession between EU (Finland, Germany) and Estonia on approximation of Estonian legislation in the field of ambient air protection to that of EU (institutions, legislation, monitoring, training), duration 1999-2001. Project activities were:

- the amendments to air quality legislation;
- the determination of zones for assessment of air quality;
- the overviews and suggestions to air protection administrative capacity building;
- the long term training plan for air protection specialists (including MoE and County Environmental Departments).

National Programme for Phasing out Substances that Deplete the Ozone Layer (1999-2002), financed (total 1.8 MEUR) by the Global Environmental Fund (GEF) and Estonian State Budget with a purpose to fulfil the obligations under *the Montreal Protocol on Substances that Deplete the Ozone Layer*. At the moment next objectives have been accomplished:

- import quotas and licences have been established, issued and implementation control performed by the Ministry of Environment;
- Ozone Bureau as a special administrative unit has been set up;
- in co-operation with UNDP, training workshops for refrigeration technicians have been carried out.

Projects for waste management:

- Danish EPA project: Assistance in Implementation of the Batteries Directive in Estonia;
- Danish EPA project: Assistance in Implementing the Directive of the Disposal of PCBs/PCTs in Estonia (phase II 2000 – 2001);
- Danish EPA project on Development Hazardous Waste Management System in Estonia (1991-2002).

Finland:

Legislation on chemical products: Cadmium and its compounds may not be used:

- to give color to finished products (except for safety reasons) manufactured from certain substances and preparations listed in an Annex to Council of State Decision 1415/1992 (see below).
- to stabilize products manufactured from polymers or copolymers of vinyl chloride (also listed

in the Annex).

- for cadmium plating metallic products or components of products used in various sectors/applications listed in the Annex. [Council of State Decision 1415/1992 on prohibitions and restrictions concerning products and equipment containing cadmium and its compounds (into force 1.1.1993). The decision implements Council Directive 91/338/EEC.]

Sludge from sewage treatment used to fertilize cultivated soils may not contain more than 3.0 mg Cd/kg dry mass of sludge. Corresponding value for sludge used as a raw material to manufacture sludge mixtures used as a fertilizer is 5.0 mg/kg.

Specific values are also given for maximum Cd content of cultivated soils and for maximum Cd load resulting from such use. [Council of State Decision 282/1994 on the agricultural use of sludge from sewage treatment (into force 1.5.1994).]

The cadmium content of fertilizer products may not exceed 3.0 mg/kg. [Ministry of Agriculture and Forestry Decision 46/1994 on certain fertilizer preparations (into force 26.1.1994).]

When marketing batteries containing more than 0.025 % of cadmium by weight, the risks of handling used batteries must be clearly indicated. [Council of State Decision 105/1995 (amended by 17/1999) on batteries containing certain dangerous substances (into force 26.1.1995).]

The packer (the definition of packer also includes the importer of packed products) must ensure that the total concentration of lead, cadmium, mercury and chromium (VI) in packages does not exceed the limit values of 600 ppm as from 1.7.1998, 250 ppm as from 1.7.1999 and 100 ppm as from 1.7.2001. [Council of State Decision 962/1997 on packages and waste consisting of packages (into force 1.12.1997).]

Legislation on production/use of cadmium: See Council of State Decisions 1415/1992, 962/1997, 46/1994 and 282/1994 in the previous answer.

Legislation on use/import of cadmium: Products and equipment containing cadmium and its compounds, given the conditions stated in the Council of State Decision 1415/1992, may not be placed on market. See the Council of State Decision 962/1997 in the first answer.

Economic instruments, voluntary agreements etc.: Currently, there are no such measures in place concerning cadmium.

Planned measures and activities: -

Permits/regulation of industrial installations: Specific discharge limit values have been set for zinc mines, refining of lead and zinc, metal industry not using iron, production of cadmium compounds, production of pigments, production of stabilizers, production of batteries, and galvanizing. [The Water Act (1961), Council of State Decision 363/1994 on the discharge into the aquatic environment of certain substances dangerous for health and the environment (into force 19.5.1994).] The decision implements Council Directive 76/464/EEC.]

Direct and indirect releases into groundwater are prohibited. [The Water Act (1961), Council of State Decision 364/1994 on the protection of groundwater against pollution caused by certain substances dangerous for health and the environment (into force 19.5.1994). The decision implements Council Directive 80/68/EEC.]

The total concentration of cadmium and thallium in exhaust gases from new incineration plants handling household wastes must not exceed the emission limit value of 0.05 mg/m3.

The concentration of cadmium in exhaust gases from old incineration plants handling household wastes must not exceed the emission limit value of 0.2 mg/m3. (New incineration plants are defined as incineration plants that have started working after 1.12.1990. Old plants may exceed the given emission limits until 1.12.1995. As from 1.12.2007 they must fulfil the requirements set on new incineration plants.) [Council of State Decision 626/1994 on the incineration of household waste (into force 1.8.1994).]

The concentration of cadmium in exhaust gases from incineration plants handling oil wastes must not exceed the emission limit value of 0.2 mg/m3. [Council of State Decision 101/1997 on the disposal of waste oils (into force 30.9.1997). The decision implements Council Directives 75/439/EEC and 87/101/EEC.]

The total concentration of cadmium, thallium and their compounds in exhaust gases from incineration plants, measured as the average value over a sample period of a minimum of 30 min and a maximum of eight hours must not exceed the emission limit value of 0.05 mg/m3 (new plants) or mg/m3 (old plants). [Council of State Decision 842/1997 on the incineration of hazardous waste (into force 1.3.1997). The decision implements Council Directive 94/67/EEC.]

Effectiveness of legislation/regulations: Cadmium emissions to air have decreased from 6.3 t in 1990 to 1.1 t in 1997. Cadmium emissions to waters from monitored sources have also decreased during 1990s. Cadmium discharges to land were estimated to be some 147 t in 1987. In 1995, the total cadmium content of solid wastes was approximately 110 t (Data sheet on cadmium published by the Finnish Environment institute in 1995).

Effectiveness of implementation of HELCOM Recommendations: HELCOM Recommendations on discharge and emission limit values for industrial sources have been implemented by plant-specific permits.

Illegal or unidentified uses: -

Administrative and financial resources needed for the implementation and supervision of measures: The administration is handled by general environmental and health authorities and no special resources have been allocated for cadmium. A few scientific and administrative reports have occasionally been produced by temporary project groups.

Germany:

Legislation concerning chemical products:

Cadmium is banned by Executive Order in many applications (Part 18) (ChemikalienverbotsVO): It is prohibited to market 1) specified plastics dyed with cadmium or cadmium compounds and having a mass content in the plastic of more than 0.01 % of cadmium metal 2) painting colours and lacquers with a mass content of more than 0.01 % of cadmium or cadmium compounds; 3) specified products or parts of products made of vinyl chloride polymers or copolymers stabilized with cadmium or cadmium compounds and having a mass content in the polymer of more than 0.01 % of cadmium metal 4) specified products or parts of products whose metallic surfaces are treated with cadmium. Some exceptions from the prohibition are mentioned.

The introduction of cadmium is subject to a charge levied under the Waste Water Charges Act. The Waste Water Charges Act was enacted on 13/9/76 (BGBl. I, p. 2721, amended p.3007), came into force on 1/1/78, and provides for the levying of charges as of 1/1/81. The act was last amended on 6/11/90 (BGBl. I, p. 2432). On the basis of the act, communities or industries, which discharge harmful waste water, are subject to the levying of a charge. The rate of the charge is determined by the harmfulness of the waste water discharged. In determining the level of harmfulness, an assessment is based on the volumes discharged, the levels of oxidisable substances (as Chemical Oxygen Demand COD), mercury, cadmium, nickel, chrome, lead, copper and organic halides (AOX), as well the toxicity to fish of the waste water (§3 with Appendix A). The harmfulness is then expressed in terms of 'unit harm' (Schadeinheit, SE). One SE corresponds roughly to the harm caused by the raw waste water produced by one inhabitant in one year (inhabitant equivalence). The less harmful the discharges, the lower the charge levied. Thus the waste water charge is intended to provide an incentive to reduce the harmfulness of waste water through preventive measures, namely pretreatment, the introduction of less waste water intensive, or even waste water-free production methods and of environmentally friendly products. The charge to be levied on one SE of waste water discharged (the charge rate) was 12,- DM in 1981. The rate of the charge has risen annually, and has been at 70,- DM/SE since 1994. If the volume and harmfulness of the waste water are reduced by preventive measures to a level corresponding to the minimum requirements laid down in §7a of the Federal Water Act (Wasserhaushaltsgesetz), or to any stricter requirements imposed in the discharge license, the waste water charges are reduced by 75 % per SE (§9 V). Further progressive reductions, according to appropriate treatment measures, are also possible, and the possibility of reducing charges to 20 % of the standard level if the Best Practicable Means (BPM) is always used offers an additional incentive. The revenue raised from waste water charges is ringfenced, and to be spent only on measures to maintain or improve the quality of water resources. (§13).

(Batteries Ordinance, which came into force in April 1998): Manufacturers now assume total responsibility for their products, via a new system for collection return, which requires new disposal methods in keeping with the Waste Recovery and Recycling Act.

On 1/7/92, a revised Sewage Sludge Ordinance (Klärschlammverordnung, BGBl. I p.912) came into effect. The revision was necessary in order to alter the limits for heavy metals to take account of new scientific knowledge, and in order to include extraordinary regulations to deal with the pollution caused by sewage sludge containing organic pollutants. In addition, the regulations had to be harmonised with EC guidelines. The Sewage Sludge Ordinance contains the following substantially new regulations:

- the maximum permitted contents of the heavy metals Cadmium and mercury are significantly reduced
- the list of maximum permitted contents of organic pollutants is supplemented
- the dumping of sewage sludge onto areas where fruit and vegetables are cultivated or onto managed forests is prohibited
- dumping onto arable land is now only permitted under more stringent conditions through stricter obligations to test sewage sludge and the dumping site for nutrients
- over-fertilisation of and nutrient leaching into surface and ground water should be prevented
- monitoring of sewage sludge dumping is improved, through the introduction of stricter obligations to furnish evidence

The ordinance regulates the dumping of sewage sludge onto agricultural, arboricultural or gardening land nation-wide. It requires that sewage sludge be sterilised before dumping, and lays down maximum levels for the content of seven heavy metals (lead, cadmium, chrome, copper, nickel, mercury and zinc). It also determines the frequency with which sewage sludge may be dumped on an area, and limits the annual volume to be dumped.

Ordinance on Drinking Water (Trinkwasserverordnung): 0.005 mg/l (+-0.002). Original: Bundesgesetzblatt, I, 2612, 1990. Amendment: Bundesgesetzblatt, I, 699, 1998.

Ordinance on the use for Plant Protections (Pflanzenschutzanwendungsverordnung): Plant protectants consisting of or containing cadmium compounds may not be used. The import of planting material containing cadmium compounds is prohibited. Original: Bundesgesetzblatt, I, 1889, 1992. Amendment: Bundesgesetzblatt, I, 60, 1997.

Ordinance on Consumer Products (Bedarfsgegenständeverordnung): concerns the leaching of cadmium from food consumer products made of ceramics.

Technical Instructions on Air Quality Control (Technische Anleitung zur Reinhaltung der Luft): concerns air emission limit values in old and new installations.

Legislation on production/use of cadmium: ban on the production/use of cadmium: see above. Cadmium compounds are completely banned for use as a plant protection product.

Legislation on use/import of cadmium: see above

Illegal or unidentified uses: no information

Administrative and financial resources needed for the implementation and supervision of measures: no information

Latvia:

Legislation on chemical products: Cadmium is registered/licensed for use as an industrial chemical only.

Legislation on production/use of cadmium: Marketing and general use of cadmium was banned 01.01.2001 (Regulations of Cabinet of Ministers no. 158, 25.4.2000, on Restrictions and bans on use and marketing of some dangerous chemical substances and dangerous chemical products) and regulations will be strengthened from year 2002.

Legislation on use/import of cadmium: no information.

Lithuania:

Legislation on chemical products: According to Hygienic standards 63:2000. Banned and restricted pesticides, import, produce and use Cadmium/compounds as pesticide is banned in Republic of Lithuania. According to Hygienic standards 36:1999. Banned and restricted substances: According to Hygienic standards 36:1999. Banned and restricted substances

Legislation on production/use of cadmium: Cd may not be used to give colour to finished products manufactured from the following substances and preparations: polyvinyl chloride (PVC), polyurethane (PUR), low-density polyethylene (ld PE), with the exception of low-density polyethylene used for the production, cellulose acetate (CA), cellulose acetate butyrate (CAB), epoxy resins, melamine - formaldehide (MF), polyethylene terephthale (PET), polybutylene terephthale (PBT), acrylonitrile methylmethacrylate (AMMA), high - impact polystyrene, polypropylene (PP).

In any case, whatever their use or intended final purpose, finished products or components of products manufactured from substances and preparations listed above coloured with cadmium may not be placed on the market if their cadmium content (expressed as Cd metal) exceeds 0.01 % by mass of the plastic material.

It is forbidden to add cadmium and its combinations into the paints with purpose to give a color. If the paints have a high zinc content, their residual concentration of cadmium must be as low as possible and at all events not exceed 0.1 % by mass.

However, the above does not apply to products to be coloured for safety reasons. Natural or legal persons, which provide market with products colored with cadmium for safety reasons, have to indicate those reasons for the competent authority.

Cd may not be used to stabilize the finished products listed below manufactured from polymers or copolymers of vinyl chloride: packaging materials (bags, containers, bottles, lids), office or school supplies, fittings for furniture, coachwork or the like, articles of apparel and clothing accessories (including gloves), floor and wall coverings, impregnated, coated, covered or laminated textile fabrics, imitation leather, gramophone records, tubes and pipes and their fittings, swing doors, vehicles for road transport (interior, exterior, underbody), coating of steel sheet used in construction or in industry, insulation for electrical wiring.

In any case, whatever their use or intended final prupose, the placing on the market of the above finished products or components manufactured from polymers or copolymers of vinyl chloride, is banned if their cadmium content (expressed as Cd metal) exceeds 0.01 % by mass of the polymer. Bans are not applied for the products which are stabilized with cadmium for safety reasons.

May not be used for cadmium plating metallic products or components of the products used as equipment and machinery for food production, agriculture, cooling and freezing, printing and book binding, for the production of household goods, furniture, sanitary ware, central heating and air conditioning plant, production of paper and board textiles and clothing, industrial handling equipment, road and agricultural vehicles, rolling stock, vessels.

The above provisions do not apply to aerospace, mining, offshore and nuclear sectors whose applications require high safety standards, and safety devices in road and agricultural vehicles, vessels, electrical contacts in any sector of use, on account of the reliability required of the apparatus on which they are installed.

Legislation on use/import of cadmium:

According to Governmental Resolution No 452 of 21.07.1999 On licensing of dangerous chemicals produce, trade and storage, to produce, trade and store Cadmium /compounds from 01.10.1999 it is necessary to receive a license from Ministry of the Environment.

According to Order of Environmental Ministry No 292 of 31.12.1998 On Regulations of Issuing

Permits for Import and Export of Dangerous Chemical substances from and into Republic of Lithuania, for import and export of Cadmium compounds it is necessary to receive permit from Ministry of the Environment.

According to Hygienic standards 36:1999. Banned and restricted substances, may not be used in substances and preparations placed on the market for sale to the general public in which concentration of cadmium chloride, cadmium sulphate, cadmium oxide greater than - in fluid and solid substances and preparations - 0.1 % by mass, in gaseous substances and preparations - 0.1 % by volume. A ban shall not apply to manufactured products, they are controlled by other statements (above).

Economic instruments, voluntary agreements etc.:

Planned measures and activities: Law on pollution charges. The draft on this Law is already prepared for: see introduction of product charge

Permits/Regulation of industrial installations:

Maximum content of cadmium in wastewater is regulated by wastewater Pollution Standards 'Land - 10', 1998

Maximum content of cadmium in wastewater sludge is regulated by Standards of Wastewater Sludge Use 'Land - 20, 1996

Effectiveness of legislation/regulations:

Effectiveness of implemented HELCOM Recommendations:

Illegal or unidentified uses:

Administrative and financial resources needed for the implementation and supervision of measures:

Poland:

Legislation on chemical products:

Act of 21 May 1963 on toxic substances, concerning chemical products

Executive Order of the Minister of Health and Social Welfare of 28 Dec. 1964 on the list of poisons and harmful substances,

Executive Order of the Minister of Health and Social Welfare of 10 Feb. 1964 on permissions for production and trade of poisons, poisons' records and rules of procedure of supervising bodies on poisons,

Act of 27 June 1997 on wastes,

Executive Order of the Council of Ministers of 17 Dec. 1996 on Fees for Economic Use of the Environment;

Executive Order of the Minister of Environmental Protection, Natural Resources and Forestry of 12 Feb. 1990 on Air Protection Against Pollution

Executive Order of the Council of Ministers of 19 May 1999 on Conditions of Waste Water Discharges into Municipal Sewerage Facilities

Executive Order of the Minister of Environmental Protection, Natural Resources and Forestry of 11 Aug. 1999 on the Conditions of using Sewerage Sludge for Non-Industrial Purposes;

Act of 16 Oct. 1991 on cultivated plants protection,

Executive Order of the Minister of Agriculture and Food Economy of 12 March 1996 on specific conditions for granting permits for trade and use of plant protection products

Executive Order of the Minister of Economy of 19 Feb 1999 on Chemical Substances Dangerous for Health and Life

Legislation on production/use of cadmium:

not registered and permitted for marketing and use as a pesticide since the year 1965 (presumably was not used also before 1965). Since 1996 granting permission is not even possible.

Legislation on use/import of cadmium:

partly restricted - production, import and selling under special permissions, with exceptions for scientific institutions (only for scientific research purposes)

Economic instruments, voluntary agreements etc.: no information available

Planned measures and activities: no information available

Permits/Regulation of industrial installations:

- concentration of cadmium in waste water discharged to sewerage systems shall not exceed 0.4 mg Cd/dm3,
- concentration of cadmium in sewage sludges for non-industrial purposes shall not exceed 10-50 mg/kg d.w. (up to 10 mg e.g. agriculture, up to 50 mg - e.g. plant land restoration)
- maximum average air concentration shall not exceed: 0.2 ì g/m3 in 24 h and 0.01 ì g/m3 a year (on specially protected areas: 0.2 and 0.001, accordingly)

Effectiveness of legislation/regulations: no information available

Effectiveness of implemented HELCOM Recommendations: partly implemented

Illegal or unidentified uses: no information available

Administrative and financial resources needed for the implementation and supervision of measures: no information available

Russia:

Legislation on chemical products: Cadmium is registered for use as an industrial chemical

Legislation on production/use of cadmium: Production, marketing and use are permitted (classified as dangerous substance)

Legislation on use/import of cadmium: Import is permitted (classified as dangerous substance)

No further information.

Sweden:

Legislation on chemical products: Ordinance on Prohibition in Connection with Handling, Importation and Exportation on Chemical Products etc. (Certain Cases, 1998:944)

Legislation on production/use of cadmium:

Since 1982, cadmium substance (= metallic cadmium or a chemical compound containing cadmium) may not be used for surface treatment or as stabilizer or colouring agent. Goods, which have been surface-treated with a cadmium substance or contain such a substance as a stabilizer or colouring agent may not be professionally offered for sale or transferred. The goods may not be professionally imported from countries not being members of the European union. The National Chemicals Inspectorate has issued a regulation of derogations from the ban, where the use in 15 areas has been derogated. Sweden has been granted exemptions with regard to current EU-legislation (Directive 76/769/EEC, amendment Dir. 91/338 and Dir. 99/51/CE) until 31 December 2002, by which time the European regulations will be reconsidered and adapted to technical progress.

Legislation on use/import of cadmium: Since 1 November 1995, phosphorus fertilizers containing more than 100 g of cadmium per t of phosphorus may not be offered for sale or transferred. (Ordinance on Prohibition in Connection with Handling, Importation and Exportation of Chemical Products Etc (Certain Cases) (1998:944). The maximum content of cadmium in sewage sludge to be spread on arable land is 2mg/ha and year. By January 1, 2000 the maximum amount of cadmium to be spread on arable land is 0,75 g/ha and year. Sweden has been granted exemption with regard to current EU-legislation on fertilizers (Directive 76/116/EEC) until 31 December 2001. The Commission will evaluate the need for regulation on community level before that date.

Economic instruments, voluntary agreements etc.: A charge of 30SEK per gram cadmium exceeding 50 g/ ton phosphorus (later changed to 5 g Cd/ton P) was introduced in 1994 and was changed to a tax in July 1995.

Effectiveness of legislation/regulations: The use of cadmium compounds as stabilizer, pigment or in alloys has almost ceased, since the introduction of the ban. However, the total amount of Cd is still at a level corresponding to the 1970s, due to the extraordinary increase in the use of NiCd-batteries (see table in section 1.1.2). The maximum limit value and the tax, combined with voluntary efforts in food industry, has led to a significantly reduced cadmium content in phosphorus fertilizers since the beginning of the 1990´s (60 mg/kg P compared to 25´). The cost to Swedish agriculture of the cadmium tax was 0,03 % of the total revenue in the agricultural sector in 1995.

ANNEX 4: CURRENT INTERNATIONAL LEGISLATION AND AGREEMENTS CONCERNING CADMIUM USE AND EMISSIONS (EU, HELCOM, OSPAR).

EU Directives relevant to cadmium

The following regulations at EU level are relevant to the cadmium problem (OSPAR 2001). It should be noted that some of these regulations are very general in scope, and some of them include cadmium as just one of a long list of hazardous substances. A number of the regulations are more directed towards public health concerns than to protection of the environment as such.

Regulation at the source:
Council Directive 76/769/EEC (and subsequent amendments, e.g. 91/338/EEC and 99/51/EC) relating to the restrictions on the marketing and use of certain dangerous substances (including cadmium).
Council Decision 75/437/EEC: Council Decision of 3 March 1975 concluding the Convention for the prevention of marine pollution from land-based sources ("Paris Convention")
Council Directive 83/513/EEC on limit values and quality objectives for cadmium discharges (daughter directive to 76/464/EEC – see below under Water)
Council Decision 85/613/EEC: Council Decision of 20 December 1985 concerning the adoption, on behalf of the Community, of programmes and measures relating to mercury and cadmium discharges under the convention for the prevention of marine pollution from land-based sources
Council Directive 98/101/EC adapting to technical progress Directive 91/157/EEC on batteries and accumulators containing certain dangerous substances.
Council Directive 96/61/EC on Integrated Pollution and Prevention Control.
European Commission, 2000. Best Available Techniques Reference Document on the Production of Iron and Steel. pp. 1-383
European Commission, 2000. Reference Document on Best Available Techniques in the Non Ferrous metals Industries. pp 1-807.

Consumer protection:
Council Directive 88/378 (the "Toy Safety" directive)
Council Directive 84/500/EEC on ceramic articles intended to come into contact with foodstuffs.
Council Directive 94/62/EC on packaging and packaging waste (sets limits for cadmium content in packaging materials).

Water:
Council Directive 75/440 and Council Directive 80/778/EEC on standards for surface freshwater destined for the production of drinking water, and for human consumption.
Council Directive 76/464/EEC concerning water pollution by discharges of dangerous substances: discharge limit criteria and environmental quality objectives for cadmium and its compounds established in daughter directive 83/513/EEC
Council Directive 78/659/EEC on the quality of fresh water for fish
Council Directive 79/923 for shellfish, no specific cadmium concentration is given.
Council Directive 80/68/EC for groundwater comprises cadmium compounds in List I for which the indirect introduction to the ground water must be prohibited and avoided.
Council Directive 83/513/EEC on limit values and quality objectives for cadmium discharges.
Water Framework Directive 2000/60/EC establishing a framework for Community action in the field of water policy.

Air:
Council Directive 89/369 and 89/429. Waste Incineration Directives: set emissions limit values to air based on BAT for new and existing municipal waste incineration plants.
Council Directive 94/67 on the incineration of hazardous wastes and controlling emissions of heavy metals by prior authorization procedures of plants.

Soil:
Council Directive 98/97/EC amending Directive 76/116/EEC permitting the prohibition in Austria, Finland and Sweden of fertilizers containing cadmium at concentration in excess of those which were fixed nationally at the date of accession (1994 Act of accession), because of the specificity of their situations (valid until 31 December 2001, at which time the Council shall review the need for establishing provisions at Community level concerning the cadmium content of fertilizers).
Council Directive 86/278/EEC on the protection of the environment, and in particular of the soil when sewage sludge is used in agriculture, gives limit values for cadmium concentrations in agricultural soils (1-3 mg/kg DM). Sewage sludge should not be applied where cadmium concentrations exceed this limit. (Other policies that influence the use of cadmium in fertilizers are regulations such as the food safety regulation, which limits the cadmium content in food products).

Waste:
Council Directive 78/319/EEC on toxic and dangerous waste determined cadmium and its compounds in requiring priority consideration in the control, prevention, recovery and recycling of any waste containing or contaminated by the substance.

HELCOM Recommendations with relevance to cadmium

The following HELCOM recommendations are currently valid:

HELCOM RECOMMENDATION 11/7 (under revision)
Adopted 14 February 1990, having regard to Article 13, Paragraph b) of the Helsinki Convention. Measures aiming at the reduction of emissions to the atmosphere from the iron and steel industry.

HELCOM RECOMMENDATION 13/4 (under revision)
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.

HELCOM RECOMMENDATION 14/5 (under revision)
(supersedes HELCOM Recommendation 6/5)
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).

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.

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.

HELCOM RECOMMENDATION 18/2
(supersedes HELCOM Recommendation 9/5 as from 1 January 1998 for new installations and as from 1 January 2001 for existing installations.)
Adopted 12 March 1997 having regard to Article 13, Paragraph b) of the Helsinki Convention. Offshore activities

HELCOM RECOMMENDATION 23/7
Adopted 6 March 2002 having regard to Article 20, Paragraph 1 b) of the Helsinki Convention. Reduction of discharges and emissions from the metal surface treatment.

HELCOM RECOMMENDATION 23/11
Adopted 6 March 2002 having regard to Article 20, Paragraph 1 b) of the Helsinki Convention. Requirements for discharging of waste water from the chemical industry.

OSPAR Recommendations and Decisions applying to cadmium

The Oslo and Paris Commission (OSPAR) has adopted the following Recommendations and Decisions with relevance for cadmium and cadmium-relevant industries (OSPAR 2001):

PARCOM Recommendation 84/2 for reducing cadmium pollution (Source: PARCOM 6/13/1, paras 4.20-4.23): calls for substitution of cadmium in electroplating, pigments and stabilizers, and for labeling, collecting and recycling cadmium batteries.

PARCOM Decision 85/2: Programmes and Measures on Limit values and Quality Objectives for cadmium Discharges: establishes same discharge limit criteria as HELCOM 6/6.

PARCOM Recommendation 90/1 of 14 June 1990 on the definition of the best available technology for Secondary iron and steel plants: lists acceptable emissions control technologies.

PARCOM Decision 90/2 on programmes and measures for mercury- and cadmium- containing batteries: requires separate collection and recycling of batteries containing more than 0.025 % cadmium by weight, such batteries must be removable without aid of special tools and should be labeled.

PARCOM Recommendation 91/2 of 20 June 1991 on the definition of best available technology in the primary iron and steel industry: favours dry methods of dust removal rather than wet scrubbing, recommends general techniques for dust prevention and removal.

PARCOM Recommendation 91/3 of 20 June 1991 on measures to be taken and investigations to be carried out in order to reduce pollution from secondary iron and steel production (as HELCOM 13/4)

PARCOM Recommendation 92/2 concerning limitation of pollution from new primary iron and steel Production installations: sets limits for dust emissions (50 mg/m3, but lower if cadmium or other heavy metals present)

PARCOM Recommendation 92/3 concerning limitation of pollution from new secondary steel production and rolling mills: sets limits for dust emissions (20 mg/m3, but lower if heavy metals present) and discharge limit criteria for waste water from pickling plants, including 0,2 mg/l for Cadmium.

PARCOM Recommendation 92/4 on reduction of emissions from the electroplating industry: sets wastewater discharge limit criteria, including 0,2 mg/l for Cadmium.

PARCOM Recommendation 93/1 concerning limitation of pollution from existing primary iron and steel production installations: applies limits as in Recommendation 92/2 to existing plant, after a phase-in period.

ANNEX 5: ABBREVIATIONS

a	annum (year)
BAT	Best Available Technology
BREF	BATs reference document prepared by the EU IPPC Bureau
Cd	Cadmium
CEFIC	European Chemical Industry Council
CPs	Contracting Parties
DAP	Di-ammonium Phosphate
DE	Germany
DK	Denmark
dw	Dry weight
EC	European Community
EE	Estonia
e.g.	Exempli gratia / for example
EU	European Union
EuroChlor	European Chlor-Alkali Industry
FI	Finland
g	Gram
HELCOM	Helsinki Commission (Baltic Marine Environment Protection Commission)
IPPC	Integrated Pollution Prevention and Control
kg	Kilogram
L	Liter
Li-ion	Lithium-ion
LV	Latvia
LT	Lithuania
MAP	Mono-ammonium phosphate
mg	Milligram
ng	Nanogram
NiCd	Nickel-cadmium
NiMH	Nickel-metalhydride
OECD	Organisation for Economic Cooperation and Development
OSPAR	Oslo and Paris Commissions
PARCOM	Paris Commission
PCB	Polychlorinated Biphenyls
PL	Poland
PLC	Pollution Load Compilation
PVC	Polyvinyl Chloride
RU	Russian Federation
SE	Sweden
T	Ton
TSP	Triple Super Phosphate
UN/ECE	United Nations Economic Commission for Europe
UNECE/LRTAP	Convention on Long-range Transboundary Air Pollution
UNEP	United Nations Environment Programme
WEEE	Waste Electrical and Electronic Equipment
WHO	World Health Organisation

ww	Wet weight
WWF	World Wide Fund for Nature
Zn	Zinc