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***Annex to the***

**Communication from the Commission to the Council and the European Parliament on Community Strategy Concerning Mercury**

***EXTENDED IMPACT ASSESSMENT***

**{COM(2005)20 final}**

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# Executive summary

## Introduction

This Extended Impact Assessment (ExIA) has been prepared by DG Environment of the Commission Services, to inform the development of the Community Strategy Concerning Mercury (COM (2005) XXX final). The Commission was requested by the Council to prepare the strategy following the Council's consideration of the Commission's previous report concerning mercury from the chlor-alkali industry (COM 2002) 489 final, 6.9.2002).

## The mercury problem

Mercury and its compounds are highly toxic to humans, ecosystems and wildlife. High doses can be fatal to humans, but even relatively low doses can have serious adverse neurodevelopmental impacts, and have recently been linked with possible harmful effects on the cardiovascular, immune and reproductive systems.

Mercury is persistent and can change in the environment into methylmercury, the most toxic form. Methylmercury readily passes both the placental barrier and the blood-brain barrier, inhibiting potential mental development even before birth. Methylmercury collects and concentrates especially in the aquatic food chain, making populations with a high intake of fish and seafood particularly vulnerable.

Most people in central and northern Europe show bioindicators of exposure below internationally accepted safe levels for methylmercury. However, there is evidence of continuing exposures at or above these levels among some of the European population, and especially in coastal areas of Mediterranean countries and the Arctic.

Although mercury is released by natural sources like volcanoes, additional releases from anthropogenic sources, like coal burning and use in products, have led to significant increases in environmental exposure and deposition. Past releases have also created a "global pool" of mercury in the environment, part of which is continuously mobilised, deposited and re-mobilised. Further emissions add to this global pool circulating between air, water, sediments, soil and biota.

## The mercury cycle

The problems associated with mercury can be addressed at various points in a "mercury cycle" comprising: production and supply; trade; use of mercury in products and processes; emissions; recycling or disposal; and control of mercury exposure.

Total global supply presently stands at around 3,600 tonnes of mercury per year. There are four main sources: primary production (mercury mining); secondary production (where mercury is a by-product, for example in zinc production); recycling (from fluorescent lamps, etc.); and reuse of surpluses. A particularly important source of surpluses is the chlor-alkali industry, which in the EU is converting away from "mercury cell" processes, with about 12,000 tonnes of mercury due to be decommissioned in the coming years.

The main global mercury supplier is the Spanish state-owned firm MAYASA (Miñas de Almadén y Arrayanes, S.A.). Under an agreement made in 2001, MAYASA buys the EU chlor-alkali sector's surplus mercury for resale. MAYASA also sells mercury that it has made from ore mined in Almadén, although mining and production are both reported to have been stopped temporarily. The other main countries that produce mercury are Kyrgyzstan, Algeria and China.

Mercury is traded freely on the world market. The EU is the major global exporter, principally as a result of the mercury produced in Almadén, and recently because of the resale of surplus mercury from the chlor-alkali industry, coupled with low internal demand. The price of mercury has fallen dramatically since its peak in the 1960s, standing relatively stably at around €5 per kilogramme for most of the past decade. This low price makes the continued use of mercury attractive outside Europe in applications such as artisanal gold mining, which is problematic in a number of developing countries.

Demand for mercury stands at around 3,600 tonnes per year globally (i.e. absorbing supply) and around 300 tonnes in the EU. The main global uses, accounting for over 75%, are artisanal gold mining, batteries and the chlor-alkali industry. Of these, only the chlor-alkali industry remains a significant user in the EU, and here the mercury cell process is being phased out. The next most significant use in the EU is in dental amalgam, in respect of which Community legislation on waste management applies. Among other major product groups, Community legislation already covers lighting and other electrical equipment. The main product group not covered by Community legislation is measuring and control equipment.

The main source of emissions of mercury is the burning of coal, both globally and in the EU. Coal burning in large combustion plants (but not smaller plants or households) is covered by Community legislation, as are some of the other major industrial sources such as the metals, cement and chemical industries. Crematoria are another relatively significant source of emissions. They are not covered by any Community legislation although there is a Recommendation on cremation that applies to parties to the OSPAR Convention.

From a human health point of view, exposure to methylmercury via diet is the main problem. Community legislation already sets limits on the mercury content of fish which may be brought to the market. Occupational exposure levels for mercury are also under consideration.

**Selection of areas for consideration of possible further action**

The Community has already taken much action to address the mercury problem, and in particular to reduce emissions, use and exposure. By looking at the various stages of the mercury cycle, the ExIA therefore considers what aspects of the problem will be addressed by the implementation of the present and already planned Community legislation and policies, and what aspects will remain. On this basis, the ExIA examines specific options for further action in relation to the following issues:

- Raw mercury supply and trade – the EU is the largest net exporter of raw mercury, and a continued oversupply and low price are significant drivers for ongoing and potentially new uses.

- The fate of surplus mercury from the chlor-alkali industry – this could, if not handled in a safe and sustainable way, be associated with considerable environmental damage in the EU, future Member States and third countries.

- Measuring equipment (e.g. thermometers, barometers, blood pressure gauges) – the largest mercury-using product group in the EU not covered by current Community legislation.

- Coal combustion – the largest source of mercury emissions in the EU and globally.

- Cremation – although this is not an especially large source of emissions in relative terms, it is significant in some countries, and unlike the main industrial emissions it is not subject to any Community legislation.

**Mercury supply and trade including the fate of surplus mercury from the chlor-alkali industry**

The analysis in this ExIA supports the conclusion that the export of mercury from the EU should be phased out. Other options that would allow continued export indefinitely do not appear acceptable, as they would extend the EU's contribution to the global mercury problem rather than helping to address it. This conclusion also reflects assessment in the ExIA of the scope to reduce global mercury demand. Clearly, the EU could not credibly argue for and support active efforts worldwide to reduce mercury demand on the one hand while intending to remain the main global supplier on the other.

Even without action on export of mercury in general, the negative environmental impacts of primary mercury mining and production, as well as their doubtful economic viability, support the permanent ending of these particular activities in the EU. Spain has stated that mining and production in Almadén have already been stopped temporarily, and does not anticipate that they will restart.

Stopping export would also remove the main market for surplus mercury from the chlor-alkali industry, such that storage or disposal would be necessary. The analysis in this ExIA favours storage of metallic mercury. Permanent disposal of stabilised mercury is a long term option, but for the moment the it appears too expensive, and has too many technical uncertainties, to be pursued at Community level.

The analysis indicates that the inclusion of metallic mercury under the Prior Informed Consent (PIC) procedure of the Rotterdam Convention would be positive, though not sufficiently effective alone to obviate the need for EU action. However, a PIC listing could still be an advantageous complementary measure, as it would act at the international level. The Commission therefore considers that the Community should promote an initiative to make mercury subject to the PIC procedure.

More broadly, to reduce mercury supply internationally the Community should advocate a global phase-out of primary production and encourage other countries to stop surpluses re-entering the market. This could be pursued under an initiative similar to that of the Montreal Protocol on substances that deplete the ozone layer. As a pro-active contribution to such a proposed globally organised effort, the

Commission intends to bring forward a proposal to phase out the export of mercury from the Community by 2011.

**Measuring and control equipment**

The ExIA indicates that it would be appropriate to introduce a Community-level marketing restriction on mercury-containing measuring and control equipment for consumer use and, with some exemptions, the healthcare sector. This is because of the relatively high level of mercury use in this sector, which will also lead to significant emissions. Establishing a restriction at Community level on measuring and control devices containing mercury would have a higher effectiveness than leaving such measures to the Member States alone, without entailing higher costs. However, extending the restriction to specialist industrial and scientific applications would need further investigations. The analysis has found that adequate substitutes for such specialist applications are not always available, and the standard of waste management should also be higher, at least as compared to that for consumer products.

**Coal combustion**

The ExIA examines whether additional Community action should be taken to reduce mercury emissions from large combustion plants, either through a traditional regulatory tool or a market-based instrument. However, the assessment indicates that it is not appropriate, at this stage, to propose any such new Community action. Primarily, this is because coal combustion in large combustion plants is already covered by Community legislation, the application of which can be expected to reduce mercury emissions significantly. The impact of this legislation will be more evident after 1 January 2008.

As regards small combustion plants and residential coal burning, consultation has revealed that data on this subject and proposals for realistic solutions are presently scarce. As a result, it has not been possible to undertake a detailed assessment of the policy options in this area. In any case, control of polluting emissions from small combustion installations is more likely to be cost-effective when considered on a multi-pollutant, rather than a single substance, basis. This is being examined with the Commission's broader Clean Air for Europe (CAFE) programme. The Commission will therefore further study the availability and costs of options to abate mercury emissions from small scale and residential coal combustion, for consideration alongside the CAFE multi-pollutant assessment.

**Cremation**

The ExIA examines whether the Community should act to reduce mercury emissions from cremation, either through a traditional regulatory tool or a standardisation initiative. However, the analysis indicates that it is not appropriate, at this stage, to pursue such Community-level action. This is because most of the problem with mercury emitted from crematoria assessed in this ExIA is already covered by an OSPAR Recommendation, and by legislation in some of the remaining Member States who are not parties to the OSPAR Convention. Therefore, the marginal benefit of Community action could be limited. In addition, presently available data on the extent of emissions from cremation are limited. This situation should be improved by reporting on emissions by parties to the OSPAR Recommendation (the first such reporting being due by 30 September 2005), which should also give an initial indication of the extent to which the Recommendation is being applied.

**Review**

The ExIA identifies a number of significant milestones in the coming years which will provide further data on the mercury problem, possible solutions, and the success of policy measures. On this basis, the ExIA concludes that an overall review of the implementation and further development of the mercury strategy should be undertaken by the end of 2010.

# 1. INTRODUCTION

## 1.1. Purpose of this Extended Impact Assessment

This Extended Impact Assessment (ExIA) has been prepared by DG Environment of the Commission Services, to inform the development of the Community Strategy Concerning Mercury (COM (2005) XXX final). It follows the guidelines for an ExIA produced by the Secretariat General of the Commission. It also takes account of a consultation exercise undertaken by DG Environment to inform the development of the mercury strategy.

The ExIA presents an analysis of the situation relating to the use, control, emissions and impacts of mercury and its compounds, identifies the main policy options that have been considered in the context of the strategy, and assesses these options in terms of their environmental, social and economic impacts.

## 1.2. The policy context for the development of the mercury strategy

### *1.2.1. The Community policy context*

The largest present user of mercury in the EU is the chlor-alkali industry. However, the use of mercury in this industry sector is being phased out as "mercury cell" technology is replaced with mercury-free processes. At the Environment Council meeting of 7 June 2001, the Council called upon the Commission to clarify the legal situation regarding the conversion of the chlor-alkali industry, identify the possible consequences for the use of mercury and report to the Council on the potential need for co-ordinated action in the EU and the accession countries.

In response to the Council's request, in December 2002 the Commission presented a report to the Council concerning mercury from the chlor-alkali industry[1]. This reviewed mercury production and use generally, use of mercury in the chlor-alkali industry, legal issues concerning the conversion to mercury-free technology and consequences of the mercury cell phase-out. In relation to the consequences of the mercury cell phase-out, the report analysed three scenarios concerning the fate of the then estimated 12-15 thousand tonnes of surplus mercury expected to arise in the EU.[2] These were:

- Reuse – for example within the chlor-alkali industry or by placing the mercury on the market;
- Intermediate storage – for an unspecified period of time until a strategy for reuse and/or safe disposal is available; and
- Definitive storage – effectively to achieve final disposal of the surplus mercury.

The Council reacted to the report by inviting the Commission to present "a coherent strategy, based, inter alia, on its report to Council (COM (2002) 489), with measures

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1 COM (2002) 489 final, 6.9.2002.
2 The amount remaining in operation is now estimated by Euro Chlor at 11,600 tonnes.

to protect human health and the environment from the release of mercury based on a life-cycle approach, taking into account production, use, waste treatment and emissions".

Hence it can be seen that the origin of the development of the mercury strategy lies in consideration of the use of mercury in the chlor-alkali industry. However, the strategy does not focus only on this industry, but rather looks at all aspects of the mercury cycle.

### *1.2.2. The international policy context*

In view of the global and transboundary nature of the mercury problem, significant action has been taken at the international level. In particular, considerable work has been undertaken under the auspices of UNEP Chemicals, which in December 2002 published its comprehensive "Global Mercury Assessment" (UNEP Chemicals, 2002). The UNEP Governing Council concluded, through decision 22/4 V at its 22$^{nd}$ session in February 2003, after considering the key findings of the Global Mercury Assessment report, that there is sufficient evidence of significant global adverse impacts from mercury to warrant further international action to reduce the risks to humans and wildlife from the release of mercury to the environment. The Governing Council decided that national, regional and global actions should be initiated as soon as possible and urged all countries to adopt goals and take actions, as appropriate, to identify populations at risk and to reduce human-generated releases.

The Governing Council also requested UNEP, in cooperation and consultation with other appropriate organisations, to facilitate and conduct technical assistance and capacity building activities to support the efforts of countries to take action on mercury pollution. In response to this request, UNEP has established a mercury programme[3] within UNEP Chemicals. This is coordinating a range of awareness-raising and capacity building efforts, for example the organisation of workshops in developing countries and economies in transition.

As further follow-up to the Global Mercury Assessment, in February 2004 UNEP Chemicals requested views from governments and other organisations on possible next steps for global action on mercury. Responses will provide a basis for discussion at the 2005 UNEP Governing Council meeting.

Beyond the UNEP mercury programme, there are a range of other relevant regional and global agreements, instruments, organisations and programmes tackling aspects of the mercury problem. A brief review of some of the main initiatives is given in Annex 1. More details are provided elsewhere, for example in the UNEP Global Mercury Assessment. Particularly notable in this regard are the Heavy Metals Protocol of the UNECE Convention on Long Range Transboundary Air Pollution (CLRTAP), and the GEF/UNDP/UNIDO Global Mercury Project which is addressing the problems of mercury used in artisanal gold mining.

3 http://www.chem.unep.ch/mercury/mercury%20programme.htm.

## 2. WHAT PROBLEM IS THE MERCURY STRATEGY EXPECTED TO TACKLE?

### 2.1 What is the mercury problem?

The extent of the mercury problem has been described in detail in other recent documents, such as the UNEP Global Mercury Assessment, and in work carried out by an independent expert group considering mercury in relation to Community air quality legislation (Pirrone et al, 2001). Annex 2 presents an overview of these issues and is largely based on these sources, plus others where noted. It considers sources and cycling of mercury in the environment, the effects of mercury on health and the environment, levels of mercury in the EU and around the world, and the transboundary nature of mercury pollution. Key points are summarised below.

Mercury is released by both natural and anthropogenic sources. Past releases have created a "global pool" of mercury in the environment, part of which is continuously mobilised, deposited on land and water and remobilised. The anthropogenic component of mercury deposition in Europe considerably exceeds the natural one.

Mercury and its compounds are highly toxic to humans, ecosystems and wildlife. Initially seen as an acute and local problem, mercury pollution is now also understood to be global, diffuse and chronic. High doses can be fatal to humans, but even relatively low doses can have serious adverse neurodevelopmental impacts, and have recently been linked with possible harmful effects on the cardiovascular, immune and reproductive systems. Mercury also retards microbiological activity in soil, and is a priority hazardous substance under the Water Framework Directive[4].

Mercury is persistent and can change in the environment into methylmercury, the most toxic form. Methylmercury readily passes both the placental barrier and the blood-brain barrier, inhibiting potential mental development even before birth. Hence exposure of women of child-bearing age and children is of greatest concern.

The largest source of mercury exposure for most people in developed countries is inhalation of mercury vapour from dental amalgam. Exposure to methylmercury mostly occurs via diet. Methylmercury collects and concentrates especially in the aquatic food chain, making populations with a high intake of fish and seafood particularly vulnerable.

Most people in central and northern Europe show bioindicators of exposure below the international "Provisional Tolerable Weekly Intake" (PTWI) for methylmercury (1.6 µg/kg body weight/week), and a lower US "Reference Dose" (RfD) (0.7 µg/kg body weight/week). However, most people in coastal areas of Mediterranean countries, and around 1-5% of the population in central and northern Europe (i.e. something around 3-15 million people in the EU), are around the RfD. In addition, large numbers of the Arctic population and Mediterranean fishing communities are above the US "Benchmark Dose Limit" (BMDL) of 10 times the RfD – the level at which it is accepted there are clear neurological effects. Some studies have suggested

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[4] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, OJ L 327, 22.12.2000, as amended by Decision 2001/2455/EC of the European Parliament and of the Council of 20 November 2001 establishing the list of priority substances in the field of water policy, OJ L 331, 15.12.2001.

that each doubling of prenatal exposure, starting from around the RfD, leads to a loss in IQ of about 1.5 point, which implies that prenatal exposure around the BMDL would equate to an IQ loss of about 6 points. Yet higher mercury exposures are seen in other parts of the world, especially in countries where mercury is used in artisanal gold mining. Recent data suggests that there may be impacts of exposure even below the RfD.

## 2.2 The mercury cycle

The problems associated with mercury can be addressed at various points in the "mercury cycle"[5]:

- Production and supply of mercury
- Trade in mercury
- Use of mercury in products and processes
- Emissions of mercury
- Recycling or disposal of mercury
- Controlling mercury exposure.

Annex 3 considers in detail each stage of the mercury cycle in turn. It includes a summary table setting out what aspects of the mercury cycle will be addressed by the implementation of the present and already planned Community legislation and policies (i.e. ahead of any additional action decided to be taken under the mercury strategy), and what aspects will remain. Key points are summarised below.

There are four main sources of mercury supply: primary production (mercury mining); secondary production (where mercury is a by-product, for example in zinc production); recycling (from fluorescent lamps, etc.); and reuse of surpluses (for example from the chlor-alkali industry). Total global supply presently stands at somewhere around 3,600-3,700 tonnes of mercury per year.

The main global supplier is the Spanish state-owned firm MAYASA (Miñas de Almadén y Arrayanes, S.A.). Under an agreement made in 2001, MAYASA buys the EU chlor-alkali sector's surplus mercury for resale. MAYASA also sells mercury that it has made from ore mined in Almadén, Spain, the site of the largest and historically most important mercury deposits in the world. Mercury production in Almadén peaked at around 2,800 tonnes in 1941, but has since fallen as the market has declined, and recently as the chlor-alkali industry has provided an alternative source. New production was reported as 523, 727 and 745 tonnes in 2001, 2002 and 2003 respectively, with total supply of around 1,000 tonnes in each case. According to MAYASA, extraction of ore stopped in June 2001, and production of mercury (from stockpiled ore) stopped in July 2003. Both of these stops are said to be

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5 This is a cycle in a policy sense rather than in an envirogeochemical sense, as it considers points where control actions can be considered.

temporary although neither activity has yet restarted. The other main countries that produce mercury are Kyrgyzstan, Algeria and China.

Mercury is traded freely on the world market. The EU is the major global exporter, principally as a result of the mercury produced in Almadén, and recently because of the resale of surplus mercury from the chlor-alkali industry, coupled with low internal demand for mercury. The price of mercury has fallen dramatically since its peak in the 1960s, standing relatively stably at around €5 per kilogramme for most of the past decade. This low price makes the continued use of mercury attractive outside Europe in applications such as artisanal gold mining. This particular use is often illegal, but nevertheless widespread, as mercury can be imported for a stated legal purpose and then diverted to mining.

Demand for mercury stands at somewhere around 3,600-3,700 tonnes per year globally (i.e. absorbing supply) and around 300 tonnes in the EU. The main global uses, accounting for over 75%, are artisanal gold mining, batteries and the chlor-alkali industry. Of these, only the chlor-alkali industry remains a significant user in the EU, and here the mercury cell process is being phased out. The next most significant use in the EU is in dental amalgam, in respect of which Community legislation on waste management applies. Among other major product groups, Community legislation already covers lighting and other electrical equipment. The main product group not covered by Community legislation is measuring and control equipment.

The main source of emissions of mercury is the burning of coal, both globally and in the EU. Coal burning in large combustion plants (but not smaller plants or households) is covered by Community legislation, as are some of the other major industrial sources such as the metals, cement and chemical industries. Crematoria are another relatively significant source of emissions. They are not covered by any Community legislation although there is a Recommendation on cremation that applies to parties to the OSPAR Convention.

From a human health point of view, exposure to methylmercury via diet is the main problem. Community legislation already sets limits on the mercury content of fish which may be brought to the market. Occupational exposure levels for mercury are also under consideration.

### 2.3 What are the risks inherent in the initial situation?

The fundamental problem in the initial situation is that certain population groups – and especially women of child-bearing age and children – are subject to unacceptable levels of exposure to mercury, principally in the form of methylmercury through diet. This presents a risk of negative impacts on health, in particular affecting the nervous system and diminishing intellectual capacity. There are also environmental risks, for example the disturbance of microbiological activity in soils and harm to wildlife populations.

Some aspects of the mercury problem are already declining. For example, intentional use of mercury has dropped substantially in the EU in recent decades, and is continuing to fall due to the significant body of Community legislation already in place. Global use is also declining, although it remains relatively high, with significant uses persisting, some of which are highly emissive. Global emissions may still be rising, and grew about 20% from 1990-2000. European emissions fell by about 60% over the same period, although Europe as a whole remains a net "exporter" of transboundary mercury pollution (i.e. there is more deposition outside Europe as a result of European emissions than deposition within Europe as a result of emissions in other regions).

The consequence of these continued mercury uses, and particularly emissions, is further additions to the "global pool". Moreover, even if uses and emissions of mercury were to stop instantly and entirely, the problem would only resolve itself slowly since the global pool is already there. Hence there is a significant body of mercury already released to the environment that can recirculate again and again, contaminating fish and causing other problems, until it at last reaches a long term sink. There is no prospect of an immediate solution to this problem.

All that can be done now, therefore, is to take action to reduce the amount of further mercury released to the global pool. However, it is not clear what precise level of further control, for example on use or emissions of mercury, is needed to address the mercury problem. For example, there is little scientific information that indicates how further cuts in mercury emissions would translate into, say, reduced levels of methylmercury in fish, or over what time period changes could be expected. Some such assessments have been made in Sweden, as outlined below.

**Analysis of the situation in Sweden**

Sweden is one of the EU Member States that has undertaken more extensive research on mercury issues. An analysis published in 1991 estimated that, in about 50% of the approximate 100,000 Swedish lakes, 1 kg pike contained mercury levels above 0.5 mg/kg wet weight (Lindquist et al, 1991). A more recent analysis has indicated that reductions in emissions and deposition have led to a general decrease of about 20% in mercury concentrations in fish in Sweden (Johansson et al, 2001). This illustrates the potential for intervention to bring successful results, but also the timescale needed for changes in emissions to translate into environmental outcomes. Moreover, the same analysis suggests that mercury deposition in some areas of Sweden still needs to decrease by a further 80% from 2000 levels to reduce the mercury content in fish to below 0.5 mg/kg, while also noting that 80% of deposition in southern Sweden originates from emissions in other countries.

The situation in Sweden is not necessarily representative of the EU as a whole. However, recent research has also supported the general conclusion that further reductions in mercury emissions are needed to protect sensitive ecosystems and to decrease levels of mercury in freshwater fish in Scandinavia and elsewhere (Pirrone et al, 2001).

## 2.4 Who is affected?

All individuals will be exposed to mercury to some degree. However, as already noted some groups are particularly vulnerable. High level fish consumers are more likely to be exposed to higher levels of methylmercury, and women who are pregnant, breastfeeding or thinking of becoming pregnant, and children, are most vulnerable to its effects. Artisanal miners may derive a benefit from using mercury to produce gold or silver. But at the same time, they, their families, their communities and others may be highly exposed to mercury released as a result of this activity. Indigenous peoples, particularly in the Artic, may be highly exposed to mercury, due to their consumption of traditional diets in which methylmercury bioaccumulates.

Producers and traders of mercury will derive income and employment from their activities. The same is true of users of mercury, such as chlor-alkali producers, and manufacturers of mercury-containing products. Some industrial or economic sectors, such as power generation, give rise to mercury emissions due to the natural mercury content of raw materials. Other sectors may be susceptible to the negative effects of mercury releases. For example, the fishing industry could be affected if levels of methylmercury affect the marketability of fish or consumer confidence.

## 3. WHAT MAIN OBJECTIVES IS THE MERCURY STRATEGY EXPECTED TO REACH?

### 3.1 What is the overall policy objective?

The overall objective presented to the Commission in the request from Council is:

*To present a coherent strategy, based, inter alia, on its report to Council (COM (2002) 489), with measures to protect human health and the environment from the release of mercury based on a life-cycle approach, taking into account production, use, waste treatment and emissions.*

A key long term aim is that levels of mercury in the environment will be reduced such that there is no longer any need for concern over methylmercury in fish. This will probably take decades, since the present levels of mercury in the environment are representative of past mercury emissions, and even without further emissions it would take some time for these levels to fall. The Community has already taken much action to reduce mercury emissions and uses, although some measures have not yet taken full effect. This does not mean that nothing more can be done, however, and this ExIA specifically assesses possible further policies. But it does mean that the scope for further action is limited, that the time period associated with the long term aim must be recognised, and that, in the meantime, it will be necessary to rely on interim protective measures such as fish consumption advisories.

This long term aim gives rise to a number of observations:

- There is a significant global dimension to the mercury problem. The mercury problem therefore cannot be solved by the EU acting alone. It is important to make progress at the global level.

- The most important need is to reduce anthropogenic mercury releases to the environment, either through measures relating directly to the control of emissions, or through measures at earlier stages of the mercury cycle such as supply and use.

- The largest proportion of mercury emissions is released to air, much of which is subject to long distance movement. European emissions to air, though a relatively small proportion of global emissions, remain the largest present contributor to European deposition. Hence, from a short term perspective, reducing EU emissions is the most important means of reducing EU deposition[6]. The implementation of the IPPC Directive[7], among other measures, will be particularly important in this regard.

- In the medium to long term, emissions in other regions are more significant. This is because emissions from outside Europe appear likely to grow relative to those within Europe. In addition, even where mercury emitted outside Europe is also first deposited outside Europe, subsequently it may be remobilised and recirculated as part of the "global pool". Hence it will be appropriate to consider what action can be taken to reduce global mercury emissions (including how internal action within the EU might affect the mercury situation internationally).

- Significant emissions result from the natural mercury contamination of raw materials, such as coal, rather than intentional use of mercury. Nevertheless, it will also be appropriate to consider what actions can be taken to reduce use of mercury in the EU and globally. The main basis for such action is to avoid consequent emissions, especially at the global level. More generally, cutting the use of mercury will help to reduce demand and therefore the global market for this substance.

- Given the declining use of mercury, and the large stocks of mercury in society that will eventually become surplus, the issue of the long term fate of surplus mercury needs to be addressed. A viable solution to this excess mercury must be found so that it does not re-enter the environment.

### 3.2 Has account been taken of any previously established objectives?

In preparing this ExIA, an exhaustive inventory has been produced covering all current and upcoming Community legislative and policy initiatives (ahead of any additional action decided to be added under the mercury strategy) that would have a bearing on mercury. This is shown in Annex 4, and has enabled the provisions and objectives of these measures, and any remaining significant gaps in addressing the mercury problem, to be taken into account in the ExIA and the mercury strategy.

## 4. WHAT ARE THE MAIN POLICY OPTIONS AVAILABLE TO REACH THE OBJECTIVE?

### 4.1 What is the basic approach to reach the objective?

The basic approach is twofold:

- To assess what additional, specific measures might be taken in the near term.

- To provide a strategic framework within which measures to address the mercury problem can be taken over the longer term.

6 Note, however, that this will only partly correlate to the long term aim relating to levels of methylmercury in fish, since some of the fish consumed in Europe will be from waters outside Europe.

7 Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control, OJ L 257, 10.10.96.

This ExIA is principally concerned with the first of these areas, since this provides a basis for a relatively concrete and specific assessment. Nevertheless, the approach adopted by the ExIA in terms of methodology, principles, etc. should equally be applicable to any future assessments under the mercury strategy.

The approach to considering what additional measures might be taken in the near term has been to review the various stages of the mercury cycle, and to consider what aspects of the problem will be addressed by the implementation of the present and already planned Community legislation and policies, and what aspects will remain. This is presented in detail in Annex 3. On the basis of this assessment, the most significant issues selected for more detailed assessment in this ExIA are:

- Supply of raw mercury – potentially including the surplus mercury from the chlor-alkali industry – and trade. This is because the EU is the largest net exporter of raw mercury, and a continued oversupply and low price are significant drivers for ongoing and potentially new uses. The surplus mercury from the chlor-alkali industry provides a significant source which could, if not handled in a safe and sustainable way, be associated with considerable environmental damage in the EU, future Member States and third countries.

- Measuring equipment – the largest mercury-using product group in the EU not covered by current Community legislation. Some measuring and monitoring equipment is due to be considered under Directive 2002/95[8], but this would not include some of the more significant mercury-using products, such as thermometers, since Directive 2002/95 only covers electrical and electronic equipment.

- Coal combustion – the largest source of mercury emissions in the EU and globally.

- Cremation – although this is not an especially large source of emissions in relative terms, it is significant in some countries, and unlike the main industrial emissions it is not subject to any Community legislation. Moreover, the estimated 1,300-2,200 tonnes of mercury in fillings in EU and EFTA states (Hylander and Meili, 2003) is the largest reservoir of mercury in society behind the chlor-alkali industry, highlighting the possibility of significant total emissions over a period of many years.

### 4.2 Which policy options have been considered?

For the key issues identified above, the corresponding policy options assessed in this ExIA are as shown in Table 1.

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8 Directive 2002/95/EC of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment, OJ L 37, 13.2.2003.

**Table 1 – Policy options**

| Key Issue | Policy Options |
|---|---|
| Supply and trade of raw mercury, including the fate of surplus mercury from the chlor-alkali industry | No additional action<br>Addition of mercury to the Prior Informed Consent (PIC) list under the Rotterdam Convention<br>Stopping primary mercury production<br>Stopping mercury export<br>Temporary storage of mercury from the chlor-alkali industry<br>Permanent disposal of mercury from the chlor-alkali industry |
| Measuring equipment | No additional action<br>Marketing and use restriction |
| Mercury emissions from coal combustion | No additional action<br>Additional Community regulatory action to limit mercury emissions from coal combustion > 50 $MW_{th}$<br>Additional Community action via a market-based instrument to limit mercury emissions from coal combustion > 50 $MW_{th}$ |
| Cremation | No additional action<br>Additional Community regulation<br>Stimulate the market to regulate via standardisation |

### 4.3 Which options have not been considered?

The mercury problem has many different facets. While the overall assessment of the problem is a broad one, therefore, the assessment of impacts that follows only examines selected issues. This is because of the need to adequately assess priority issues at this stage, as outlined above, rather than to assess every possible option in less detail. Hence things already covered by Community legislation generally have not been revisited (coal burning > 50 $MW_{th}$ is an exception as it is such a significant source of mercury), and nor were less significant uses or emissions assessed in detail. In addition, some issues – such as use of mercury in dental amalgam, and small scale coal burning – were not assessed in this ExIA because there is not sufficient data or consensus on the availability of policy options, at this time, to make such assessment fruitful. However, these are both important issues which will be considered further as part of the mercury strategy.

The ExIA also concentrates on the "hard" measures that would have direct and relatively predictable impact in the EU. The strategy itself also includes "softer" measures such as promoting research on aspects of the mercury problem, and reduction of mercury use and emissions in third countries through bilateral means.

## 5. WHAT ARE THE IMPACTS – POSITIVE AND NEGATIVE – EXPECTED FROM THE DIFFERENT OPTIONS IDENTIFIED?

### 5.1 What kind of benefits can be expected?

The key, long term benefit of reducing mercury emissions will be decreased levels of mercury in the environment. This, in turn, will lead to lower levels of human exposure to mercury, including methylmercury in fish, with resultant health benefits. It will also reduce the impacts of mercury on soils and biodiversity.

Some additional potential benefits, which can be noted in general terms, are:

- Protection of food sources. Fish is a valuable part of the diet. Reducing mercury in the environment will reduce or avoid the need for people to limit their fish consumption.

- Protection of fishing, tourism and leisure interests. The fishing industry will be affected if fish sources contain such levels of methylmercury that they cannot be brought to the market. Areas relying in part on angling to promote tourism and leisure may be similarly affected. Reducing mercury releases will help to lessen or avoid such problems.

- Protection of indigenous communities and traditional lifestyles. Certain indigenous communities, for example in the Arctic, are particularly vulnerable to mercury due to high levels of deposition (even though they use and emit virtually no mercury) and accumulation in their traditional foods. Reducing mercury emissions will therefore protect these peoples and their traditional lifestyles.

### 5.2 How benefits are assessed

Some previous attempts have been made at valuing in monetary terms the benefits of preventing mercury emissions and pollution. These are summarised in Annex 5. However, it is evident that there are a number of difficulties and discrepancies in the valuation efforts. As a result, there does not appear to be an adequate basis to monetise the costs of mercury pollution for the purposes of this ExIA.

In the absence of monetisation it is nevertheless important to have some idea of the potential benefit of the various options assessed. The principal measure is the effect on mercury emissions. Depending on the data available, this may be stated in qualitative terms (e.g. a large reduction) or, more preferably, in quantitative terms.

A second measure is the effect on mercury use. It should be noted that there is a strong preference for understanding how changes in the level of use will affect levels of emissions, since this is what ultimately affects the environment. Nevertheless, as a secondary measure the effect of a policy on the use of mercury is itself useful, since it provides an indication of the extent to which demand can be cut.

A third measure is the effect on global mercury supply and price. A cut in global supply and a rise in the price of mercury are both seen as desirable to create incentives to use less mercury and to handle it more carefully. The potential effect of a measure on supply can be quantified by mass, while the potential effect on price is harder to predict and realistically can only be estimated in broad, qualitative terms.

# 6. IMPACTS OF OPTIONS RELATIONG TO MERCURY SUPPLY AND TRADE, INCLUDING THE FATE OF SURPLUS MERCURY FROM THE CHLOR-ALKALI INDUSTRY

## 6.1 Description of the options

### *6.1.1 No additional action*

No constraints would be introduced on mercury supply and trade. Mercury production could restart in Almadén, and potentially also in other EU locations (although this seems unlikely given current and foreseeable market conditions). Surplus mercury from the chlor-alkali industry would be returned to the market, and for the purposes of this option it is assumed that this would take place under the agreement between MAYASA and the European chlor-alkali industry described previously. The supply of chlor-alkali surplus mercury would therefore replace the production of new mercury. Raw mercury could be exported from the EU without restriction.

### *6.1.2 Addition of mercury to the PIC list under the Rotterdam Convention*

Metallic mercury would be added to the list of substances covered under the Prior Informed Consent (PIC) procedure of the Rotterdam Convention. This would seek to make international mercury trade more transparent, and potential importers more informed about the impacts of mercury, without introducing any general restrictions.

Under the procedure established for adding a chemical to the PIC list, two parties to the Convention from two different geographical regions would have to notify regulatory actions banning or severely restricting the chemical in order to protect human health and/or the environment. Another party to the Convention from another geographical region would therefore have to notify mercury as well as the EU. Once two such notifications were received, a chemical review committee would consider whether the criteria for PIC listing were met. If the committee were so satisfied, it would prepare a recommendation as the basis for a final decision by the conference of the parties to the Convention.

### *6.1.3 Stopping primary mercury production*

The current temporary stoppage of primary production of mercury at Almadén would be made permanent. Production and supply from other methods and sources – i.e. secondary production, recycling and surpluses from the chlor-alkali industry – would continue. Export of mercury from the EU would also continue.

This option could be pursued via legal action or other means. If legal action were favoured to implement this option, the Community would be competent to adopt this kind of general ban on production of a substance for environmental reasons. The legal basis could be either Article 95 or 175 of the EC Treaty. Article 95 would seem more relevant as a market for mercury does still exist in Europe (there is trade/movement between Member States). In such a case a ban on primary production of mercury would be a measure influencing the functioning of the internal market, even if there is presently only one company producing primary mercury in Europe. Article 175 would be more relevant if there were no real demand for mercury and the ban could be considered as a purely environmental measure.

#### 6.1.4 *Stopping mercury export*

The export of metallic mercury from the EU would stop. This could be achieved by amending Regulation 304/2003[9] concerning the export and import of dangerous chemicals, so as to add metallic mercury to Annex V of this Regulation, which already prohibits the export of cosmetic soaps containing mercury. Export prohibitions are generally prohibited under the GATT, but are allowed where necessary to protect human, animal or plant life or health. The Commission believes that a mercury export ban would therefore be compatible with the GATT rules, given the toxic nature of mercury.

As a consequence of this option, primary production in the EU would almost certainly end too (even if no explicit action were taken to achieve this), since the level of use of mercury in the EU is much lower than current production levels. Similarly, most if not all of the surplus mercury from the chlor-alkali industry would need to be stored or disposed of, since the demand for mercury in the EU would be much less than the potential supply from this source.

#### 6.1.5 *Temporary storage of mercury from the chlor-alkali industry*

Surplus mercury from the chlor-alkali industry would not be returned to the market, but would be subject to temporary storage. This option could be achieved by legal means (under Article 175 of the EC Treaty) or other means (for example, an agreement with the chlor-alkali industry). It would be similar to the situation in the USA, where raw mercury is being stored in liquid form in sealed flasks in above-ground warehouses. Note, however, that this policy in the USA applies to Government-owned mercury, not that held privately by the chlor-alkali industry. If the storage option were pursued in the EU, it could be above or below ground[10], and in one, few or many locations.

If the surplus mercury were considered “waste”[11], then its storage would appear to constitute a landfill for the purposes of Directive 1991/31[12]. A policy in favour of storage would therefore require an amendment to Article 5(3)(a) of this Directive, which presently prohibits the acceptance of liquid waste in a landfill.

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9 Regulation (EC) No. 304/2003 of the European Parliament and of the Council of 28 January 2003 concerning the export and import of dangerous chemicals, OJ L 63, 6.3.2003.

10 For example, Germany is examining the idea of storing metallic mercury in disused salt mines.

11 For a discussion of this issue, see COM (2002) 489 final, 6.9.2002.

12 Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste, OJ L 182, 16.7.99.

### *6.1.6 Permanent disposal of mercury from the chlor-alkali industry*

This option would be similar to the previous option except that the mercury would be converted into a different form and disposed of permanently. In other words, while the previous option would present an ongoing management requirement for the storage facility, the permanent disposal option would aim to place the mercury out of normal human reach. An example is the approach advocated by Sweden, which would involve processing mercury into sulphide and disposing of it in a deep bedrock depository (Naturvårdsverket, 2003a). If the permanent disposal option were pursued in the EU, different approaches could be considered and disposal undertaken at one, few or many sites.

## 6.2 A context for the assessment of impacts

Before considering the impacts of each option individually, it is possible to provide a context for such assessment, by looking at questions of supply and demand and by considering whether the available mercury supply choices can be placed in some sort of hierarchy. These issues are examined in detail in Annex 6. Key points are summarised below.

In relation to supply choices, it seems clear that secondary production, recycling and reuse of surpluses from the chlor-alkali industry should be favoured over primary production. This is because primary production puts new mercury into circulation, and also appears to generate quite high levels of emissions.

Of the other three sources, only secondary production also puts new mercury into circulation, but this is to avoid the mercury from going to waste disposal or contaminating another product. Judging between these other three sources depends on a long term view of supply and demand. If there is no reasonable expectation that supply will exceed demand to such an extent that storage or disposal will become necessary, then there would seem to be good reason to use surpluses, although this could inhibit recycling and secondary production. But if there is such a reasonable expectation, then reusing the chlor-alkali industry surpluses would involve the release into society of the most readily manageable mercury reservoirs, from where future recapture might be extremely expensive if not impossible.

In relation to demand, Annex 6 identifies a “no additional action” global demand for mercury of around 1,700 tonnes in 2020, compared to an estimate of around 3,675 in 2003. However, given the growing global concern about mercury, and the possibilities for significant cuts in use that could be made in a number of areas under a more purposeful demand reduction effort, it is considered that a greater decrease should be pursued. That is to say, it would not be appropriate to simply predict future demand under a continuation of current trends and then assess how to meet it. Rather, efforts should be made to manage demand downwards, such that supply considerations can take account of the potential outcome of such efforts.

Reductions of demand to around 2,400 tonnes in 2010, 1,650 tonnes in 2015 and 1,000 tonnes in 2020 are believed to be reasonably achievable at an acceptable cost, and certainly are not the most ambitious reductions that could be pursued. With these figures, demand could be met with some excess by a combination of secondary production, recycling and reuse of surpluses even as early as 2010. By 2015 secondary production and recycling alone could meet the predicted demand, and by 2020 even these sources, if continued at present levels, would be generating large surpluses.

## 6.3 Environmental impacts

### *6.3.1 No additional action*

The possible resumption of mercury mining and primary production in the EU would bring new mercury into circulation, and also would generate emissions at the site of production. If production at Almadén were on average 275 tonnes per year[13], then the direct emission to air would be of the order of 2 tonnes per year. Surplus mercury from the chlor-alkali industry would be recirculated into society. The EU would remain the dominant global mercury supplier, and the continued high level of supply would keep prices low (and possibly reduce them further) and stimulate demand. The likely result would be increased consumption and emissions, compared to other options, although this cannot be quantified. It seems inevitable that some of the mercury would find its way to illegal and poorly controlled applications with high levels of emissions.

### *6.3.2 Addition of mercury to the PIC list under the Rotterdam Convention*

The inclusion of metallic mercury under the PIC procedure could be expected to achieve some reduction in mercury use and therefore emissions. This cannot be quantified, but would probably be of a moderate order of magnitude. A very large impact could not be expected, because under this option mercury production, supply and export could remain broadly as in the previous option, i.e. no general restrictions would be introduced. The main difference is that importing countries would be more informed about the impacts of mercury and could refuse import consent. This should reduce supply and use, with a knock-on effect on emissions.

The advantage of this option is that it would operate at an international level, affecting exports from and to those countries that are parties to the Rotterdam Convention, of which there are 78 at present, rather than just mercury supply from the EU. Of the two other main nations that produce mercury for export, Kyrgyzstan has ratified the Convention and Algeria is not a signatory. Many of the countries where artisanal mining takes place have not signed or ratified the Convention. The success of the PIC scheme is also dependent in part on importing countries giving import responses, which only occurs in about 50% of cases at present. Hence it would be appropriate to support a wider and more effective application of the PIC process in order to maximise the effectiveness of this option.

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13 Although mining and production in Almadén have temporarily stopped, there is at present no commitment that such activities will not restart. Moreover, MAYASA has indicated that it currently works on the assumption of supplying about 1,000 tonnes of mercury to the market per year. If it is conservatively assumed that the remaining 11,600 tonnes of mercury in the chlor-alkali industry is decommissioned over 16 years, i.e. by 2020, this will supply about 725 tonnes of mercury per year on average. Once current stockpiles in Almadén are exhausted, therefore, new production in Almadén could recommence in order to maintain a continued supply of 1,000 tonnes per year.

Note that for the EU, Regulation 304/2003 goes further than the Rotterdam Convention which it implements. The Regulation requires exports of PIC substances to have the explicit consent of the importing country, whereas under the Convention alone exports would, after a period of time, be permitted to a country that has failed to communicate an import decision. This requirement of Regulation 304/2003 extends to all countries, irrespective of whether or not they are parties to the Convention. However, mercury could still receive import consent for a purportedly legal purpose, and then be diverted to an illegal one such as artisanal gold mining. In addition, mercury could be exported from the EU to another country in accordance with the controls of Regulation 304/2003, and then could be re-exported to a third country without consent.

### *6.3.3 Stopping primary mercury production*

If the EU is considered in isolation, the benefit of stopping primary production is quite clear. Less new mercury would be put into circulation, and emissions from production would be avoided. However, when one considers the global situation the position is more complex. In particular, there is a risk that the gap in the mercury market left by stopping production in the EU would be filled by other producers increasing their supply. If this were the case, there would still be the benefit of the EU providing a visible commitment to addressing the global mercury problem, but the immediate environmental benefit would be reduced. It is therefore necessary to attempt to gauge the extent to which this might happen.

Given recent production figures at Almadén (over 700 tonnes in each of 2002 and 2003), it is apparent that permanently stopping production would seriously decrease (at least in the near term) the mercury supply. This would raise the market price, on the one hand discouraging use, but on the other encouraging new production.

The other main nations that produce mercury for export are Algeria and Kyrgyzstan. There will be some differences between the main current destinations of mercury from these countries compared to that from Almadén. Nevertheless, analysis has found that the mercury market is reasonably efficient, matching suppliers with sellers worldwide (Maxson, 2004b). Hence present trading patterns are not assumed to provide a significant constraint on the potential for other suppliers to fill the gap that would result from stopping EU production.

Mine capacity in Algeria is given as 450 tonnes per year, which suggests some increase in output from current levels (120-320 tonnes) is possible. Additional reserves are reportedly located in the same region. However, it is difficult to imagine a much greater level of production without a serious government investment in operations and management, which seems unlikely in view of competing, and probably more profitable, alternative investments in Algerian resource development, such as hydrocarbons.

The Khaidarkan mining complex in Kyrgyzstan produces mercury using raw material from its own mines and from Russia and Tajikistan. Recent production has been around 600 tonnes per year. Production capacity has been reported at up to 1,000 tonnes per year, which suggests a reasonably significant potential to increase production. However, for a variety of reported reasons – including recent difficulties with flooding and maintenance, complex mining conditions, potential exhaustion of the higher quality ore reserves, and tension over mercury production with neighbouring Uzbekistan[14] – a real increase in production up to this capacity figure seems unlikely. An attempt to privatise the complex in August 2003 failed due to lack of interest from investors.

Overall, it appears that production in Algeria and Kyrgyzstan could rise in response to a permanent halt in production in Almadén, but probably not very quickly, and also not sufficiently – at least in the short term – to match recent years' production at Almadén. Note also that the mining operations in both Algeria and Kyrgyzstan are government-owned and subsidised, and so would not necessarily react in a normal market-based way in any case.

At best, therefore, permanently stopping production at Almadén would achieve a net cut in global supply, a rise in mercury prices and a fall in the amount of new mercury entering circulation. Support for this conclusion is provided by the significant and rapid rise in the market price of mercury, from around US $200/flask at the start of 2004 to around $500/flask by September 2004. This was reportedly due to a serious undersupply brought about by the temporary production halt in Almadén, coupled with flooding in Kyrgyzstan and shipment delays in Algeria (Hayes, 2004).

At the same time, it is reasonable to expect that a cut in supply would encourage other producers to gradually enter the fray, reactivating mines that have long been closed, searching out alternative mercury sources, re-establishing supply lines, etc. However, it is anticipated that much of such production increases would result from producers collecting and producing more mercury wastes in order to recover the mercury content, or producing more mercury as a secondary product, effectively decreasing the quantities of mercury in landfills and mine tailings.

Even if the Almadén supply were eventually totally replaced by other sources, stopping primary production in the EU could have a major impact on global debate and action concerning mercury. For example, as noted earlier there is significant scope for uses and emissions of mercury to be reduced in other parts of the world, as shown by many years of improved performance in the EU. However, it would be very difficult for the EU to be credible in promoting action to limit mercury use and emissions in other regions, if in parallel it were to remain the world's major mercury producer and supplier.

#### 6.3.4 *Stopping mercury export*

Stopping mercury export would cut the supply to the global market in the short term by about a thousand tonnes per year. This ought to have a significant impact on prices, and therefore also some effect on demand and emissions. The GEF/UNDP/UNIDO Global Mercury Project has strongly advocated an EU export ban as an effective way of reducing mercury demand in artisanal gold mining.

As a consequence of this option, it is assumed that primary production in the EU would not restart – due to lack of internal demand – with impacts as discussed in the

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[14] See for example Bogdetsky (2001), Kyrgyzstan Development Gateway (http:///eng.gateway.kg/mercury) and Kyrgyzstan Daily Digest (http://www.eurasianet.org/resource/kyrgyzstan/hypermail/200203/0039.shtml).

previous section. Similarly, most if not all of the surplus mercury from the chlor-alkali industry would need to be stored or disposed of, with impacts as discussed in the two following sections.

This option would again raise the possibility of replacement sources filling the gap left by the EU's action. However, as this option would apply to all sources of mercury, rather than just primary mercury, the amount withdrawn from the market would be yet larger, so the possibility of it all being replaced would be smaller.

Stopping all exports might also have some negative environmental effect. In particular, as the use of mercury is so low in the EU (300 tonnes and falling), and some of that mercury will be in products imported from outside the EU, it seems unlikely that the present levels of recycled and secondary mercury in the EU could continue to find market outlets. Hence there is a risk that more mercury would go to waste disposal, possibly leading to some increased release to the environment. However, waste management requirements would limit the potential for harm. The impact would also depend on whether recycling and secondary production take place only because there is a market, or would continue even if there were no such market (as in the Netherlands, for example).

#### 6.3.5 *Temporary storage of mercury from the chlor-alkali industry*

It is assumed that this option, and the following option concerning permanent disposal, would only be pursued on top of the option of permanently stopping primary production. This is because it would be environmentally and economically illogical to carry on producing new mercury for use in products and processes while at the same withholding the potential supply of mercury from the chlor-alkali industry.

Temporary storage of the surplus mercury would mean that, on average, 725 tonnes of mercury per year (or more depending on Member States implementation of the IPPC Directive) would be withheld from the market. Coupled with stopping new production at Almadén, the reduction would be about 1,000 tonnes per year. The issue of mercury from other sources filling the gap, already discussed, would again arise.

The environmental impact of the temporary storage itself could be expected to be negligible. In the USA, for example, 4,436 tonnes of surplus mercury is currently stored in liquid form, in steel flasks in enclosed warehouses at four sites. The US Defense Logistics Agency (DLA) has recently finalised an Environmental Impact Statement that compares the options of maintaining this arrangement, consolidating the mercury for storage at one site, or selling it on the market (DLA, 2004). Both of the storage alternatives were assessed as having negligible human health and ecological risks, considering both routine operations and the risk of facility accidents. The consolidated storage option was seen as presenting slightly higher (but still low and short term) risk, connected with transporting the mercury. For the purposes of this assessment for the EU, however, the option of storage is being considered as an alternative to resale of the mercury, such that transport would be required in either case. Hence this option presents no additional risk in terms of transport.

A concern with temporary storage is that there is a possibility that the storage facilities might be neglected or damaged in the future. However, the DLA assessment assessed the risks over a 40 year period, from a variety of accident scenarios such as fires, earthquakes, vehicle and aircraft crashes, etc., to be negligible.

### *6.3.6 Permanent disposal of mercury from the chlor-alkali industry*

The impact of this option on market supply would be identical to that of the previous option.

The environmental impact of the disposal operation itself would depend on the nature and location of the operation. Sweden, for example, has developed the idea of a deep bedrock depository which would isolate mercury from the biosphere for more than 1,000 years. The disposal would be preceded by the conversion of metallic mercury into highly insoluble mercury sulphide. The Swedish analysis notes that such conversion may be a highly complicated process, however, which may give rise to occupational health and safety problems, and difficulties in limiting process emissions and wastes (Naturvårdsverket, 2003a). The scale of such impacts was not quantified.

The advantage of this option relative to temporary storage is that it eliminates the possibility of the mercury escaping into the environment as a result of neglect or accidents at a storage facility. But a disadvantage is that it would intentionally put the mercury outside human control, and when considering the long term, it might not be entirely predictable what might happen to the mercury as a result of natural processes.

A final comment is that while mercury demand is now declining, we cannot be 100% certain that some future discovery might not suggest a new and valuable use. In such a scenario, if the surplus mercury had been permanently disposed of it would be necessary to generate new mercury for such new uses, whereas if it had merely been stored no such production would be required.

## 6.4 Economic impacts

### *6.4.1 No additional action*

Based on the relatively stable price of mercury of around €5/kg seen over most of the past decade (see Annex 3), the EU's supply of raw mercury onto the global market would have a value around €5 million per year. Chlor-alkali producers would receive some modest income from selling their surplus mercury to MAYASA. The total stock of 11,600 tonnes would be worth about €58 m at a market price of €5/kg, so if sold to MAYASA at 30-50% of this price (the band specified in the agreement with the chlor-alkali industry) it would fetch about €17-29 million. If averaged over 16 years this would be an income of around €1-2 million, which is around €20-40 thousand per plant. In comparison, the total conversion cost for the EU chlor-alkali industry to move away from mercury cells has been estimated by Euro Chlor at €3.1 billion.

MAYASA would derive some income by selling the surplus mercury – around € 29-41 million at a market price of €5/kg, less transaction and operating costs. Averaged over 16 years this would equate to about €2-2.5 million per year.

In parallel, any resumption of new mercury production by MAYASA would also have an economic impact. If, on average, it is assumed that MAYASA were to produce 275 tonnes of new mercury per year, this would have a value of about €1.4 million. However, the overall economic benefit will be less, and possibly negative, since the costs of production must be subtracted.

An analysis in 2001 stated that mining in Almadén operated at a loss every year from 1986 to 1997 (Ortega and Díez, 2001). The state reportedly contributed about US $150 million to sustain the company's activities over this period, of which about $60 million corresponded to direct subsidies for mineral exploitation and the remainder was losses assumed by the state.

More recently, the Spanish authorities and MAYASA have indicated that mercury production itself is not subsidised, but rather that subsidies are provided to develop alternative lines of business in Almadén. However, no specific data have been provided, and given the recent state of the global mercury market and the closure of private mines, it seems evident that the economic viability of large scale mercury mining and production is doubtful. Recent figures indicate that MAYASA was unprofitable across the totality of its business sectors in 2000, 2001, 2002 and 2003 (specific data for mercury production/trade versus other business sectors are not available), as shown in Table 2.

**Table 2 – Operating revenue/turnover and pre-tax losses at MAYASA, 2000-2002 (Source: Amadeus database, Amadeus.bvdep.com)**

| Year | Operating revenue/turnover € | Loss before tax € |
|---|---|---|
| 2003 | 7,682,000 | 6,444,000 |
| 2002 | 12,214,000 | 9,751,000 |
| 2001 | 13,300,000 | 16,602,000 |
| 2000 | 17,414,000 | 6,302,000 |

#### 6.4.2 *Addition of mercury to the PIC list under the Rotterdam Convention*

Assuming this option would have a moderate impact on levels of mercury use, by extension it would make a moderate difference in economic terms compared to the no additional action option described above. Probably there would be little or no discernible effect on the chlor-alkali industry, whose surplus mercury would be supplied preferentially over primary mercury. The increased controls applying to international trade ought to lead to some decrease in the demand for new mercury production, but as stated above the economic benefits of such production are marginal anyway.

There would be some additional administrative burden for exporters and authorities associated with export notifications and consent. However, this burden should not be unduly large, in part because the number of mercury trades is small, and in part because the infrastructure to implement the PIC regime is already established.

#### *6.4.3 Stopping primary mercury production*

For reasons described above, this would be expected to have a marginal net economic impact. One the one hand there would be some loss of income associated with the lost sales of mercury, but on the other it appears that such production generates little if any profit.

#### *6.4.4 Stopping mercury export*

As described previously, stopping mercury exports would have the effect of stopping primary production in the EU and of requiring storage or disposal of most if not all of the surplus mercury from the chlor-alkali industry. Stopping primary production would have marginal economic impact. The economic impact concerning the chlor-alkali surplus mercury, meanwhile, would depend on whether storage or disposal was pursued. In either case, there would also be a modest economic impact associated with the loss of sales by the chlor-alkali industry to MAYASA (about €1-2 million per year), and then onwards by MAYASA (about €2-2.5 million per year less transaction and operating costs).

The likely scale of the costs of storage can be estimated based on the US figures for temporary storage of 4,436 tonnes of surplus mercury (DLA, 2004). Real costs of about $26 million for the "no action" (i.e. maintaining storage at the four present sites) option and $29 million for consolidated storage were calculated, covering a forty year period in both cases. Allowing for the current €/$ exchange rate, and the greater amount of mercury to be stored in the EU, the equivalent figures would be around €55-62 million. Over a 40 year period, this would amount to about €1.5 million per year. In the initial period, however, the storage costs could be less, as there would be less mercury to store, although there would also be start-up costs.

These figures should only be taken as a rough estimate of the costs of storage in the EU, since differences compared to the situation in the US – e.g. the amount of mercury involved, the costs of storage facilities, the nature of the storage, the length of storage, etc. – could affect the calculation. Note also that the later a policy of storage were to come into effect, the less mercury there would be left to store, and therefore the lower the cost would be. However, for the purposes of this assessment, which aims to identify in principle which option is to be preferred, the figures should give an acceptable idea of the scale of the costs.

The likely scale of the costs of permanent disposal can be estimated based on Swedish calculations for terminal storage of mercury in deep bedrock (Naturvårdsverket, 2003a). The Swedish estimation of the costs for this approach, excluding pretreatment, is €15-22/kg mercury. For 11,600 tonnes of decommissioned mercury this would lead to a cost of €174-255 million plus pretreatment costs, which are not known at this stage.[15]

If storage or disposal were pursued, it would also be necessary to determine who would bear the costs. The "polluter pays" principle might be applied, but in the case of permanent disposal this could affect the competitiveness of the European chlor-alkali industry relative to non-European competitors. The additional cost would be about 6-8% on top of the €3.1 billion estimated for conversion of the industry. In contrast, storage would add less than 2% to the total conversion cost and so would seem unlikely to have a significant competitiveness impact.

### *6.4.5 Temporary storage of mercury from the chlor-alkali industry*

The economic impact of temporary storage is described above as part of the assessment for stopping export.

### *6.4.6 Permanent disposal of mercury from the chlor-alkali industry*

The economic impact of permanent disposal is described above as part of the assessment for stopping export.

## 6.5 Social impacts

### *6.5.1 No additional action*

Socially, the main benefit of the mercury industry is in providing a source of employment. MAYASA employed 148 people in 2003.[16] This is a small number in absolute terms, but is significant when compared to the population of about 7,000 people in the town of Almadén (being about 2% of the population, although it is also not clear how many of the 148 people are based in Almadén, since the company also has an office in Madrid). Some of these positions will relate to areas other than the mercury business (e.g. agriculture, geological services) into which MAYASA has diversified in recent years. The precise breakdown between business sectors is not known, although Ortega and Díez (2001) reported that in 1997 only about 26% of MAYASA's sales were from mercury and by-products, with 41% from technical and mining services, 9% from public works and 24% from agricultural activities. Note also that as extraction and production of mercury have both temporarily stopped in Almadén (since June 2001 and July 2003 respectively), there can be no current operational employment associated with these activities. Presumably, therefore, such limited employment as continues to be connected with the mercury business in Almadén will relate to management of the stockpiles of ore and mercury, handling of surplus mercury from the chlor-alkali industry, and handling of mercury trades.

It is apparent that the area around Almadén historically has been heavily dependent on mercury mining and production. For example, the mines reportedly had 2,400 workers on the payroll in 1956, and the population in 1960 was recorded at over 13,000. Since then the population has shrunk in parallel with the falling levels of

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15 On the basis of these figures, the one-off cost of permanent disposal, excluding pre-treatment, would be equal to the cost of storage for between about 112-185 years.

16 Data from www.sepi.es. SEPI is the Spanish state-owned holding company which owns MAYASA.

employment provided by the mine (Ortega and Díez, 2001). The continuing decline in employment is also evident in recent years, with the number of employees having dropped from 298 in 2001 to 178 in 2002[17], before reaching the figure of 148 reported at the end of 2003. The scale of MAYASA's recent losses (see Section 6.4.1) suggests that the current level of implicit subsidy for the firm's employees is around €50 thousand per person per year. As already noted, the Spanish authorities and MAYASA have indicated that mercury production itself is not subsidised, but rather that subsidies are provided to develop alternative lines of business in Almadén.

Ortega and Díez (2001) also describe some of the wider social benefits and disbenefits that have resulted from mercury mining and production in Almadén. Significant social benefits occurred in the 17th and 18th centuries, including a privileged social life, technology and health care, as well as advantageous fiscal exemptions. However, these benefits reportedly were not maintained during the entire 19th century and most of the 20th century. In parallel, there have been certain social disbenefits. These have included significant deforestation of a considerable part of the surrounding area, arrival of marginalised peoples as forced labour, and the acquisition of a reputation of being a highly contaminated area.

Almadén is in the Ciudad Real province of the Castile-la-Mancha region of Spain, one of the most economically depressed areas in the country, with the lowest population density and per capita income. In view of the declining global mercury market, the authorities have been trying to develop diversified areas of business and employment in the Almadén region for some time, largely in the areas of agriculture, forestry and tourism. However, these efforts reportedly have met with only limited success to date. Ortega and Díez (2001) have suggested that this is because of the region's reputation as being contaminated (thus creating marketing difficulties for agricultural produce), and problems of adaptation and resistance against new jobs in attempts to retrain mining personnel.

More broadly, Castile-la-Mancha is an Objective 1 region, with Structural Fund assistance for 2000-2006 amounting to €2.1 billion. There are already two projects in Almadén supported under the European Regional Development Fund. The first concerns rehabilitation of an old hospital to create a museum of the region's mining history (€1.2 million of Community funds). The second will support the conversion of an old mine into a related museum (€3 million of Community funds).

Elsewhere, there will be a modest amount of employment associated with mercury production (e.g. from recycling) and trading. On the other hand, there will be social disbenefits where mercury is used, especially in the case of artisanal mining in developing countries.

### 6.5.2 *Addition of mercury to the PIC list under the Rotterdam Convention*

The main practical impact of this option would probably be a moderate reduction in mercury exports, particularly to developing countries where certain prevalent uses (e.g. in artisanal gold mining) are illegal. Hence a proportionate social benefit could be expected. At the same time, since the expected impact on overall production

[17] Source: Amadeus database.

levels would be small, there should be only a marginal social impact in terms of employment associated with the mercury trade.

### 6.5.3 *Stopping primary mercury production*

This would have a social impact on the region of Almadén, in view of the historical significance of mercury mining and production for the region. It would lead to the loss of employment for up to 148 people, although redevelopment activities are already underway to provide alternative sources of employment.

### 6.5.4 *Stopping mercury export*

There would be a social impact on the region of Almadén as outlined above. There would also be a social impact from the practical effect of requiring storage or disposal of surplus mercury from the chlor-alkali industry. Either activity could lead to some – probably modest – loss of employment in the mercury trading business, yet in parallel generate new employment in storage or disposal operations. The area(s) selected as the site(s) for storage or disposal might also suffer some negative social consequences, associated with being the location of a depository of toxic material. However, a very strong reaction – such as that resulting from the possibility of an area being used for the disposal of nuclear waste – seems unlikely, since mercury storage has neither the emotive nor the potential environmental impact and complexity of radioactive material.

This option could be expected to have the largest impact on the price and availability of mercury in developing countries, and so would bring the most significant social benefit in reducing mercury emissions associated with artisanal gold mining.

### 6.5.5 *Temporary storage of mercury from the chlor-alkali industry*

The social impact of storage is described above as part of the assessment for stopping export.

### 6.5.6 *Permanent disposal of mercury from the chlor-alkali industry*

The social impact of permanent disposal is described above as part of the assessment for stopping export.

## 6.6 External impacts (i.e. outside the EU)

### 6.6.1 *No additional action*

The EU would remain the dominant global supplier. Hence a significant amount of the negative effects associated with global mercury use described in this ExIA would be attributable to EU-sourced mercury. Continuing mercury production in the EU could be taken as a sign in other countries that mercury is not a problem that needs to be taken seriously. Likewise, allowing the surplus mercury from the chlor-alkali industry to re-enter the global market could undermine decisions to store mercury elsewhere (e.g. by the US Government), and could also provide a more general precedent for selling the mercury from this industry globally.

*6.6.2 Addition of mercury to the PIC list under the Rotterdam Convention*

Countries outside the EU would have the opportunity to make informed decisions on whether or not to permit mercury imports. This option would operate at an international level, affecting exports from and to those countries that are parties to the Rotterdam Convention, rather than just mercury supply from the EU.

*6.6.3 Stopping primary mercury production*

The EU's role as the world's major mercury producer would end. This could have an important impact in improving the EU's credibility with other countries, and demonstrating its commitment to addressing the global mercury problem, in any international discussions concerning mercury. However, mercury from other sources exported from the EU could still be the cause of pollution in other countries.

*6.6.4 Stopping mercury export*

This would significantly cut the global supply of mercury. It would provide the strongest international demonstration of EU commitment to addressing the global mercury problem.

*6.6.5 Temporary storage of mercury from the chlor-alkali industry*

This would have a similar external impact to stopping mercury export. However, recycled and secondary mercury exported from the EU could still cause pollution in other regions.

*6.6.6 Permanent disposal of mercury from the chlor-alkali industry*

This would have a similar external impact to stopping mercury export. However, recycled and secondary mercury exported from the EU could still cause pollution in other countries.

## 6.7 Subsidiarity and proportionality

*6.7.1 No additional action*

There are no subsidiarity and proportionality issues to address in this option.

*6.7.2 Addition of mercury to the PIC list under the Rotterdam Convention*

The EU alone could not make raw mercury subject to the PIC procedure. Rather, this would require a common decision under the Rotterdam Convention, following a review of notified bans or restrictions of the use of metallic mercury by two Parties located in two different PIC regions. Notification by an individual Member State following the procedure of Article 10(7) of Regulation 304/2003 is possible, but would still necessitate a notification by another Party from another PIC region to trigger the process of inclusion. Hence there is no obstacle on the basis of subsidiarity. Similarly, this does not appear to be a disproportionate measure, given the well documented difficulties in monitoring and managing mercury trade flows (Maxson, 2004b).

### *6.7.3 Stopping primary mercury production*

The subsidiarity issue here is whether it would be appropriate for the EU to take action to stop primary production when there is only one Member State – in this case Spain – concerned. It could be argued that, on subsidiarity grounds, it would be more effective for Spain to take action at the national level to cease production permanently. However, if this action were thought to be desirable as part of a Community strategy, it could be appropriate to support it through Community action.

On the question of proportionality, it would not seem disproportionate to stop primary mercury production, especially given the existing oversupply of mercury and the availability of other sources to meet demand.

### *6.7.4 Stopping mercury export*

This option presents no subsidiarity concern, as stopping export from the EU as part of a Community mercury strategy could only work if applied equally in all Member States. It also would not seem disproportionate to pursue this option, given the EU's present position as the major global mercury exporter and the documented problems associated with mercury.

### *6.7.5 Temporary storage of mercury from the chlor-alkali industry*

If some Member States were to take action to prevent surplus mercury from the chlor-alkali industry from re-entering the market, and others not, then the impact of the action by the former would be undermined. Hence there appears to be no obstacle on the basis of subsidiarity. Given the very large volumes of mercury associated with the chlor-alkali industry, and their potential effect on the global mercury market, this option also does not seem disproportionate.

### *6.7.6 Permanent disposal of mercury from the chlor-alkali industry*

Subsidiarity and proportionality issues here are broadly the same as outlined above for temporary storage. Given the additional cost (and technical uncertainty) of the disposal option, however, it could be argued that this might be disproportionate.

## 7. IMPACTS OF OPTIONS RELATING TO MEASURING AND CONTROL EQUIPMENT

Traditionally mercury has been used in a wide variety of measuring devices and control equipment. The most common items are thermometers, blood pressure gauges (sphygmomanometers) and manometers. From a risk management perspective it is appropriate to distinguish between measuring devices for consumer uses (namely the said types of instruments) and professional uses in science and industry. The professional uses are highly specialised.[18] While the mercury content per item can be quite high, the numbers are rather limited and this equipment is typically used in systems with well established control procedures on safety at the work place and management of dangerous waste. In contrast it has proved extremely difficult to keep used measuring devices from consumer uses out of the waste stream,

[18] See Galligan et al (2003) and contribution from VROM in response to the consultation exercise.

and some Member States report that mercury from products is the main source of mercury in surface waters (e.g. Netherlands, France).

## 7.1 Description of the options

### *7.1.1 No additional action*

In this case, no Community action is taken for the time being. Measures are left to the Member States and to the private sector. A number of Member States have already passed national legislation. In addition, more recent studies show a progressing substitution of mercury in thermometers, barometers and blood pressure gauges especially for use in private households.

### *7.1.2 Marketing and use restriction*

This option would prohibit the marketing of measuring and control devices containing mercury by means of an amendment to the "Limitations Directive".[19] The scope of such a limitation is to be based on a risk assessment and an investigation of the advantages and drawbacks of the risk management measure proposed. The information available to the Commission now can be considered as sufficient to prepare such a proposal for consumer uses, and for fever thermometers and blood pressure gauges used in healthcare, at an early date. It would be necessary to include some exemptions, for example use of mercury sphygmomanometers for reference purposes. The coverage of most specialist professional uses, which are excluded from the scope of most national legislation as adequate substitutes are not always available, would need complicated further investigations and is therefore excluded from the analysis of this option at present.

The introduction of a marketing restriction could not address the handling of measuring and control equipment already in households, which from a quantitative perspective is more important than the rather limited sales of new instruments. At various places special collection campaigns have been organised with considerable success. Such measures are certainly useful to address the problem, but are not considered further in this assessment. However, the need to address the large amount of mercury held in products already circulating in society was raised by many stakeholders during DG Environment's consultation on mercury. The Commission therefore intends to undertake further, separate study of this issue.

## 7.2 Environmental impacts

### *7.2.1 No additional action*

It is difficult to quantify the impact over time as most of the measuring and control devices have a very long technical lifetime. However, the information available shows that 80-90% of all such devices using mercury are thermometers, of which most are medical thermometers and other thermometers for household use. As

[19] Directive 76/769/EEC on the approximation of the laws, regulations and administrative provisions of the Member States relating to restrictions on the marketing and use of certain dangerous substances and preparations, OJ L 262 , 27.9.76.

something over 33 tonnes[20] of mercury are estimated to be used for measuring and control devices per year in the EU, on an annual basis some 25-30 tonnes of mercury enter the cycle via thermometers alone. The level of emissions will be considerably lower, as an increasing share of the equipment is collected and the mercury is recovered, but nevertheless still significant.[21] Much of the mercury will end up being landfilled with potential for slow but long term leaching. Some mercury containing instruments will be subject to spills in dwellings.

#### *7.2.2 Marketing and use restriction*

The main advantage of a restriction on the marketing of measuring devices for consumer and healthcare uses would be a reduction of mercury in the municipal and healthcare waste streams and therefore, firstly, a facilitation of waste management, and secondly, a reduction of mercury emissions from landfill and incineration. A reduced use of mercury containing instruments in households will in addition avoid mercury spills in dwellings. Although such spills rarely have a direct effect on human health, they are a source of exposure and emissions which should be minimised.

### 7.3 Economic impacts

#### *7.3.1 No additional action*

There is a modest economic benefit associated with the production of measuring and control devices in the EU, which would be unaffected in this option.

#### *7.3.2 Marketing and use restriction*

For the measuring devices used by private households substitutes are available at about the same price and in fact the substitution process is already fairly advanced. The remaining producers in the EU seem to be limited to a small number of small and medium sized enterprises. The economic impact of a marketing restriction seems therefore small, but consultation of the industry has not been finalised yet. The negative impact on the producers has to be balanced against the avoided costs in waste management and the impacts of emissions. While it would be somewhat artificial to quantify the avoided collection and separation costs, even a rough estimate shows that the costs of avoiding mercury emissions are lower in this area than emission reduction costs in sectors like coal combustion. The measure can therefore be regarded as relatively cost efficient.

The available studies and contributions from industry show that for specialist industrial and scientific measuring devices the situation is far less clear cut. In quite a number of cases adequate substitutes are not available, or have considerably higher costs. This has forced those governments that have implemented restrictions in this

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[20] This is higher than the figure of 26 tonnes for this sector given in Annex 3. However, that figure is only for EU15. The estimate of 33 tonnes is from RPA (2002) and covers EU15 plus 3 of the then accession countries. The figure for the enlarged EU would be somewhat higher still.

[21] RPA (2002) has suggested the emission to air will be about 8 tonnes per year resulting from 33 tonnes of consumption of mercury per year in new measuring and control equipment plus 27 tonnes entering the waste stream from old equipment.

area to provide for numerous exemptions. On the other hand collection and recovery of the mercury discarded from this area can be assumed to be much cheaper as the sources are limited in number and should have suitable waste management systems in place. The cost-effectiveness of restrictions in this comparably small area is therefore at least questionable.

## 7.4 Social impacts

### *7.4.1 No additional action*

There is some employment associated with the production of measuring and control devices in the EU, although many such products are now made overseas.

### *7.4.2 Marketing and use restriction*

The expected social impact from a restriction of consumer uses is largely limited to some job losses with the producers in the case that they cannot switch to the production of substitutes. At present the Commission expects that the negative effect on employment will be very limited, but it will follow up thoroughly all comments received in the consultation process indicating such an effect.

In the literature it is also mentioned that a number of consumers show a preference for blood pressure gauges using mercury, which they consider as more reliable than the nevertheless widely used automated devices. However, the same literature suggests that this is rather a perception and the effect of being more familiar with the traditional sphygmomanometers than a true feature of the substitutes.

## 7.5 External impacts (i.e. outside the EU)

### *7.5.1 No additional action*

It has been reported that a large proportion of mercury thermometers is imported from Asia, in particular China (RPA 2002). This could continue to be the case under this option. More broadly, taking no additional action in this product group, despite the possibility of significant substitution, could negatively affect the EU’s credibility in any international or bilateral discussions concerning mercury. In particular, it could be taken as a sign in other countries that mercury is not a problem that needs to be taken seriously.

### *7.5.2 Marketing and use restriction*

Under this option, the restriction on marketing certain products would apply regardless of whether those products were made in the EU or externally. As a result, some external producers would lose a market for their products, although at the same time any external producers manufacturing mercury-free substitutes would find their market expanded. This option would also support any broader action the EU took or advocated to promote global reduction of mercury use.

### 7.6 Subsidiarity and proportionality

#### *7.6.1 No additional action*

There are no subsidiarity and proportionality issues to address in this option.

#### *7.6.2 Marketing and use restriction*

The transboundary nature of the mercury problem is presented in Annex 2 of the ExIA. In addition, a large number of Member States have expressed their preference for (additional) Community measures in the area of measuring and control devices at a discussion in the Working Group for implementation of Directive 76/769, as well as in responses to the DG Environment consultation document on mercury. The main reason given is that any national restriction of these traded goods is difficult to enforce in the internal market. Hence there appears to be a good basis for Community action according to the principle of subsidiarity.

As regards proportionality, the relatively high quantities of mercury which are still used for the production of measuring and control devices indicate the importance of Community action on this application. This would be fully in line with legislation for this substance used in other applications, such as electrical and electronic equipment. It would also contribute to implementing the Water Framework Directive which considers mercury as one of the priority hazardous substances.

## 8. IMPACTS OF OPTIONS RELATING TO COAL COMBUSTION

### 8.1 Description of the options

The options below concentrate on emissions from large combustion sources only. Measures for emissions from sources less than 50 $MW_{th}$ have not been considered. This is because consultation has revealed that data on this subject and proposals for realistic solutions are presently scarce. This issue will be studied further separately. The possible extension of the Large Combustion Plants (LCP) Directive[22] or IPPC Directive to installations of thermal capacity below 50 $MW_{th}$ could be considered in the reviews of these Directives in due course. Also, separate regulation of emissions from small scale combustion installations could be considered.

There are three major policy options, described below, that could be considered for large combustion installations:

- no additional action (beyond implementing existing legislation)
- extend the existing legislation to cover mercury emissions
- adopt a new Community-wide market-based instrument such as a cap and trade system.

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[22] Directive 2001/80/EC of the European Parliament and of the Council of 23 October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants, OJ L 309, 27.11.2001.

There are some basic assumptions common for all of the options considered. In order to avoid repetition when analysing impacts these assumptions are presented here:

- Some abatement techniques for mercury removal are not fully fledged and need some time to mature.
- Reductions can be obtained at different combustion stages (from coal washing to removal from flue gases), or their combination.
- Mercury abatement efficiency varies greatly depending on the fuel type and installation.
- Knowledge about mercury deposition patterns is limited. Mercury speciation during combustion, which is a key factor in deposition patterns, also varies highly depending on the type of installation and fuel.

### *8.1.1 No additional action*

This option assumes that all Community legislation that has been so far adopted will be implemented according to the time frame envisaged. The key measures are the IPPC Directive and the LCP Directive.

### *8.1.2 Extend existing legislation to cover mercury emissions*

This option would extend or supplement one or both of the above-mentioned Directives, in order to set explicit emission limit values for mercury. An advantage would be that the mercury-related requirements would be integrated into legislation already containing requirements for other pollutants. For this option to have any added value, the emission limit values would have to be more stringent than the emission reductions expected to be achieved under the business-as-usual scenario. Taking into account techniques possibly available in the future, a requirement for the removal of around 90-95% of mercury could be considered. In order to streamline the scenario for the purposes of this assessment, no difference in requirements for power plants fired with bituminous and lignite coal has been taken into account. However, such differentiation would be desirable if the initial assessment were to indicate that the option should be pursued further.

### *8.1.3 Market-based instrument*

This option would involve reducing mercury emissions via a market-based instrument rather than a more traditional form of regulation. For the purposes of this assessment a cap and trade scheme is considered. Similar to the Community greenhouse gas emission trading Directive[23], this would allow trading in allowances for mercury emissions. Introducing such a scheme for mercury as from 2005 is already being considered by the US Environmental Protection Agency. An advantage of this option is that, as a market-based instrument, it should be quite flexible and

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[23] Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC, OJ L 275 , 25.10.2003.

cost-effective. A disadvantage is that there has been no experience so far in running such a scheme for a heavy metal pollutant.

## 8.2 Environmental impacts

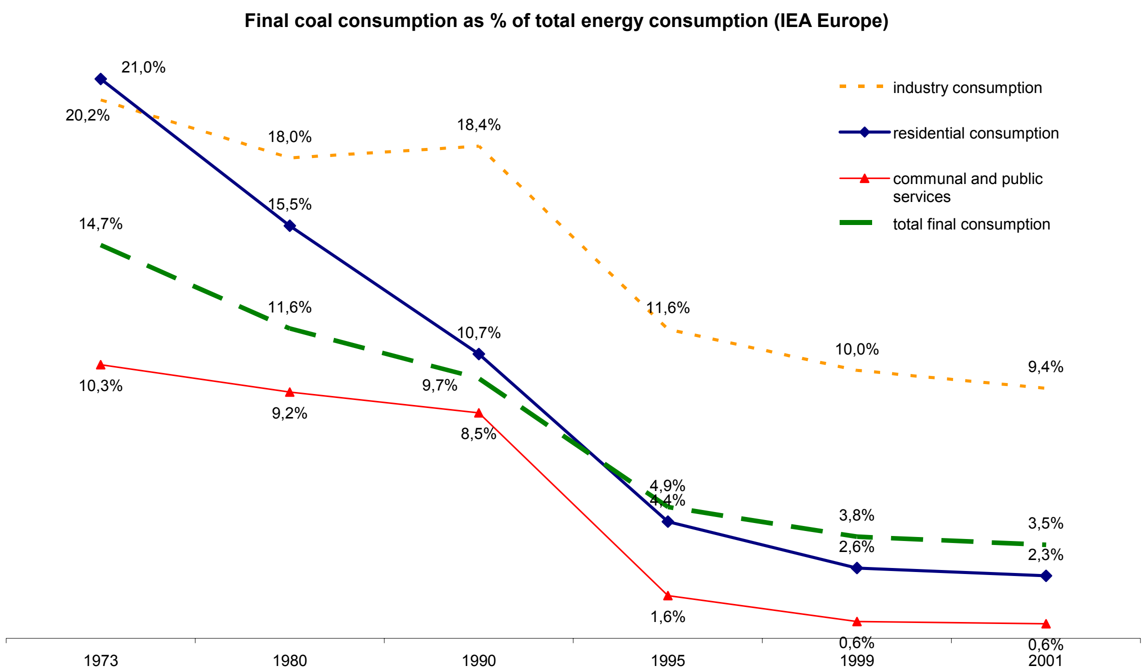
### *8.2.1 No additional action*

No Community legislation explicitly sets mercury emission targets for large combustion plants. Nevertheless, there are three main factors that can be expected to contribute to decreasing emissions in future:

- decrease in coal use in the EU
- change in coal consumption practices
- requirements of the legislation already in place.

The trend concerning **decreasing coal use** in the EU is shown in Figure 1 below.

**Figure 1 (Source: IEA, 2003a)**




Overall consumption of coal, as a percentage of total energy consumption, dropped by a factor of four from 1973 to 2001. The biggest relative change was in the communal and public services sector (17-fold), whereas the smallest one was in industry (50%), which remains the biggest consumer of coal.

As regards **changes in coal consumption practices**, there are two factors that are likely to contribute to a continuing decrease in mercury emissions: the growing share of imported coal; and decreasing consumption of non-bituminous coal.

As shown in Table 3 below, where 109 samples of coal imported to the Netherlands were tested, on average imported coal was found to have lower mercury content than European coal.

**Table 3 – Mercury content of bituminous steam coal imported to the Netherlands (Source: Eurelectric response to DG Environment consultation on mercury)[24]**

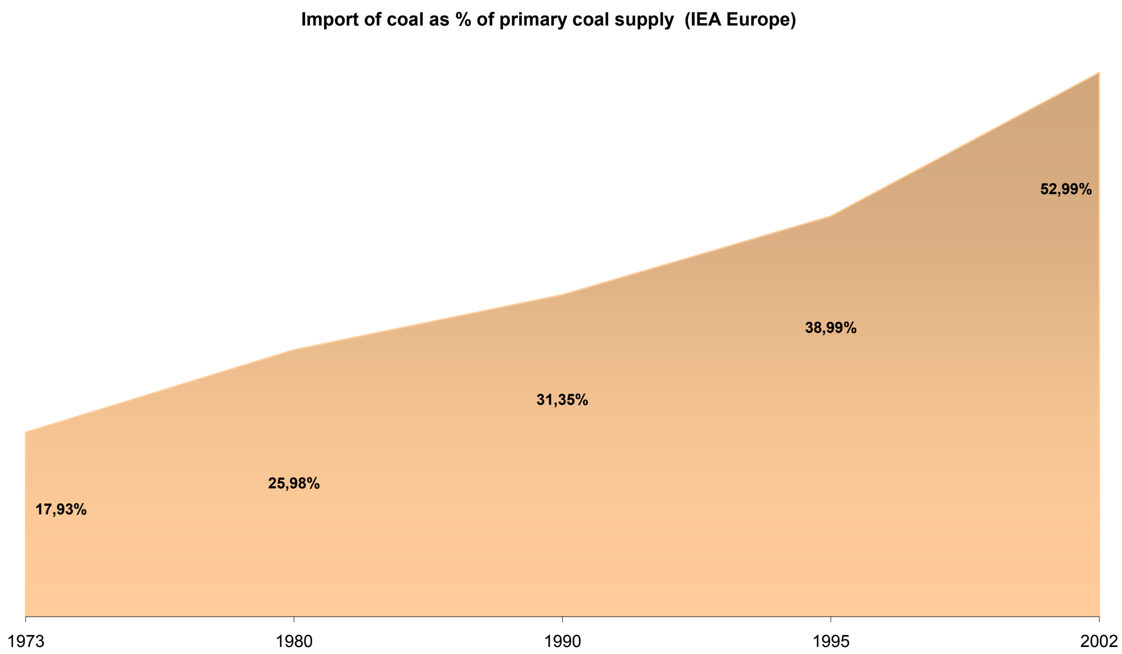
| Country of origin (concentrations are in mg/kg) | Number | Mean | Standar Dev. |
|---|---|---|---|
| Australia | 17 | 0.08 | 0.06 |
| Colombia | 7 | 0.06 | 0.03 |
| China | 2 | 0.15 | - |
| Egypt | 1 | 0.10 | - |
| Germany (Ruhr area) | 1 | 0.16 | - |
| Indonesia | 7 | 0.04 | - |
| New Zealand | 1 | 0.05 | - |
| Poland | 10 | 0.35 | 0.55 |
| Russia (Kuzbass) | 1 | 0.06 | - |
| South Africa | 12 | 0.09 | 0.02 |
| Spitsbergen (Norway) | 2 | 0.14 | 0.12 |
| United States (Eastern) | 15 | 0.14 | 0.12 |
| Venezuela | 2 | 0.08 | - |
| Blend | 36 | 0.09 | 0.07 |
| Total | 109 | 0.12 | 0.19 |
| Weighted averaged in the Netherlands in 1999 | | 0.11 | 0.20 |

24 Note that, according to Eurelectric, Polish coal imported to other countries shows much lower mercury content than that reported in the table: 0.09 mg/kg (Denmark), 0.07 mg/kg (the UK), 0.06-0.2 mg/kg (Austria).

According to Eurelectric, comparable results have been found in Ireland and Denmark. In the UK, analysis of coal consumed has found a weighted mean value for mercury content of 0.07 ppm. In Germany the average content varies from 0.15 ppm for low ash coal to 0.25 ppm for high ash coal.

The share of coal imported to Europe continues to grow and rose from 18% in 1973 to more than 50% in 2002, as shown in Figure 2.

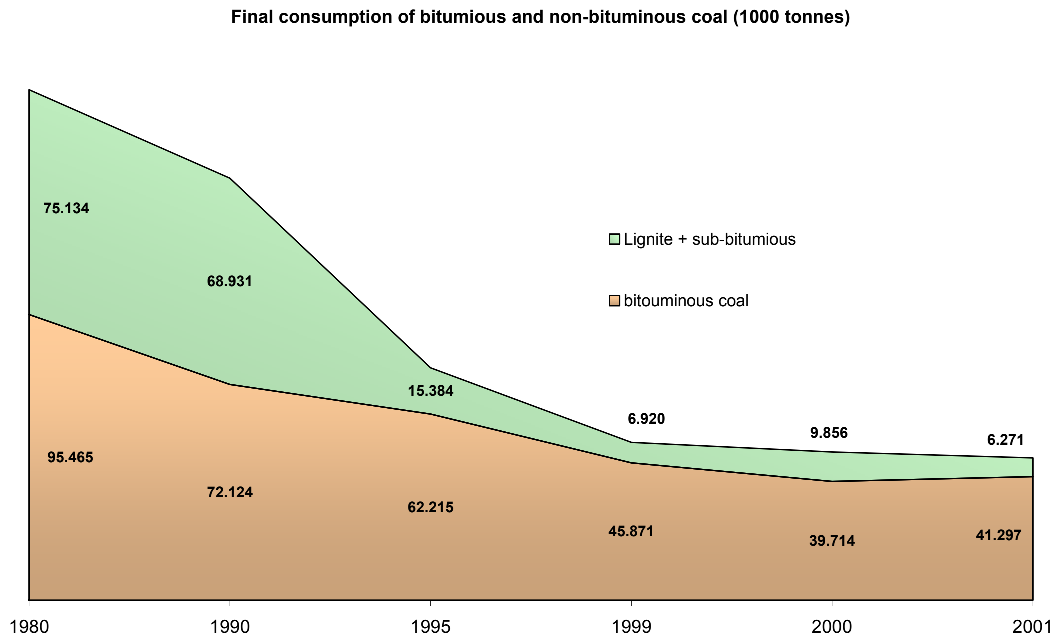
**Figure 2 (Source: IEA, 2003b)**




This trend is complemented by a higher rate of decrease in the consumption of non-bituminous coal[25] compared to bituminous coal (see Figure 3). As shown later in this section non-bituminous coal has lower mercury removal efficiencies, so the fact that less and less of this coal is being consumed will have a positive effect in reducing mercury emissions.

[25] Sub-bituminous and lignite; for coal definitions see www.iea.org.

**Figure 3 (Source: IEA, 2003b)**




As regards the **effects of the legislation already in place**, emission reductions can be expected as a co-benefit in reducing other pollutants, such as dust, sulphur dioxide and (to a lesser extent) oxides of nitrogen. The most important legal instruments will be the IPPC and LCP Directive, and to some extent the National Emission Ceilings Directive[26].

More specifically, the IPPC Directive requires taking account of Best Available Techniques (BAT) when issuing a permit for an installation[27]. The BATs described in BREF documents[28] are developed with input from industrial and other stakeholders. The final draft BREF for large combustion installations describes typical mercury removal efficiencies for various possible control techniques, as illustrated in Table 4.

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26 Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants, OJ L 309 27.11.2001.

27 Article 9(4).

28 See http://eippcb.jrc.es.

**Table 4 – Typical mercury removal efficiencies given in the final draft LCP BREF**

| **System** | **Mercury removal efficiency** |
|---|---|
| **Particulate matter (PM) reduction systems** | |
| Fabric Filter (FF) | 40% |
| **Flue gas desulphurisation (FGD) systems** | |
| Wet scrubber FGD | 30-50% |
| Spray Dry (SD) | 35-85% |
| Spray Dry + FF | 70% |
| Activated carbon + SD/electrostatic precipitator (ESP) (140ºC) | 78% |
| Activated carbon + SD/ESP (110ºC) | 86% |
| Activated carbon + SD/FF | 91-95% |

The draft BREF also discusses the development of systems for the express purpose of removing metals such as mercury from flue gas streams. For example, it is reported that a lignite coke filter and catalyst system removed virtually all the mercury in the flue gases of a municipal waste incinerator, when tested at pilot scale. However, the draft BREF states that at present most processes relating expressly to mercury are not at a commercial stage, or seem more appropriate for controlling emissions from waste incineration, with additional research required before they can be applied in large combustion installations.

The draft BREF provides the following overall conclusions regarding BAT for mercury emissions:

Mercury has a high vapour pressure at the typical control device operating temperatures, and its collection by particulate matter control devices is highly variable. Taking into account that spray dryer FGD scrubbers and wet lime/limestone scrubbers are regarded as BAT for the reduction of $SO_2$ for larger combustion plants, low Hg emission levels are achieved.

For the reduction and limitation of Hg emissions, it can be stated, that coals of good quality have comparably low Hg contents and that the best levels of control are generally obtained by emission control systems that use FFs and ESPs, where high efficiency ESPs show good removal of Hg (bituminous coal) at temperatures of less than 130ºC. In addition, some combinations of flue-gas cleaning systems can remove oxidised and particle bound Hg to some extent. For FFs or ESPs operated in combination with FGD techniques, such as wet limestone scrubbers, spray dryer scrubbers or dry sorbent injection, an average removal rate of 75% (50% in ESP and 50% in FGD) or 90% in the additional presence of SCR can be obtained. The reduction rate when firing sub-bituminous coal or lignite is considerably lower and ranges from 30-70%. The lower levels of Hg capture in plants firing sub-bituminous coal and lignite are attributed to the low fly ash carbon content and the higher relative amounts of gaseous Hg in the flue-gas from the combustion of these fuels.

Periodic monitoring of Hg is BAT. A frequency of every year up to every third year, depending on the coal used, is recommended. Total Hg emissions need to be monitored and not only Hg present as part of the particle matter.

The draft BREF also describes a flue gas treatment system that employs a gas-phase oxidation process to capture 100% of mercury as well as high levels of other pollutants. This is under demonstration in the USA and is therefore presented as an "emerging technique" (i.e. not yet an "available technique" under the definition of BAT).

The above data from the draft BREF can be compared with results of research undertaken in the USA. Table 5 below shows percentage reductions from inlet concentrations available now and expected to be available in the near future. It also shows the importance of fuel type.

**Table 5 – Mercury control in the USA for pulverised coal-fired boilers and units with cold-side electrostatic precipitators or fabric filters (Source: Wayland, 2001)**

| Technology | Current percentage reduction | | Near term percentage reduction (2007-2008) | |
|---|---|---|---|---|
| | Bituminous | Sub-bituminous | Bituminous | Sub-bituminous |
| ESP | 36 | 3 | 70 | 45 |
| FF | 89 | 73 | 90 | 85 |
| Spray dry absorber (SDA) + ESP | 70 | 50 | 80 | 70 |
| SDA + FF[29] | 95 | 25 | 90 | 80 |
| ESP+ wet FGD | 80 | 0 | 90 | 50 |
| FF + wet FGD | 90 | 75 | 90 | 85 |

[29] The reason for the apparent drop from the "current" (2001) to the "near term" percentage reduction for bituminous-fired units has been checked with the author. The explanation is that data for mercury removal from SDA+FF units were very limited. The 95% figure reflected the limited current data set, while the 90% figure reflected an expected industry-wide reduction in the near-term.

Another US study confirms significant variations in emission reductions depending on fuel type and control technology employed – see Table 6.

**Table 6 – Average mercury capture by existing post-combustion control configurations used for pulverised coal-fired boilers (Source: Staudt and Jozewicz, 2003)**

| Post-combustion Control Strategy | Post-combustion Emission Control Device Configuration | Average Mercury Capture by Fuel Type | | |
|---|---|---|---|---|
| | | Bituminous Coal | Sub-bituminous Coal | Lignite |
| PM Control Only | ESPc (cold side) | 36 % | 9 % | 1 % |
| | ESPh (hot side) | 14 % | 7 % | not tested |
| | FF | 90 % | 72 % | not tested |
| | Particle scrubber (PS) | not tested | 9 % | not tested |
| PM Control And Spray Dryer Adsorber (SDA) | SDA+ESP | not tested | 43 % | not tested |
| | SDA+FF | 98 % | 25 % | 2 % |
| | SDA+FF+SCR | 98 % | not tested | not tested |
| PM Control And Wet FGD System[(a)] | PS+FGD | 12 % | 10 % | not tested |
| | ESPc+FGD | 81 % | 29 % | 48 % |
| | ESPh+FGD | 46 % | 20 % | not tested |
| | FF+FGD | 98 % | not tested | not tested |

(a) Estimated capture across both control devices

Eurelectric, in its response to the DG Environment consultation on mercury, gives the following removal efficiencies obtained in different EU Member States (Table 7).

**Table 7 – Mercury removal efficiencies in EU Member States (Source: Eurelectric)**

| System | Country where tested | Average removal efficiency |
|---|---|---|
| ESP | Denmark, the Netherlands, UK, Ireland | 48-52% |
| ESP | Germany | 10-50% |
| ESP + FGD | Denmark, the Netherlands, UK | 72-87% |
| ESP + FGD | Germany | 35-70% |
| SDA + ESP | Denmark | 75% |
| SCR + ESP + FGD | Germany | 60-80% |
| SCR + ESP + FGD | Austria | 80-85% |

Under the previous LCP Directive[30] Member States were required to report emissions of sulphur dioxide and nitrogen oxides for existing (pre-1987) plants on an individual basis for plants over 300 $MW_{th}$, and on an aggregate basis for plants between 50 and 300 $MW_{th}$. A previous analysis of these data showed that the greater part of $SO_2$ emissions comes from plants of thermal capacity greater than 300 $MW_{th}$. Hence, as coal fired plants tend to be quite large one can assume that most (over 90%) of $SO_2$ emissions come from plants over 300 $MW_{th}$.

In the current LCP Directive, existing (pre-1987) plants have to meet new requirements for $SO_2$, $NO_x$ and dust in 2008 and also again in 2016 for $NO_x$. The dust emission limit values in the Directive for solid fuels applicable in this case are 50 mg/$Nm^3$ for plants over 500 $MW_{th}$ and 100 mg/$Nm^3$ for plants less than 500 $MW_{th}$. These values can be met with ESPs and are not significantly more ambitious than current practice. Therefore the effect on mercury emissions would be rather negligible as compared to the current situation.

For $SO_2$ emissions, from 1 January 2008 existing plants have to meet emission limit values of 2,000 mg/$Nm^3$ at less than or equal to 100 $MW_{th}$, declining to 400 mg/$Nm^3$ for plants over 500 $MW_{th}$. One way of meeting these standards could be acquiring low sulphur coals that would allow achievement of emission limits of about 1,000 mg/$Nm^3$ required at about 300 $MW_{th}$. For plants greater than this capacity some form of secondary desulphurisation will probably be required, such as wet limestone FGD or more basic lime injection depending on the size of plant and sulphur content of the fuel. Obviously, in such a case there will be a positive impact on mercury emissions.

30 Council Directive 88/609/EEC of 24 November 1988 on the limitation of emissions of certain pollutants into the air from large combustion plants, OJ L 336, 7.12.88

For $NO_x$ emissions, from 1 January 2008 solid fuelled plants have to meet emission limit values of 600 mg/Nm$^3$ (<500 $MW_{th}$) and 500 mg/Nm$^3$ (>500 $MW_{th}$) both of which should be achievable with primary abatement measures (burner modification etc.) and which presumably would have no impact on mercury emissions. However, it should be noted that in Germany (one of the highest coal users) most if not all hard coal plants of this size already have secondary $NO_x$ abatement.

From 1 January 2016 plants greater than 500 $MW_{th}$ will have to meet a $NO_x$ limit of 200 mg/Nm$^3$. This will require selective catalytic reduction, which will have a positive impact on mercury emissions.

Hence, for existing (pre-1987) plants using coal and with a capacity over 500 $MW_{th}$ there should be a two stage decrease in mercury emissions: in 2008 as a result of secondary $SO_2$ abatement and again in 2016 as a result of secondary NOx abatement. The extent of this could be affected by the take-up of the national plan option which may allow some plants to avoid installation of secondary abatement facilities, although it is not possible to quantify this. Existing plants that do not comply with these new requirements have to be shut down by 31 December 2015.

New solid fuel plants built since 1987 of capacity greater than 500 $MW_{th}$ would have been fitted with secondary $SO_2$ abatement to comply with Community requirements. Those built from now on with a capacity over 100 $MW_{th}$ would require both secondary $SO_2$ and $NO_x$ abatement with a positive impact on mercury emissions.

In conclusion, it can be assumed that the requirements of the LCP Directive will have a significantly positive impact in reducing mercury emissions. However, due to the variety of possible combustion and pollution control system configurations it is not possible to quantify this effect precisely.

Note also that the LCP Directive sets only the minimum requirements for pollution abatement, which are over-ruled by any stricter obligations arising from application of the IPPC Directive, as described previously. The IPPC Directive will also apply in cases where a single combustion installation constitutes a significant source of mercury emissions. Permits must contain provisions on the minimisation of long distance or transboundary pollution, which clearly applies to mercury. Moreover, the setting of permit conditions is also to take account of local environmental conditions, which provides a basis to alleviate the problem of any local “hot spots”.

### 8.2.2 *Extend existing legislation to cover mercury emissions*

Setting explicit limit values at the Community level would have a positive environmental impact. However, its scope might be limited. For instance, as shown in the tables above, a plant fired with bituminous coal, equipped with wet FGD, is capable of achieving up to a 90% reduction. At the other end of spectrum there are plants fired with sub-bituminous coal and equipped only with fabric filters. Taking into account the decreasing consumption of non-bituminous coal and the requirements of the LCP and other Directives, however, the latter case is expected to be rare.

Quantifying the total additional emission reduction that would be achieved by setting explicit emission limit values (as compared to no additional action) is not possible due to large variations at the plant level. The US Environmental Protection Agency also expects some co-benefits of further limiting mercury emissions, via additional reductions of $NO_x$, $SO_2$ and particulate matter (EPA, 2004a).

Requiring more stringent mercury emission reductions would have some negative environmental impacts too. Control systems require energy, clean water and chemicals, while the process produces wastewater and waste, both containing mercury. Due to the variety of combustion and control systems available, it is difficult to provide an overall quantification. Some assessment for individual plants has been done in the USA.[31] It shows that the biggest impact in water use and solid waste generation appears in the case of lignite, whereas the electricity use factor is equal for sub-bituminous coal and lignite, and only slightly higher than that for bituminous coal.

#### *8.2.3. Market-based instrument*

The environmental impacts of a market-based instrument such as a cap and trade scheme would be dependent on the design of the system. In principle, the effects could be as positive as in the case of the previous option.

### 8.3 Economic impacts

The economic effects presented below are mostly limited to costs for industry and effects on electricity prices. As discussed in Annex 5, the available evidence is rather scarce when estimating the economic benefits of mercury reduction. But in general terms emission reductions would have positive long term economic impacts for the fishing industry and could also reduce spending on healthcare.

#### *8.3.1 No additional action*

This option would have no additional economic impacts, positive or negative, beyond those expected as a result of the measures already in place.

#### *8.3.2 Extend existing legislation to cover mercury emissions*

There is no aggregated estimate of costs for the EU resulting from possible requirements to further reduce mercury emissions beyond what would be achieved anyway. But two main effects could be expected on the costs side.

Firstly, a change in the structure of fuel consumption that might follow from stricter mercury controls – with a wider switch to gas and/or renewable fuels as well as larger imports of low mercury coal – could affect some of the EU coal producers by lowering demand. However, no ban on exporting coal with high mercury content is foreseen, so any losses on the internal market could be partly offset by larger exports – although this would simply transfer the potential mercury emissions to another part of the world.

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[31] http://www.epa.gov/ttn/atw/utility/costs_hgcoal_docket.xls and http://www.epa.gov/ttn/atw/utility/utiltoxpg.html.

Secondly, and more significantly, higher heat and energy production costs could result from increased abatement requirements, probably translating into higher prices for final consumers (businesses and households). In the case of households the effect could be amplified by rising energy consumption. But at the same time, the price rise could be cushioned by liberalisation of energy markets and/or higher energy efficiency.

Estimates of mercury control costs in the USA (Hoffman and Ratafia-Brown, 2003) show a wide range of costs, depending on the system configuration, type of coal fired and emission reduction required. The results are shown in Tables 8 and 9 below, reflecting impacts on the price of energy and the cost per pound of mercury removed respectively (one pound (lb.) = approximately 0.45 kg). The thermal capacity of the plant in question is 500 MW.

**Table 8 – Mercury control costs estimate for a 500 $MW_{th}$ plant in the USA (US $2003) (Source: Hoffman and Ratafia-Brown, 2003)**

| Fuel | Mercury Reduction | Unit Configuration | Capital Cost, $1,000[a] | Total Capital Requirement (TCR), $/kW | First Year Annual O&M, $1,000[b] | COE Increase, 20-year annualized costs and current dollar basis, mills/kWh | |
|---|---|---|---|---|---|---|---|
| | | | | | | w/o by-product impact | with by-product impact |
| Bituminous | 50% | ACI/ESP | $984 | $1.97 | $931 | 0.37 | 2.79 |
| | 70% | ACI/ESP | $984 | $1.97 | $3,401 | 1.27 | 3.69 |
| | 70% | ACI/COHPAC | $28,267 | $56.53 | $2,609 | 1.89 | 1.89 |
| | 90% | ACI/ESP | $1,262 | $2.52 | $15,647 | 5.72 | 8.14 |
| | 90% | ACI/COHPAC | $28,267 | $56.53 | $3,311 | 2.15 | 2.15 |
| Subbituminous | 50% | ACI/ESP | $984 | $1.97 | $1,501 | 0.58 | 1.82 |
| | 60% | ACI/ESP | $984 | $1.97 | $5,165 | 1.91 | 3.15 |
| | 60% | ACI/COHPAC | $28,719 | $57.44 | $3,352 | 2.18 | 2.18 |
| | 90% | ACI/COHPAC | $28,719 | $57.44 | $3,863 | 2.36 | 2.36 |

[a] Capital equipment cost for ACI dosing and storage equipment is assumed a "per installation" cost and is not expected to vary much with injection rate, with some increase assumed for significantly higher injection rates for higher levels of ACI/ESP control.

[b] Annual O&M includes sorbent consumption and disposal but does not include fly ash disposal costs or loss of revenue from by-product sales.

**Table 9 – Marginal costs of mercury control (US $2003) (Source: Hoffman and Ratafia-Brown, 2003)**

| Fuel | Mercury Reduction | Unit Configuration | Incremental Cost of Control, $/lb mercury removed | |
|---|---|---|---|---|
| | | | w/o by-product impact | with by-product impact |
| Bituminous | 50% | ACI/ESP | $32,598 | $245,731 |
| | 70% | ACI/ESP | $45,740 | $133,796 |
| | 70% | ACI/COHPAC | $68,575 | $68,602 |
| | 90% | ACI/ESP | $130,649 | $185,962 |
| | 90% | ACI/COHPAC | $49,005 | $49,022 |
| Subbituminous | 50% | ACI/ESP | $17,472 | $54,950 |
| | 60% | ACI/ESP | $48,086 | $79,318 |
| | 60% | ACI/COHPAC | $54,837 | $54,837 |
| | 90% | ACI/COHPAC | $39,672 | $39,672 |

According to the US EPA reducing mercury emissions by one third would have a rather limited impact on electricity prices (EPA, 2004b). The expected change until 2010 is a rise of 0.6%, and in the long term (2020) only 0.2%. No such overall data for the EU are available. However, information provided by the German power company STEAG in response to the DG Environment consultation exercise has given an illustration of the costs of taking further measures to reduce mercury emissions. The illustration relates to a 500 $MW_{el}$ power plant already equipped with SCR, ESP and FGD, which achieves a mercury reduction of 70-75%. The options of adding activated carbon in the FGD to bring the total mercury removal to above 90%, or adding an activated carbon-containing reagent in combination with a baghouse filter to bring the total removal to above 95%, are considered. The estimated costs are shown in Table 10.

**Table 10 – Costs for additional mercury reduction measures (Source: STEAG)**

| | **Activated Carbon Addition in FGD** | **Baghouse Filter** |
|---|---|---|
| **Investment cost** | €1.8 million | €30 million |
| **Additional operating cost** | €0.6 million | €0.8 million |
| **$CO_2$ allowances** | - | €0.15 million |
| **Total annual cost** | €0.8 million | €4 million |
| **Increase of electricity tariff** | €0.32 / MWh<br>(+ 1-2 %) | €1.6 / MWh<br>(+ 5-10%) |

### *8.3.3 Market-based instrument*

The economic impact of a market-based instrument will depend on the target set and time horizon. An important factor is that accurate monitoring of emissions would be required in order to manage the operation of any emissions trading scheme, which would add to the cost. In theory, however, a market-based instrument ought to be more efficient, and therefore achieving the same total reduction level should be less costly than with a purely regulatory solution.

## 8.4 Social impacts

### *8.4.1 No additional action*

There should be no negative effects resulting from reducing mercury emissions as a co-benefit of implementing current controls. The mercury emission reductions should generate some positive social impacts, such as reduced impacts on health.

### *8.4.2 Extend existing legislation to cover mercury emissions*

The social effects of adopting Community emission limit values would depend on the standards adopted and the methods chosen by the companies to comply with them.

In the case of fuel switching, either to gas or to cleaner coal from imports, there would be negative effects in the EU coal mining sector, including loss of employment.

In the case of retrofitting installations with additional control systems, there would be additional demand for employment in the sectors providing such systems. On the other hand, in some cases adding a new control system may require use of new land that can have negative implications for communities living in the vicinity of the plant. The additional costs of abatement would also lead to higher electricity prices.

### *8.4.3 Market-based instrument*

The social effects of a market-based solution would be similar to the impacts described above. In the case of a cap-and-trade option some additional employment might be created by the monitoring requirements. On the negative side, a cap and trade scheme could create some local hot-spots, i.e. areas where due to a particular plant's investment in allowances rather than in control techniques, local levels of mercury pollution would be higher than elsewhere.

## 8.5 External impacts (i.e. outside the EU)

Lower mercury emissions are expected under all three options. This will have positive external effects, in particular for those countries that are the biggest recipients of transboundary pollution originating in the EU.

Positive effects may also include an increase in demand for low mercury coal and/or other fuels such as gas and oil. On the other hand there might be an increase in the export of the EU coal that has higher mercury content. However, the highest mercury content is in sub-bituminous coal and lignite, which usually is not shipped over long distances due to its relatively low calorific value.

## 8.6 Subsidiarity and proportionality

Taking into account the transboundary nature of mercury pollution, Community action would be more effective than uncoordinated action by the Member States.

This is already illustrated by the action taken against other pollutants under the LCP Directive. However, when considering the question of proportionality the basis for immediate Community action is more questionable. Certainly there is no doubt about the significance of mercury emissions from this sector. But the facts that the application of the LCP Directive can already be expected to reduce mercury emissions significantly, that the IPPC Directive additionally requires the setting of ELVs based on BAT, and that the main techniques to further reduce mercury emissions are not yet seen as fully proven, all place question marks against the proportionality of further action at this stage.

## 9. IMPACTS OF OPTIONS RELATING TO CREMATION

### 9.1 Description of the options

#### *9.1.1 No additional action*

This option assumes that no new action at Community level is taken and that the OSPAR Recommendation 2003/4 on Controlling the Dispersal of Mercury from Crematoria is implemented in all the countries that are party to it (i.e. in Belgium, Denmark, Finland, France, Germany, Ireland, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the UK, as well as Iceland, Norway and Switzerland). According to the available data, EU Member States where cremation is commonly employed but which are not a party to the OSPAR Commission are: Austria, Czech Republic, Estonia, Hungary, Italy, Latvia, Poland, Slovak Republic and Slovenia.

#### *9.1.2 Regulate at the Community level*

A second option is to bring mercury emissions from crematoria under Community legislation. The Community could set emission limit values for crematoria in a new law, or add the larger installations under existing legislation to require the application of BAT. However, cremation is common only in a limited number of EU Member States. Most of these countries are already covered by the OSPAR Recommendation, which requires applying BAT, with an anticipated average mercury emission reduction of >90%. Therefore, the value added by regulating at the Community level could be rather limited. Enforceability could be improved, but on the other hand adoption of any legal instrument would be time consuming. The main potential benefit would be that a Community measure would apply in all Member States, whether a party to OSPAR or not. But some of the non-OSPAR Member States have their own emission standards anyway. For instance, in the Czech Republic[32], the sum of cadmium, mercury and thallium emitted from cremation cannot exceed 0.2 mg/m$^3$. Similar emission limits are set in some German Länder and in Norway[33].

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32 Order of Government 356/2002 Coll. of Laws CR, p. 7574 Notice of Ministry of Environment 117/1997 and 97/2000.

33 0.2mg/Nm$^3$ in Sachsen and 0.5 mg/Nm$^3$ in Brandenburg and in Norway.

### *9.1.3 Stimulate the market to regulate (via standardisation)*

A third option would involve stimulating the market (the cremation business) to regulate itself via standardisation. For instance, a mandate could be issued by the Commission asking CEN to develop standards on emissions from crematoria. Since cremation is a technically complicated process, such an approach could be advantageous compared to legislating at Community level. However, it probably would cover only new installations. Additionally, developing a standard is time consuming, on average taking 3-5 years.

## 9.2 Environmental impacts

### *9.2.1 No additional action*

On the one hand, emissions from crematoria are expected to rise. There are two simultaneous trends contributing to this: a rise in the average number of fillings per body cremated (due to increasing life expectancy) and a rise in the number of cremations.

The OSPAR Commission Recommendation covers 87-90% of cremations in countries for which data are available[34]. The data show a slight increase in the number of cremations of about 5% from 1995 to 2002 (see Figure 4). According to UK estimates the peak level of mercury emissions would be in 2020-2035, with a later decrease and a levelling off at 2000 levels in 2055 (DEFRA, 2003). Some further indicators from selected countries from a 2003 OSPAR report (OSPAR, 2003a) are that:

- In the Netherlands it is expected the average amount of fillings will go up from 3.2 to 5 per person by 2020. Mercury emissions from cremation would have been expected to double by 2020 in the absence of abatement measures.[35]
- Norway also anticipated an increase in emissions due to the increasing number of mercury amalgam fillings.
- In France the rate of cremations increased from 2% of deceased persons in the 1970s to 16% in 2000, and the number of cremation ovens had risen from 90 to 110 in the two years preceding the OSPAR report.

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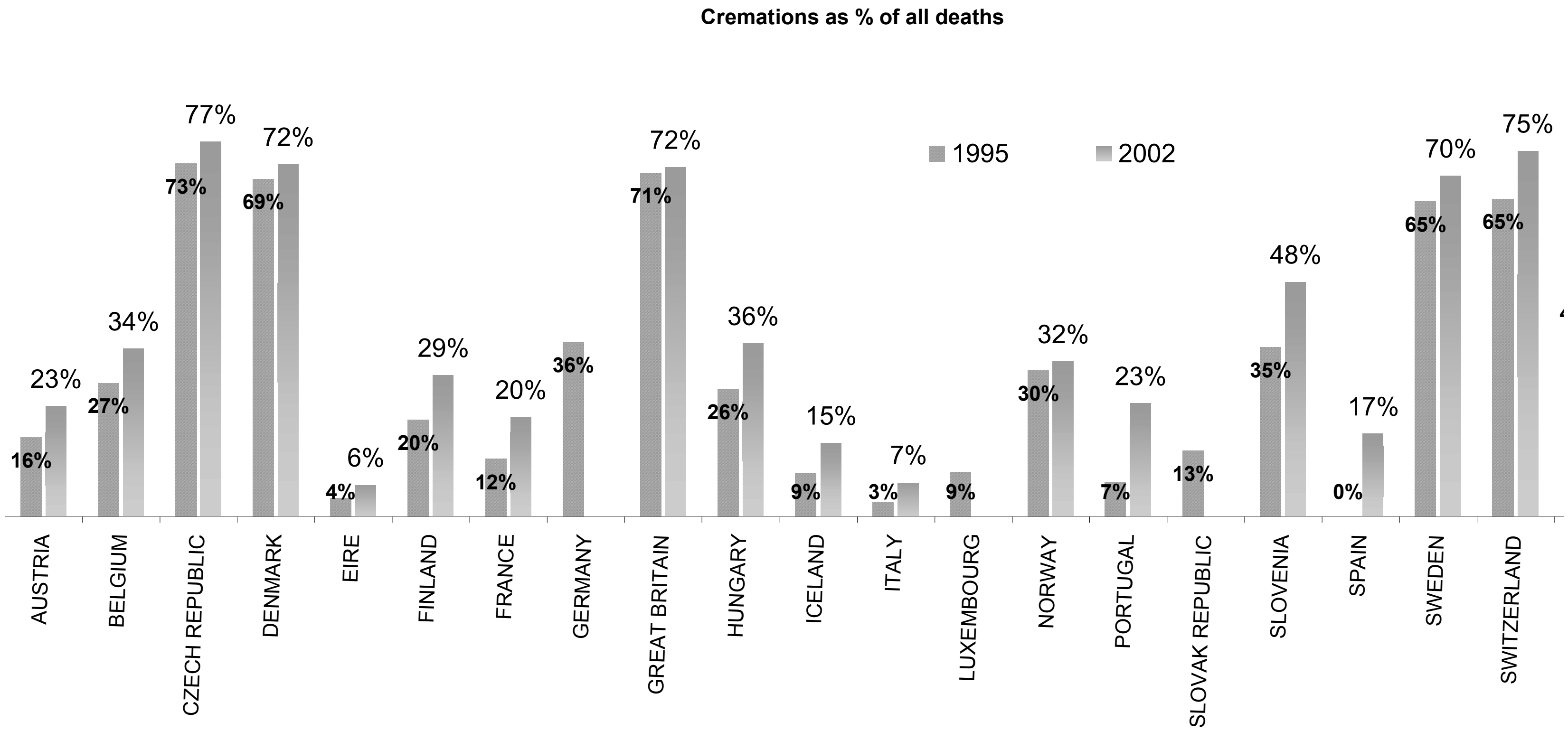
[34] Data from http://www.srgw.demon.co.uk/CremSoc5/Stats/Interntl/2002/StatsIF.html for: Austria, Belgium, Czech Republic, Denmark, Ireland, Finland, France, Germany, Great Britain, Hungary, Iceland, Italy, Luxembourg, Norway, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Netherlands.

[35] Abatement measures for new crematoria have been obligatory since 1999 in the Netherlands, and must be added by the end of 2006 or 2012 for large or small existing crematoria respectively.

On the other hand, if the OSPAR Recommendation is implemented correctly, the anticipated increase in the number of cremations and mercury fillings in cremated bodies is not likely to translate into significantly larger emissions. Moreover, there is already some national legislation in other countries where cremation is quite common, but which are not parties to OSPAR Recommendation, for example as seen in the Czech Republic.

**Figure 4 (Source: Cremation Society of Great Britain, National Cremation Statistics 1960-2002 http://www.srgw.demon.co.uk/CremSoc5/Stats/Interntl/2002/StatsIF.html)**



### 9.2.2 *Regulate at the Community level*

The environmental impact would be positive. Its magnitude, relative to no additional action, would be dependent on two factors: implementation of the OSPAR Recommendation, and the extent of cremation in the countries that are not parties to the Recommendation. In the first case environmental benefits would occur under this option if the OSPAR Recommendation were poorly implemented, for example due to the lack of an enforcement sanction. In the latter case, regulating at the Community level would only really add value if there were significant cremation activity in the countries not covered by the OSPAR Recommendation. Yet, the available data suggests that the scale of emissions from countries not covered by the OSPAR Recommendation must be relatively small, since they only account for around 10-13% of total EU cremations.[36]

### 9.2.3 *Let the market regulate*

The environmental impact would be positive, but might be delayed due to the long time needed for adoption of the standard. It could also be limited by the possibility that standardisation might certify what is currently on the market, rather than setting ambitious new targets. Furthermore, the impact would depend on whether the standardisation work concerned cremation as a whole or, as seems more likely, only product standards for new furnaces. In the latter case, the positive impact would be small, as there are already many furnaces operating. For instance, in the UK there were only 21 new crematoria opened in 1990-2002, whereas in 2002 the total number amounted to more than 240 crematoria.[37]

## 9.3 Economic impacts

### 9.3.1 *No additional action*

The overall economic impact would be negligible. There would be no new investment requirements for operators running crematoria. The additional mercury pollution, relative to other options, would have some negative economic impact, but this would be a small contribution to a problem caused predominantly by other sources of mercury.

### 9.3.2 *Regulate at the Community level*

The OSPAR Commission has made some estimates of costs of applying abatement techniques to crematoria (OSPAR, 2003a), as shown in Table 11. These include installation, additional emission monitoring, transport, assembly and civil engineering costs.

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36 Data from http://www.srgw.demon.co.uk/CremSoc5/Stats/Interntl/2002/StatsIF.html.

37 http://www.srgw.demon.co.uk/.

**Table 11 – Costs of mercury abatement at crematoria (Source: OSPAR, 2003a)**

| Type of installation | Low end costs | High end costs[38] |
|---|---|---|
| Cold start furnace | € 27,270 | €48,180 |
| Warm start furnace | €45,460 | €74,550 |

Costs per gram of avoided mercury emission show greater effectiveness in the case of warm start furnaces – see Table 12.

**Table 12 – Cost effectiveness of mercury abatement at crematoria (Source: OSPAR, 2003a)**

| Type of installation | Number of cremations per year | Mercury emissions (g/year) | Cost per gram of avoided mercury emission (€) |
|---|---|---|---|
| Cold start furnace | 300 | 450 | 100-145 |
| Warm start furnace | 850 | 1275 | 50-73 |

The expected cost increase per cremation is also higher in the case of cold start furnaces (Table 13).

**Table 13 – Cost increase of mercury abatement per cremation (Source: OSPAR, 2003a)**

| Type of installation | Low end | High end |
|---|---|---|
| Cold start furnace | €150 | €225 |
| Warm start furnace | €75 | €110 |

The expected cost of abating mercury emissions is estimated by the OSPAR Commission to make cremation 15-20% more expensive.[39] There are no data on price elasticities, therefore the impact on demand is difficult to estimate.

More broadly, the economic benefits of Community regulation would be rather limited. On the one hand there is virtually no internal market between Member

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38 Donau-Carbon gives a higher estimate: €60-100 thousand. See response by Donau Chemie to the consultation on mercury.

39 However, the response from the Netherlands to the consultation on mercury suggested that mercury abatement there would be only about 2% of the cost of cremation. But it also appears that the overall cost of cremation is higher in the Netherlands than in other countries, as the net cost of abatement per cremation, of around €100 – 150, is very similar to that shown in Table 13.

States for funeral services on the demand side, because for practical and societal reasons most funerals will take place in the local area of the deceased. On the other hand, there is competition between companies delivering funeral services at the local level, and between crematoria furnace suppliers. However, it is difficult to asses to what extent Community regulation would level the playing field. Presumably, there would be some benefits for businesses providing abatement techniques for crematoria. Again, however, the impact of this option relative to no additional action would partly depend on the extent and control of cremation in non-OSPAR countries.

#### *9.3.3 Let the market regulate*

The economic impact would be rather limited. It should be positive for manufacturers of cremation furnaces, but if the standards make furnaces more expensive, it could be negative for companies providing cremation services.

### 9.4 Social impacts

#### *9.4.1 No additional action*

The social impact would be negative to neutral. Negative social impacts could arise for the populations affected by emissions from crematoria, although as already noted, cremation is a relatively small contributor to these problems. More broadly, cremation is a culturally and socially sensitive issue in many countries, hence any action on the Community level could be controversial. The no additional action option would avoid such impacts.[40]

#### *9.4.2 Regulate at the Community level*

The social impact of reduced emissions might be only slightly positive, taking into account the marginal emission reductions of this option as compared to implementation of the OSPAR Recommendation. Undesirable social impacts might appear as cremation is a culturally sensitive issue. It might be very difficult to address all cultural differences and concerns in a single act of Community legislation.

#### *9.4.3 Let the market regulate*

Allowing the market to regulate itself would be less controversial from the perspective of cultural sensitivity. For instance, CEN already works on standards for funeral services, setting general rules regarding the quality of the services, and this could serve as a basis for further, more detailed standards in this area. On the other hand, due to the long time needed for standard setting, the social benefits of additional emission control could be seen only in the longer term.

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[40] Note, however, that the response from Norway to the consultation on mercury suggested that, as cremation may be difficult to discuss at a national level for cultural and social reasons, an international initiative might in fact help countries to address this issue.

### 9.5 External impacts (i.e. outside the EU)

All three options may have a modest impact on foreign manufacturers who export cremation equipment to the EU. The no additional action option would leave differences in national requirements concerning emissions control, although differences among OSPAR countries should not be significant. The other two options would eventually set more or less the same requirements for all Member States. No other external impacts are expected.

### 9.6 Subsidiarity and proportionality

Mercury emissions from crematoria are small compared to other sources. Therefore, it is questionable whether it would be proportionate to take additional action at the Community level for this relatively small – albeit growing – problem, especially when the OSPAR Recommendation already covers the majority of cremations in the EU. Similarly, the cultural and social sensitivity of cremation would suggest it might better be addressed at the Member State level on the basis of subsidiarity.

## 10. How to monitor and evaluate the results and impacts of the mercury strategy after implementation

### 10.1 How will the strategy be implemented?

The mercury strategy is presented in the form of a Communication. Therefore implementing the strategy is a matter of realising the various different types of actions envisaged in the strategy, rather than simply pursuing a single measure. Elements of the strategy's implementation will include:

- Contributions of the Community, Member States and other EU stakeholders/actors to international discussions and actions concerning mercury, including the UNEP Governing Council meeting in February 2005.
- Development or revision of Community legislation, subsequently to be transposed and implemented by the Member States.
- Actions at the level of the Member States or below, where Community action is not considered appropriate.
- Undertaking further studies, assessments and research to fill gaps in knowledge about the mercury problem and its possible solutions.

### 10.2 How will the strategy be monitored and reviewed?

A number of significant milestones can be identified which will provide further data on the mercury problem, possible solutions, and the success of policy measures. Principally these include:

- Annual reporting of emissions by parties to the UNECE CLRTAP, or estimation of such emissions by experts.

- The IPPC Directive, which with very limited exceptions for some of the new Member States is to be fully implemented through the permitting of all existing installations by 30 October 2007. Member States are next due to report on implementation in September 2006 (covering 2003-2005) and then again in September 2009 (covering 2006-2008).

- The LCP Directive, under which certain emission limit values for $SO_2$, $NO_x$ and dust must be met by 1 January 2008. How these ELVs are met will affect how much mercury is also removed from the combustion emissions.

- The OSPAR Recommendation on cremation, under which parties are due to submit a first implementation report on estimated mercury releases by 30 September 2005, and a second report by 30 September 2009.

- The publication of the second European Pollutant Emission Register (EPER)[41] in 2006, which is to contain data reported by the Member States for 2004. Thereafter, the EPER is due to be replaced by a broader Pollutant Release and Transfer Register (PRTR), with a first reporting year of 2007, to be published in 2009.

- The publication of river basin management plans including programmes of measures under the Water Framework Directive. The plans are due to be first published by 22 December 2009 and then every 6 years thereafter, with interim reports at the halfway period between plans.

- The EU funded ESPREME project, on estimation of willingness-to-pay to reduce risks of exposure to heavy metals, and cost-benefit analysis for reducing heavy metal occurrence in Europe. This project was launched in 2004 and will be completed in 2007.

As regards monitoring levels of exposure, action will be taken under the European Environment and Health Action Plan 2004-2010[42] to improve determination of human exposure, by developing integrated monitoring of the environment and food and investigating the scope for a coherent approach to biomonitoring. This will cover a range of environmental stressors including mercury.

Finally, the Commission is due to prepare a report on mercury (and certain other pollutants) under Article 8 of the recently agreed 4th Air Quality Daughter Directive[43] by 31 December 2010. This is to cover, *inter alia*, experience of applying the Directive, the results of the most recent scientific research on the effects of mercury exposure on human health and the environment, and

[41] Commission Decision 2000/479/EC of 17 July 2000 on the implementation of a European pollutant emission register (EPER) according to Article 15 of Council Directive 96/61 concerning integrated pollution prevention and control, OJ L 192, 28.7.2000.

[42] COM (2004) 416 final, 9.6.2004.

[43] Proposed Directive of the European Parliament and of the Council relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air, COM (2003) 423 final, 16.7.2003. Final text not yet published in the Official Journal.

technological developments including progress in methods of assessing concentrations in ambient air as well as deposition. Taking account of measures adopted pursuant to the mercury strategy the report is also to consider whether there would be merit in taking further action in relation to mercury, taking account of technical feasibility and cost-effectiveness and any significant additional health and environmental protection that this would provide.

Overall, therefore, it appears that preparation of the report anticipated by the 4th Air Quality Daughter Directive will provide a suitable occasion to review the implementation and further development of the mercury strategy as a whole. The review will use data from various sources and cover all media, rather than simply reporting from an air quality perspective.

Ahead of this broad review, the Commission may decide to take or propose additional action at an earlier stage. Such additional action might be justified by global developments concerning mercury, or by information becoming available some years ahead of the anticipated 2010 reporting date of the 4th Air Quality Daughter Directive.

## 11. STAKEHOLDER CONSULTATION

### 11.1 Which interested parties were consulted, when in the process and for what purpose?

DG Environment undertook two consultation exercises in the course of preparing the mercury strategy.

Firstly, in September 2003, DG Environment organised a meeting for Member States on the development of the strategy. This was undertaken to allow Member States to present information on their existing legislation and other initiatives relating to mercury, and to discuss the possible content and objectives of the strategy without seeking any commitments or final positions.

Secondly, DG Environment published an open consultation document on development of the mercury strategy on 15 March 2004. The document was published on the DG Environment website[44] and so was available to all. It invited comments from any interested person over a consultation period of 8 weeks.

The consultation document presented an analysis of the situation relating to the use, control, emissions and impacts of mercury and its compounds. It invited stakeholders to comment on a range of issues relating to this subject, in order to inform the development of the mercury strategy. Stakeholders were asked to provide feedback on the analysis presented, technical, scientific or economic information relevant to the different options to address the mercury situation, or other comments. They were also asked to provide or refer to the evidence that

[44] http://europa.eu.int/comm/environment/chemicals/mercury/index.htm.

supported their views, so that development of the mercury strategy could proceed on the basis of established facts and data.

As part of the consultation exercise, DG Environment organised a stakeholder consultation meeting on 31 March 2004. This was attended by nearly 100 representatives from Member States and other countries, trade associations, businesses, environmental NGOs, researchers and international bodies. The meeting provided an opportunity for stakeholders to give initial reactions to the consultation document, and to exchange views ahead of their consultation responses. Subsequently, about 50 written consultation responses were received. All responses were placed on the DG Environment website.

### 11.2 What were the results of the consultation?

In terms of the number of responses, the results of the consultation were as follows:

- Member States and other countries – 9
- Public authorities below Member State level – 2
- Industry associations – 15
- Individual businesses – 11
- Environmental NGOs and consumer organisations – 5
- Universities and research institutes – 3
- Individuals – 6
- International bodies – 2.

The substance of responses is summarised on a question-by-question basis in Annex 7.

## 12. COMMISSION DECISION AND JUSTIFICATION

### 12.1 What is the final policy choice and why?

This section of the ExIA explains the final policy choices. It describes why more or less ambitious choices were not made, based on the trade-offs associated with the various options.

The first part of the answer to this question explains why the mercury strategy is set out in a Communication and not a legislative proposal. This is because, as a broad initiative, development of the strategy has looked across a wide range of issues, examined the extent of the problem, reviewed current legislation and policy, and considered possible additional actions. The strategy therefore provides a base for such additional action, including some further Community legislation, but could not itself appropriately be presented as a legislative proposal.

The second part of the answer addresses the particular areas that were considered in detail in this ExIA.

### *12.1.1 Mercury supply and trade including the fate of surplus mercury from the chlor-alkali industry*

On the basis of the analysis in this ExIA, the Commission favours stopping the export of mercury from the EU. Other options that would allow continued export indefinitely do not appear acceptable, as they would extend the EU's contribution to the global mercury problem rather than helping to address it. This conclusion also reflects the ExIA's assessment of the scope to reduce global mercury demand. Clearly, the EU could not credibly argue for and support active efforts worldwide to reduce mercury demand on the one hand while intending to remain the main global supplier on the other.

Even without action on export of mercury in general, the negative environmental impacts of primary mercury mining and production, as well as their doubtful economic viability, support the permanent ending of these particular activities in the EU. Spain has stated that mining and production in Almadén have already been stopped temporarily, and does not anticipate that they will restart.

Stopping export would also remove the main market for surplus mercury from the chlor-alkali industry, such that storage or disposal would be necessary. On the basis of the analysis in this ExIA, the Commission favours storage of metallic mercury. This could be pursued via legislation. However, as the industry is a large and well established one, with a relatively small number of players, the possibility of proceeding via an agreement can be explored in the first instance. The industry has already stated a preference for storage over permanent disposal, and has begun to investigate the possibilities in this area. Permanent disposal of stabilised mercury is a long term option, but for the moment the Commission considers that it is too expensive, and has too many technical uncertainties, to be pursued at Community level.

The analysis indicates that the inclusion of metallic mercury under the PIC procedure of the Rotterdam Convention would be positive, though not sufficiently effective alone to obviate the need for EU action. However, a PIC listing could still be an advantageous complementary measure, as it would act at the international level. The Commission therefore considers that the Community should promote an initiative to make mercury subject to the PIC procedure.

More broadly, to reduce mercury supply internationally the Community should advocate a global phase-out of primary production and encourage other countries to stop surpluses re-entering the market. This could be pursued under an initiative similar to that of the Montreal Protocol on substances that deplete the ozone layer. As a pro-active contribution to such a proposed globally organised effort, the Commission intends to bring forward a proposal to phase out the export of mercury from the Community by 2011.

### *12.1.2 Measuring and control equipment*

The Commission considers it would be appropriate to introduce a marketing restriction on measuring and control equipment for consumer use and, with some exemptions, the healthcare sector. This is because of the relatively high level of mercury use in this sector, as assessed in this ExIA, which will also lead to significant emissions. Establishing a restriction on measuring and control devices containing mercury at Community level would have a higher effectiveness than leaving such measures to the Member States alone, without entailing higher costs. Therefore this option seems preferable. However, extending the restriction to specialist industrial and scientific applications would need further investigations. The analysis has found that adequate substitutes for such specialist applications are not always available, and the standard of waste management should also be higher, at least as compared to that for consumer products.

### *12.1.3 Coal combustion*

The Commission considers it is not appropriate, at this stage, to propose new Community action in order to target mercury emissions from the combustion of coal. The analysis in this ExIA gives a number of reasons for this conclusion. Primarily, coal combustion in large combustion plants is already covered by two major pieces of Community law – the IPPC and LCP Directives. The IPPC Directive applies the concept of BAT to minimise emissions of mercury and other pollutants, and as BAT evolves competent authorities are required to reconsider and update permit conditions (see Article 13(2)). The LCP Directive, meanwhile, does not apply explicitly to mercury but includes requirements for other pollutants which will also reduce mercury emissions. The impact of these requirements will be more evident after 1 January 2008.

As regards small combustion plants and residential coal burning, consultation has revealed that data on this subject and proposals for realistic solutions are presently scarce. As a result, it has not been possible to undertake a detailed assessment of the policy options in this area. In any case, control of polluting emissions from small combustion installations is more likely to be cost-effective when considered on a multi-pollutant, rather than a single substance, basis. This is being examined with the Commission’s broader Clean Air for Europe (CAFE) programme. The Commission is therefore planning to launch a study of the availability and costs of options to abate mercury emissions from small scale and residential coal combustion, to be considered alongside the CAFE multi-pollutant assessment.

There are significant emissions from coal combustion outside the EU. To help combat this, the Commission will consider establishing a specific funding scheme for research and pilot projects to reduce mercury emissions from coal combustion in countries with a high dependency on solid fuels such as China, India and Russia. This would be similar to the CARNOT programme that promotes the clean and efficient use of solid fuels.

### *12.1.4 Cremation*

The Commission considers it is not appropriate, at this stage, to pursue Community-level action on cremation. This is because most of the problem with mercury emitted from crematoria assessed in this ExIA is already covered by an OSPAR Recommendation, and by legislation in some of the remaining Member States who are not parties to the OSPAR Convention. Therefore, the marginal benefit of Community action could be limited. In addition, presently available data on the extent of emissions from cremation are limited. This situation should be improved by reporting on emissions by parties to the OSPAR Recommendation (the first such reporting being due by 30 September 2005), which should also give an initial indication of the extent to which the Recommendation is being applied.

### *12.1.5 Other issues*

In addition to the key issues discussed above, development of the mercury strategy has also considered some other issues in less detail.

(a) Other mercury emissions

In respect of mercury emissions, there are a number of sectors other than those discussed above which cause significant releases. However, these are all already covered by the IPPC Directive and the requirement to apply permit conditions based on BAT. Moreover, the Commission has published a series of BREF documents for the various industry sectors covered by IPPC, and with the first round of BREFs virtually completed an updating process is due to start this year. The Commission will therefore encourage Member States and the industries concerned to provide more information on mercury emissions and possible prevention and control techniques, so that conclusions can be drawn helping Member States to achieve further emission reductions. The Commission will also review the effects of applying IPPC on mercury emissions, and the extent to which further emissions reductions are required, after the permitting of existing installations has been completed.

(b) Decommissioning of mercury cells

A specific area where more information concerning mercury will be provided is in updating the BREF for the chlor-alkali sector. This will address BAT for the decommissioning of mercury cells, using information from Euro Chlor and other sources.

(c) Dental amalgam

This sector will soon be the major user of mercury in the EU, and given the contribution of dental amalgamation to human mercury exposure, it seems appropriate to re-examine the possibilities for substitution. The Commission will therefore raise this issue for consideration in the Medical Devices Expert Group, and will also seek an opinion from the Scientific Committee on Health and Environmental Risks.

(d) Other products and applications

There are some remaining products and applications of mercury in the EU that individually use small amounts of mercury but collectively consume a more significant total. The Commission plans to undertake further study of these remaining uses.

(e) Mercury already circulating in society

The Commission also recognises the large amount of mercury held in products already circulating in society as an important issue, where more active collection and recycling could be considered. However, some Member States argue that mercury should not be recovered for reuse, but rather should be taken out of circulation via storage or disposal. The Commission will undertake further study of this issue.

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## Annex 1: Regional and Global Initiatives Relating to Mercury

**The 1998 Protocol on Heavy Metals under the UNECE Convention on Long Range Transboundary Air Pollution (CLRTAP).**[45] Provisions of the protocol require parties to reduce total annual emissions of mercury into the atmosphere, secure application of the best available techniques for stationary sources, and consider applying additional product controls. The protocol entered into force on 29 December 2003. Scientific support for the development and implementation of this and other protocols under the CLRTAP is provided by the Cooperative Programme for Monitoring and Evaluation of the Long Range Transmission of Air Pollutants in Europe (EMEP).

**The OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic.**[46] The Convention's objective of preventing and eliminating pollution is reflected in a strategy on hazardous substances, agreed in 1998. This has the ultimate aim of achieving concentrations in the marine environment near background values for naturally occurring substances (such as mercury) and close to zero for man-made synthetic substances, with every endeavour to be made to move towards the target of cessation of discharges, emissions and losses of hazardous substances by 2020. A number of specific Decisions and Recommendations relating to mercury have also been adopted, recently including Recommendation 2003/4 on Controlling the Dispersal of Mercury from Crematoria.

**The Helsinki Convention on the Protection of the Marine Environment of the Baltic Sea Area.**[47] The Convention aims to prevent and eliminate pollution in order to promote the ecological restoration of the Baltic Sea Area and the preservation of its ecological balance. A specific strategy on hazardous substances was adopted in 1998. Its objective is to prevent pollution by continuously reducing discharges, emissions and losses of hazardous substances towards the target of their cessation by 2020. The ultimate aim is to achieve concentrations in the environment near background values for naturally occurring substances and close to zero for man-made synthetic substances. A number of Recommendations specifically affecting mercury have been adopted, recently including Recommendations 23/4 and 23/6 of 2002 concerning mercury in lighting/electrical equipment and the chlor-alkali industry respectively.

**The UNEP Mediterranean Action Plan (MAP).**[48] MAP is an effort involving 21 countries bordering the Mediterranean Sea, as well as the EU. There are three protocols which control pollution to the sea, including the input of hazardous substances.

45 http://www.unece.org/env/lrtap/hm_h1.htm.
46 http://www.ospar.org.
47 http://www.helcom.fi/.
48 http://www.unepmap.gr/.

**The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.**[49] The Convention strictly regulates the transboundary movements of hazardous wastes and establishes obligations for parties to ensure such wastes are managed and disposed of in an environmentally sound manner. Any waste containing or contaminated by mercury or its compounds is considered hazardous waste and is covered by the provisions of the Convention. Hazardous wastes may not be exported from the EU or OECD for disposal, recovery or recycling in other countries.

**The Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade.** [50] The Convention establishes the principle that export of specified chemicals and pesticides can only take place with the prior informed consent of the importing party. At present, mercury compounds used as pesticides are covered by the PIC procedure, but mercury and its compounds intended for industrial use are not.

**The Arctic Council Action Plan to Eliminate Pollution of the Arctic (ACAP).**[51] The Arctic Council is a high-level intergovernmental forum that provides a mechanism to address the common concerns and challenges faced by the Arctic governments and peoples. The ACAP, agreed in 1997, prioritises a number of pollutants of special concern for the Arctic Region, including mercury. Planned activities include identification and quantification of major point sources, with the aim of implementing concrete emission reduction pilot projects.

**The Nordic Environmental Action Programme 2001-2004.**[52] This programme establishes environmental priorities within the framework of Nordic cooperation in the fields of nature and the environment. It follows up on commitments in a Nordic sustainable development strategy, which has as one of its objectives the discontinuation within 25 years of discharges of chemicals posing a threat to health and the environment.

**International action relating to use of mercury in artisanal gold mining.** A number of international bodies have worked on this issue, including the International Labour Organisation,[53] the World Bank,[54] and the United Nations Industrial Development Organisation (UNIDO).[55] UNIDO, in particular, hosts the Global Mercury Project, also supported by the United Nations Development

49 http://www.basel.int/.
50 http://www.pic.int/.
51 www.arctic-council.org/.
52 www.norden.org/.
53 http://www.ilo.org/public/english/dialogue/sector/techmeet/tmssm99/tmssmr.htm.
54 http://www.worldbank.org/ogmc/mining_artisinal.htm.
55 http://www.unido.org/es/doc/4571.

Programme (UNDP) and the Global Environment Facility (GEF), which is undertaking projects in countries affecting international waters with mercury from artisanal mining.

# Annex 2: An Overview of the Mercury Problem

## 1. INTRODUCTION

This annex presents an overview of the mercury problem. The problem has been described in detail in other recent documents, such as the UNEP Global Mercury Assessment (UNEP Chemicals, 2002), and work carried out by an independent expert group considering mercury in relation to Community air quality legislation (Pirrone et al, 2001). The discussion below is largely based on these sources, plus others where noted

## 2. SOURCES AND CYCLING OF MERCURY IN THE ENVIRONMENT

Mercury comes from a variety of sources, both natural and anthropogenic. Natural sources include volcanoes, evaporation from soil and water surfaces, degradation of minerals and forest fires. Anthropogenic sources include a variety of industrial activities, some involving intentional use of mercury, such as the chlor-alkali industry, and others involving the release of the natural mercury content of raw materials, such as coal combustion. Use in products such as thermometers and dental amalgam also leads to mercury releases. Sources of anthropogenic release, and possibilities for control, are discussed in more detail on the basis of the mercury cycle in Annex 3.

Mercury also exists in a variety of forms. The majority of emissions to air, for example, are in the form of gaseous elemental mercury, which can be transported globally to regions far from the emissions source. The remaining emissions are in the form of gaseous inorganic ionic mercury forms (such as mercuric chloride) or bound to emitted particles. These forms have a shorter atmospheric lifetime and will deposit to land or waterbodies within roughly 100 to 1,000 kilometres of their source. The ocean currents are also media for long range mercury transport.

Once deposited, the mercury form can change (primarily by microbial metabolism) to methylmercury, which has the capacity to collect in organisms (bioaccumulate) and to concentrate up food chains (biomagnify), especially in the aquatic food chain.

Mercury has been used for thousands of years. For example, records of mining the mercury deposits in Almadén, Spain, date back to the Roman era.[56] Use and emissions have generally risen with industrialisation, but are now declining in some regions as the toxic nature of mercury is increasingly recognised and controls are introduced. Compared to natural levels, anthropogenic activities are thought to have increased levels of mercury in the atmosphere by roughly a factor of 3, average deposition rates by a factor of 1.5 to 3, and deposition near industrial areas by a factor of 2 to 10.

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56 See http://www.mayasa.es/PATRIMONIO.htm.

Given this long historic use of mercury, it is relevant to consider the fate of the mercury released over hundreds of years. The UNEP Global Mercury Assessment refers to a "global pool" – mercury that is continuously mobilised, deposited on land and water, and remobilised. Further emissions add to this global pool that circulates between air, water, sediments, soil and biota in various forms.[57]

The earth's surface soils, water bodies and bottom sediments are thought to be the primary biospheric sinks for mercury. The only long term sinks for removal of mercury from the biosphere are deep sea sediments and, to a certain extent, landfills. In the case of landfills, however, leaching and evaporation of mercury can be expected to occur over decades, or even centuries. The UNEP Global Mercury Assessment indicates that, in the long term (centuries or millennia), the fate of mercury in normal surface landfills cannot be considered to be well defined, for example due to uncertainties over how long leachate treatment will continue, and the possibilities of disturbance due to human, geological or climatic processes.

Releases due to remobilisation of previously deposited mercury are not well understood and are largely beyond human control. The main opportunities for control therefore lie in intervention at or before the point of release.

## 3. THE EFFECTS OF MERCURY ON HEALTH AND THE ENVIRONMENT

Mercury and its compounds are highly toxic to humans, especially to the developing nervous system. They are also harmful to ecosystems and wildlife populations. Top predators in aquatic food webs (such as fish-eating birds and mammals), Arctic ecosystems, wetlands, tropical ecosystems and soil microbial communities are particularly vulnerable.

The toxicity of mercury to humans and other organisms depends on the chemical form, the amount, the pathway of exposure and the vulnerability of the target exposed. Methylmercury is the form of greatest concern, although elevated exposures to elemental mercury are also undesirable, as it too is toxic to the nervous system.

Methylmercury readily passes both the placental barrier and the blood-brain barrier, therefore human exposures during pregnancy are of highest concern. Some studies suggest that even small increases in methylmercury exposures may cause adverse effects on the cardiovascular system, and methylmercury compounds are also considered possibly carcinogenic to humans.

57 There is a fixed amount of mercury on earth that cannot be reduced or increased, but its form and location can be changed. An effect of anthropogenic activities, therefore, has been to move mercury from relatively stable geological deposits to the "global pool" where it is more subject to (re-) mobilisation and transformation.

**The effects of severe contamination or poisoning**

This is illustrated by the methylmercury poisoning, first observed in the 1950s, of people in Japan living around the Yatsushiro Sea, which had been polluted by wastewater discharges into Minamata Bay from an acetaldehyde chemical plant. Many severe effects were observed including parasthesia (abnormal physical sensations such as numbness), ataxia (unsteadiness due to the brain's failure to regulate the body), sensory disturbances, tremors, hearing impairment, difficulty in walking and many fatalities. There have been approximately 3,000 certified patients, of whom nearly 1,800 have died, and over 10,000 people with conditions such as sensory disorders who have received medical payments.[58] Children of exposed women showed a higher incidence of symptoms than people who were exposed as adults. Severe neurological effects and grossly abnormal behaviour were also noted in animals in the Minamata area.

Fortunately instances of severe poisoning such as the Minamata case are rare, although some high exposures continue to occur, for example in some developing countries where mercury is used in small scale artisanal gold mining. However, mercury continues to have effects at much lower levels, and the problems addressed in this document are largely concerned with chronic, long term effects rather than acute poisoning.

The US National Research Council (NRC) has established an intake "reference dose" (RfD) for methylmercury of 0.7 µg/kg body weight per week (NRC, 2000). This represents an estimate of a daily exposure to the human population (including sensitive subgroups) likely to be without appreciable risk of deleterious effects during a lifetime. Similarly, the FAO/WHO Joint Expert Committee on Food Additives (JECFA) has established a "Provisional Tolerable Weekly Intake" (PTWI) for methylmercury of 1.6 µg/kg body weight.[59]

The US EPA has calculated that an average intake of methylmercury at the RfD by an adult woman would typically result in hair mercury concentrations of about 1 µg/g, cord blood levels of about 5-6 µg/l, and blood mercury concentrations of about 4-5 µg/l (EPA, 2001). Similarly, an intake at the JECFA PTWI would lead to a hair mercury concentration around 2 µg/g. By comparison, the maternal hair concentrations associated with the very serious prenatal effects that occurred in Minamata were thought to be in the range of about 10-100 µg/g (Tsubaki and Irukayama, 1977; NRC, 2000; UNEP Chemicals, 2002).

The difference between the NRC and JECFA figures is partly explained by the fact that JECFA used a smaller uncertainty factor than NRC.[60] The NRC RfD used a safety margin of a factor of 10 from the "Benchmark Dose Limit" (BDML) of 58 µg/l cord blood, while JECFA used a factor of 6.4 from a BDML of 14 µg/g hair. The BDML is the level at which it is accepted there are clear

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58 See National Institute for Minamata Disease website at http://www.nimd.go.jp/english/index.html.

59 See http://who.int/pcs/jecfa/Summary61.pdf.

60 For a more detailed discussion of the differences see Grandjean et al, 2005.

neurological effects – in this case a slight impairment of cognitive function as measured during neuropsychological tests in children, which should be considered relatively serious.[61] The BMDL is not a no-adverse-effect level (NOAEL), but rather a lowest-observed-effect level (LOEL)

A recent survey (Grandjean et al, 2005) has summarised and compared the results of the major prospective cohort studies carried out on methylmercury exposure, plus a number of cross-sectional studies. Although there is not full coherence among all of the evidence, two of the three major prospective cohort studies carried out to date – in New Zealand and the Faroes – are in good agreement. They suggest that each doubling of prenatal mercury exposure, starting from around the NRC RfD, leads to a loss in IQ of about 1.5 points. More specifically, in New Zealand an IQ below 70 (indicating mental retardation) was twice as common in the highest hair mercury group (> 10 µg/g) compared to the group with hair mercury below 6 µg/g (Kjellström, 2000).

The third study, carried out in the Seychelles, found no evidence of impairment of methylmercury-exposed children (Myers et al, 2003). Some uncertainties associated with that study have been noted (Grandjean et al, 2005), however, and the US NRC found that it had only a 50% chance of finding a statistically significant effect.

Although the developing brain is considered the critical target organ in regard to methylmercury, Grandjean at al (2005) also note recent evidence suggesting that mercury from fish and seafood may promote or predispose the development of heart disease. This is a relatively new subject of research and the evidence is yet inconclusive, but the increased risk seems to occur at hair-mercury concentrations above 2 µg/g, i.e. only twice the level corresponding to the NRC RfD and around that of the JECFA PTWI.

Finally, the most recent data (Murata et al, 2004) suggest that the effects of methylmercury exposure may yet extend significantly below even the US RfD. Although effects at such levels would be likely to be less important than those occurring at higher exposures, this nevertheless suggests there may be benefits of decreasing exposures even for populations who are below the present RfD/PTWI levels.

## 4. COMPOUNDING FACTORS ASSOCIATED WITH METHYLMERCURY IN FISH

The UNEP Global Mercury Assessment notes two compounding factors associated with the problem of methylmercury in fish. Firstly, fish consumption is generally on the increase. Secondly, rising water levels associated with global climate change may also have implications for the methylation of mercury and its accumulation in fish. For example, there are indications of increased formation of methylmercury in small, warm lakes and in many newly flooded

[61] In statistical terms the BMDL is the lower 95% confidence limit of the benchmark dose (BMD), where the BMD is an exposure that results in an increased frequency of a pathological outcome from 5 to 10%.

areas. The effect of flooding forests for hydroelectric reservoirs, which can raise mercury levels by an order of magnitude, has been documented (St. Louis et al, 2004; Povari, 2003). The impacts of factors such as clearcutting and forest fires on mercury levels have also attracted attention (Erickson, 2003; Garcia and Carignan, 2000).

# 5. LEVELS OF MERCURY IN THE EUROPEAN UNION

## 5.1. Air

Emissions of mercury to air in Europe, reported in the context of the UNECE CLRTAP, fell by about 60% from 1990 to 2000 (UNECE, 2003). However, towards the end of this period emissions appeared to have levelled off. The data reported by the few parties to the Convention that have estimated future emissions present a rather variable picture, with emissions projected to rise in some countries and fall in others.

Concentrations of mercury in ambient air in Europe are generally below a level where they are believed to have adverse effects on human health. Therefore, mercury in ambient air is not regulated in the fourth daughter Directive under the framework Directive 96/62/EC on ambient air quality assessment and management. Concentrations that exceed this level have been recorded at specific, heavily impacted locations in Europe in the mid and late 1990s, however.

## 5.2. Water

The European Environment Agency has recently published an indicator-based assessment of Europe's waters (Nixon et al, 2003). There are a number of positive indicators relating to mercury. For example, direct and riverine inputs of mercury into the North-East Atlantic between 1990 and 1999, and atmospheric inputs of mercury into the North Sea between 1987 and 1995, both fell by over 50%. Concentrations regulated by Directive 76/464[62] are also decreasing in some European rivers where data series are available. The average concentration of mercury measured at river stations in 6 EU countries fell from just under 0.25 µg/l in 1977 to 0.1 µg/l in 1995. Exceedences of the current environmental quality standard[63] for mercury are relatively rare: 32 monitoring stations out of a total of 2,281 exceeded the mercury standard in the period 1994-1998.

The EEA report also reviewed concentrations of hazardous substances in marine organisms. Mercury was found to be decreasing in mussels in the NE Atlantic

62 Directive 76/464/EEC of 4 May 1976 on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community, OJ L 129, 18.5.76.

63 This refers to the present EQS for mercury as a List I substance under Directive 76/464, and Directive 82/176 on limit values and quality objectives for mercury discharges by the chlor-alkali electrolysis industry, OJ L 81, 27.3.82. However, the need for a lower EQS has been recognised and is currently under discussion in the context of Directive 2000/60/EC.

and the Mediterranean, but remaining constant in Baltic Herring and NE Atlantic Cod, despite the measures taken. As regards hazardous substances in lakes, the report notes that, based on data from the Nordic countries, there are elevated concentrations of heavy metals in several lakes. In Sweden, for example, women who are pregnant, breastfeeding or planning to have children are recommended not to eat certain fish species at all due to their mercury content.

The Secretariat of the HELCOM Convention has provided some information on mercury in the Baltic Sea, in response to DG Environment's consultation on mercury. Heavy metal concentrations in the Baltic Sea are reportedly many times higher than in the northern Atlantic, and have not decreased since the 1990s. The total atmospheric deposition of mercury to the Baltic Sea in 2001 amounted to 3.2 tonnes. Atmospheric deposition increased by about 14% from 1996 to 2000, even though emissions from HELCOM countries fell by about 15% over this period.

### 5.3. Soil

The UNEP Global Mercury Assessment states that microbiological activity in soil appears to be very sensitive to mercury, and that significant impacts may already be taking place in forest soils over large parts of Europe. Microbiological activity is vital to the processing of carbon and nutrients in the soil, and the health of the microbiological community has a great effect on the living conditions of trees and soil organisms, which form the basis for the terrestrial food chain. Mercury also has a long retention time in soil. As a result the mercury accumulated in soil may continue to be released to surface waters and other media for long periods of time, possibly hundreds of years.

The extent to which mercury concentrations in soils have increased over the last century or so depends on the depth of soil and the region considered. In organic forest topsoils, the increase is estimated to be about a factor of 10 in and around the Czech Republic, a factor of 4 in southern Sweden, and a factor of 2 in Arctic Sweden (Meili et al, 2003; Suchara and Sucharová, 2002). A critical limit of 0.5 mg/kg for mercury in soil organic matter has been proposed (Meili et al, 2003), which appears to be exceeded in most of central Europe. More work on the concept of "critical loads" for mercury is being carried out under the UNECE CLRTAP (UNECE, 2004).

### 5.4. Human exposure

In developed countries, humans are principally exposed to mercury through inhalation of mercury vapour from dental amalgam and methylmercury from diet. Most sources suggest that the exposure to mercury vapour from amalgam is of less concern than ingestion of methylmercury, which is usually dominated by the consumption of fish. The Community has set a maximum allowable level for total mercury of 0.5 mg/kg for fishery products and a separate maximum level of 1 mg/kg for certain fish species[64]. The mercury present in fish and seafood products is largely, but not entirely, in the form of methylmercury.

On 24 February 2004, at the Commission's request the Scientific Panel on Contaminants in the Food Chain of the European Food Safety Authority (EFSA) adopted an opinion on mercury and methylmercury in food.[65] This took into account the JECFA PTWI and the US NRC RfD. It compared them against data gathered by 12 EU Member States and Norway on levels of mercury in foods and estimates of dietary exposure as part of a scientific co-operation (SCOOP) task.[66] The EFSA opinion and the SCOOP report should be referred to directly to see their full analyses and conclusions in context. Selected findings are shown in the box below.

The EFSA opinion concluded that the reduction of the PTWI for methylmercury by JECFA in June 2003, from 3.3 to 1.6 µg/kg body weight, was justified because, rather than focusing on risks to the general population, it was based on the most susceptible lifestage, i.e. the developing foetus and intake during pregnancy. Comparison with the lower US NRC recommendation may offer additional guidance.

The estimated intakes of mercury in Europe varied by country, depending on the amount and type of fish consumed. Based on the SCOOP document, national average exposures to methylmercury[67] from fish and seafood products were between 1.3 and 97.3 µg/week, corresponding to <0.1 to 1.6 µg/kg body weight per week (assuming a 60 kg adult body weight). Hence the highest average intake estimates were just at the PTWI, thereby exceeding the US NRC recommendation.

In general, EU consumers who eat average amounts of varied fishery products are not likely to be exposed to unsafe levels of methylmercury. However, people who eat more than average amounts of fish are more likely to exceed these recommended safety thresholds. In particular, population groups who frequently consume top predatory fish, such as swordfish and tuna, may have a considerably higher intake of methylmercury and exceed the PTWI. The range of national high exposures[68] was estimated to be between 0.4 and 2.2 µg/kg body weight per week of methylmercury.

64 Regulation 466/2001 of 8 March 2001 setting maximum levels for certain contaminants in foodstuffs, OJ L 77, 16.3.2001, as amended by Commission Regulation 221/2002 of 6 February 2002, OJ L 37, 7.2.2002.

65 See http://www.efsa.eu.int/science/contam_panel/contam_opinions/259_en.html.

66 See http://europa.eu.int/comm/food/food/chemicalsafety/contaminants/scoop_3-2-11_heavy_metals_report_en.pdf.

67 The SCOOP data recorded total mercury rather than methylmercury. Methylmercury is the chemical form of most concern and can make up to more than 90% of the total mercury in fish and seafood. The EFSA opinion based its calculations on the conservative assumption that all the mercury in fish and seafood products is methylmercury.

68 High exposure is measured at the 95th or 97.5th percentile of the distribution for fish- and seafood product consumption depending on the country considered.

The SCOOP data showed that, although the population in Norway had the highest total consumption of fish and seafood products, the estimated high intake of methylmercury from these foods was lower in Norway than in southern European countries. The reason for this is probably that the type of fish consumed in Norway consists of species, such as cod and saithe, containing relatively low levels of methylmercury. The consumption of top predatory fish, such as swordfish and tuna, which can contain higher levels of methylmercury, may be significantly greater in countries in southern Europe.

A probabilistic analysis carried out by EFSA using the French data from the SCOOP report suggested that, based on the distribution of consumption and fish contamination, in France 11.3% of 293 children aged 3-6 years would exceed the JECFA PTWI for methylmercury and 44% would exceed the US NRC recommendation. The figures for 248 adults were 1.2% and 17% respectively. However, the figures for children exceeding the PTWI are likely to represent an overestimate, because young children often tend to eat fish from species that are more likely to contain only low levels of methylmercury, such as the white fish in fish fingers/fish sticks. It is also important to note that some of the calculated high intakes may be overestimates in view of limitations on the available data, as indicated in the SCOOP report.

Specific intake data for pregnant women were not available for the assessment. Because the intake estimates for high consumers were close to the PTWI established by JECFA, and exceeded the US NRC limit, EFSA highlighted the need to generate reliable intake data from studies focused on women of childbearing age.

The extent of mercury contamination has led many countries to issue advisory warnings for some groups of consumers to limit fish consumption or avoid eating certain fish altogether. However, fish is a valuable part of the diet. Indeed, consumption of fish is recommended in many cases – for example the UK Food Standards Agency (FSA) recommends consumption of at least two portions of fish a week. At the same time, the FSA advises that women who are pregnant or thinking of becoming pregnant, and children, should avoid eating shark, swordfish and marlin, and should limit their consumption of tuna, because of their relatively high levels of methylmercury.[69]

Another recent review (Barregård, 2005) has examined human biomonitoring data concerning mercury in Europe and the Arctic. This concluded that the hair mercury content of most people in Central and Northern Europe is below the levels corresponding to the NRC RfD and the JECFA PTWI. However, most people in coastal areas of Mediterranean countries, and around 1-5% of the population in Central and Northern Europe, are around the RfD. In addition, large numbers of the Arctic population and Mediterranean fishing communities are above the NRC BMDL equivalent figure for hair of 10 µg/g.

[69] See http://www.foodstandards.gov.uk/multimedia/faq/mercuryfish/.

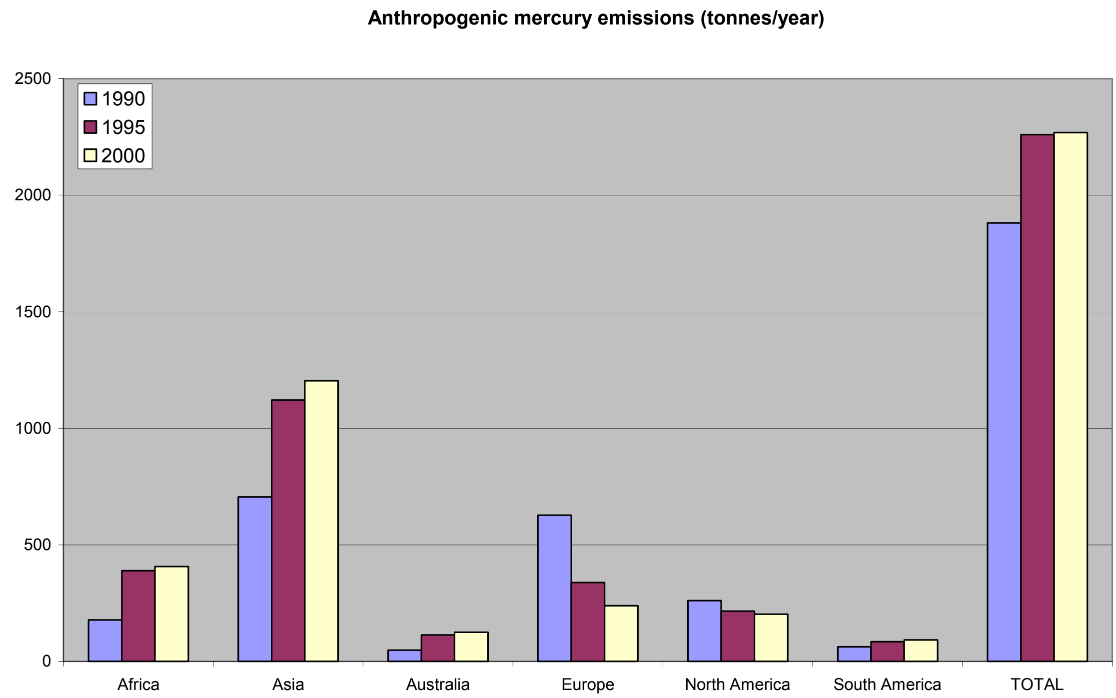
Particularly elevated levels of mercury have been found in some areas. For example, hair mercury concentrations have been measured in Madeira, Portugal, where the population eats a lot of black scabbard (Murata et al, 1999). The hair mercury concentrations of 149 children ranged from 0.4-26.0 µg/g, with a median of 3.82 µg/g. Maternal hair concentrations were generally higher and varied from 1.1 to 54.4 µg/g, with a median of 9.64 µg/g. Hair mercury concentrations have also been measured among regular consumers of large tuna in Sardinia (Carta et al, 2003). Among a sample of 8, the median hair concentration was 9.6 µg/g. In Sweden, measurements of mercury in blood found a median level of about 2 µg/l, but a high value of 31 µg/l recorded in a study of women with high consumption of fish (Naturvårdsverket, 2003b).

# 6. A GLOBAL AND TRANSBOUNDARY PERSPECTIVE

## 6.1. Mercury emissions

As has already been noted, mercury is a global pollutant, and in many respects the problems of mercury are greater in other parts of the world than in the EU. Figure 5 shows how overall emissions to air in Europe[70] decreased by about 60% from 1990 to 2000, while global emissions rose by about 20% over the same period (Pacyna et al, 2003). As a result, the European share of the total global mercury emissions to air fell from about 33% in 1990 to about 10% in 2000.

**Figure 5 (Source: Pacyna et al, 2003)**




[70] Note that these data are for geographic Europe hence data coverage is wider than EU15 or EU25.

## 6.2. Transboundary pollution to, from and within Europe

It is also possible to look at the extent to which European emissions lead to deposition in other parts of the world, and vice versa. This is shown in Tables 14 and 15, based on EMEP modelling results using data for 1995 (Ilyin et al, 2003; Travnikov, 2004). The figures represent total annual deposition from both anthropogenic and natural sources. The anthropogenic component is given in parentheses.

**Table 14 – Deposition of mercury in 1995 from European sources to continents of the northern hemisphere and to the Arctic (Source: Ilyin et al, 2003; Travnikov, 2004)**

| **Continent** | **Europe** | **Asia** | **N. America** | **Africa (N. Hemisphere)** | **S. America (N. Hemisphere)** | **Arctic Region** |
|---|---|---|---|---|---|---|
| **Deposition of mercury emitted in Europe (t/y)**[71] | **120**<br>**(116)** | **62**<br>**(54)** | **33**<br>**(29)** | **8**<br>**(7)** | **5**<br>**(4)** | **61**<br>**(54)** |

**Table 15 – Deposition of mercury in 1995 to Europe from continents of the northern hemisphere and through the equator (Source: Ilyin et al, 2003; Travnikov, 2004)**

| **Continent** | **Europe** | **Asia** | **Americas** | **Africa (N. Hemisphere)** | **Oceans** | **Equator** |
|---|---|---|---|---|---|---|
| Deposition (t/y) | 120<br>(116) | 30<br>(23) | 10<br>(6) | 5<br>(2) | 24<br>(0) | 8<br>(8) |
| % of total deposition | 61 | 15 | 5 | 3 | 12 | 4 |

From Tables 14 and 15 the following points can be noted concerning the situation in 1995:

- The majority of deposition in Europe resulted from emissions in Europe.
- The anthropogenic component of mercury deposition to Europe considerably exceeded the natural one.
- Most of Europe's anthropogenic mercury left Europe and was deposited elsewhere. A much smaller amount of mercury originating in other regions was deposited in Europe. As a result, in 1995 Europe was a net "exporter" of mercury deposition to Asia, North America, Africa, South America and the Arctic Region.

71 These figures do not sum to the total European emission because some of that total will be deposited elsewhere – principally in the oceans but also in the southern hemisphere.

- Europe is a major contributor to mercury deposition in the Arctic.

The level of decrease in European emissions between 1995 and 2000 (see Figure 5) suggests that these broad outcomes remain true, though to a somewhat reduced degree. This conclusion is also borne out in a recent discussion by Ryaboshapko et al (2005), which additionally presents an analysis of the origin of mercury deposited in a number of different European countries. This is reproduced in Table 16. The data are for 2000. For each receiving country they show the total deposition in tonnes and break this down into percentages according to the origin of the mercury. Percentages are shown for the own contribution, the two other main source countries and the aggregate for other EMEP countries, all reflecting only anthropogenic emissions. The last column shows the "NSR" contribution. This is the totality of the contribution from natural emissions and secondary anthropogenic re-emissions in Europe, and all emissions outside the EMEP region.

**Table 16 – Mercury depositions on countries-receptors and contributions of different sources into the depositions (Source: Ryaboshapko et al, 2005)**

| Country-receptor | Total deposition, tonnes | Contribution to the deposition from different sources, % | | | | |
|---|---|---|---|---|---|---|
| | | Main countries-sources* | | Other EMEP countries* | Own sources* | NSR sources |
| Austria | 1.35 | Italy : 8 | Germany : 4 | 17 | 15 | 56 |
| Belgium | 1.05 | France : 38 | Germany : 4 | 8 | 30 | 20 |
| Bulgaria | 1.88 | Romania : 9 | Greece : 7 | 8 | 36 | 40 |
| Czech Rep. | 1.97 | Germany : 18 | Poland : 14 | 11 | 31 | 26 |
| Denmark | 0.65 | Germany : 16 | Poland : 3 | 10 | 40 | 31 |
| Finland | 2.41 | Poland : 4 | Germany : 3 | 8 | 3 | 82 |
| France | 8.43 | Spain : 7 | Switzerl. : 2 | 5 | 43 | 43 |
| Germany | 10.48 | France : 4 | Switzerl. : 2 | 10 | 61 | 23 |
| Greece | 3.04 | Bulgaria : 3 | Romania : 1 | 3 | 69 | 24 |
| Hungary | 1.87 | Slovakia : 14 | Romania : 3 | 12 | 42 | 29 |
| Italy | 4.82 | France : 3 | Spain : 2 | 2 | 52 | 41 |
| Netherlands | 0.69 | France : 20 | Belgium : 13 | 21 | 16 | 30 |
| Norway | 2.60 | Germany : 3 | Poland : 3 | 5 | 6 | 83 |
| Poland | 11.99 | Germany : 10 | Czech R. : 4 | 7 | 61 | 18 |
| Romania | 3.69 | Hungary : 4 | Poland : 3 | 13 | 41 | 39 |
| Russia | 26.92 | Ukraine : 3 | Poland : 3 | 5 | 13 | 76 |
| Slovakia | 1.61 | Hungary : 11 | Poland : 6 | 10 | 49 | 24 |
| Slovenia | 0.43 | Italy : 12 | Austria : 2 | 10 | 24 | 52 |
| Spain | 6.65 | Portugal : 3 | France : 1 | 1 | 55 | 40 |
| Sweden | 2.88 | Germany : 7 | Poland : 7 | 12 | 1 | 73 |
| Switzerland | 1.09 | France : 10 | Italy : 7 | 3 | 47 | 33 |
| Ukraine | 7.92 | Poland : 7 | Romania : 3 | 12 | 32 | 46 |
| UK | 3.43 | France : 2 | Ireland : 2 | 3 | 56 | 37 |

* Anthropogenic sources only

This table shows that transboundary pollution can be significant for most European countries. For all countries, a considerable share of mercury deposition is caused by NSR sources, and especially Finland, Norway and Sweden. But transboundary anthropogenic pollution is also significant. Over 50% of the deposition in Belgium and the Netherlands, for example, is caused by anthropogenic emissions in other European countries, and more than half the countries shown in the table derive over 20% of their deposition from this source.

## 6.3. Mercury exposure

Human exposure to mercury is also higher in other parts of the world compared to the EU. For example, the UNEP Global Mercury Assessment reports average mercury intakes in some countries where artisanal gold mining takes place that are many times those typically seen in Europe. This was also illustrated by a 1999 study by the Danish National Environmental Research Institute (Glahder et al, 1999), which reviewed a wide range of literature and produced an approximate ranking of selected human groups according to their magnitude of mercury content in hair, as reproduced in Table 17.

**Table 17 – Approximate ranking of selected human groups according to their magnitude of mercury content in their hair (Source: Glahder et al, 1999)**

| Group | Mercury Content (mg/kg) |
|---|---|
| Women using mercury soaps | 122 |
| Fish consumers in Brazilian Amazon tributaries with gold exploitation | 75 |
| Fish consumers in Bolivia | 16 |
| Seal consumers in Scoresbysund, Greenland | 15 |
| Greenland Inuits | 10 |
| Non-fish consumers in the Amazon | 6 |
| Miners in Tanzania | 3 |
| Citizens of Arhus, Denmark (average, 7 persons) | 2 |
| Non-miners at Lake Victoria, Tanzania | 1.1 |
| Danes (average) | 0.6 |

## 6.4. Mercury in the Arctic

Mercury pollution is of particular concern in the Arctic. Despite generally low levels of mercury contamination in Arctic abiotic environments, biomagnification in food-webs (especially marine food-webs) can result in very high levels of mercury in certain Arctic species. Top predators such as seals, polar bears and toothed whales (and humans) exhibit some of the highest concentrations. High maternal blood levels have been recorded in some Arctic indigenous populations, in particular the Inuit. These high blood levels are associated with high consumption of meat from marine mammals as part of traditional diets. Increasing contamination of the Arctic by mercury is exemplified by the fact that mercury levels are 3- to 7-fold higher in the 20$^{th}$

century Inuit hair samples than in 15th and 16th century samples. Mercury levels in some Arctic human populations exceed US and Canadian health guidelines and have been associated with subtle (neurobehavioural) health effects in children. Dietary intake by some Arctic populations exceeds WHO tolerable daily intake values. (AMAP, 2002, 2003)

# Annex 3: The Mercury Cycle

## 1. OVERVIEW OF THE MERCURY CYCLE AND CURRENT COMMUNITY CONTROLS

The problems associated with mercury can be considered at various points in the mercury cycle, for example:

- Production and supply of mercury
- Trade in mercury
- Intentional use of mercury in products and processes
- Unintentional emissions of mercury
- Recycling or disposal of mercury
- Controlling mercury exposure.

Table 18 below sets out an overview of what aspects of the mercury cycle will be addressed by the implementation of the present and already planned Community legislation and policies, and what aspects will remain.

**Table 18 – Mapping of present and forthcoming Community legislation and policy against stages of the mercury cycle**

**Key:**

| | |
|---|---|
| (red) | Significant issue not addressed by current or forthcoming measures, or partially covered but with significant gaps |
| (orange) | Issue partially addressed by current or forthcoming measures, or not addressed but less significant |
| (yellow) | Issue substantially or fully addressed by current or forthcoming measures |

| Possible focus of control | Present/forthcoming Community measures | Quantification (1) | Trend |
|---|---|---|---|
| **Production and Supply** | | | |
| Primary production | None | About 200-700 t/y in Spain in recent years. Global production about 2,000 t/y. | Generally declining. |
| Secondary production | None. | About 40-90 t/y (in Finland). | Growing. |
| Recycling | Some recycling required e.g. under WEEE, ELV, batteries Directives. | About 180 t/y. | Growing. |
| Chlor-alkali | Case-by-case | About 725 t/y from | Significant potential supply source |

| | | | |
|---|---|---|---|
| surplus mercury | determination of applicability of waste legislation. | EU25 chlor-alkali plants. | until 2020. |
| **Trade** | | | |
| In raw mercury | None | EU is main net exporter – about 1,000 t/y. | Generally declining. |
| In mercury-containing products | Export of cosmetic soaps containing mercury banned by Regulation 304/2003. Other products banned in EU can still be exported. | Wide range of traded products but typically with only small levels of mercury. | Levels of mercury in products generally declining, hence mercury in traded products should also be declining. |
| In mercury-containing wastes | Waste containing mercury cannot be exported to non-OECD countries under Regulation 259/93. | Mercury-containing wastes should not be exported from EU to non-OECD countries. | |
| **Intentional use of mercury in products and processes** | | | |
| Use of mercury in the chlor-alkali industry. | The mercury cell process is not BAT under the IPPC Directive. | Consumption of about 120 t/y in EU15.(2) | Declining as mercury cells are phased out. |
| Use of mercury based dental amalgam | No controls on use, but Community waste legislation covers the fate of amalgam waste. | About 70 t/y used in EU15 – largest use after chlor-alkali industry. | Conflicting assessments suggest increasing and decreasing trends. |
| Use of mercury in measuring equipment | No present controls. Discussion under Directive 76/769. Commission also to present proposals for including medical devices and monitoring/control instruments under Directive 2002/95 | About 26 t/y used in EU15. | General decline but still a major user in relative terms in the foreseeable future |
| Use of mercury in electrical equipment and lighting | Directive 2002/95 requires substitution of mercury in electrical and electronic equipment by 1.7.06. Exemptions for fluorescent lamps to be reviewed every 4 years. | About 21 t/y used in EU15 for lighting and 25 t/y for other electrical control and switching applications. | Declining. |
| Use of mercury in batteries | Mercury content limited by Directives 91/157, 98/101. | About 15 t used in EU15 in 2000 | Probable gradual rise in use of button cells. |
| Use of mercury in laboratory chemicals, electrodes and analysis | None. | Low relative to others, e.g. 0.09 t in DK in 2000/01, c.f. 0.9 t in dental amalgam, 0.2 t batteries, 0.17 t lamps. | Probably declining. |

| | | | |
|---|---|---|---|
| Use of mercury in pesticides and biocides | Prohibited by Directives 79/117 and 98/8. | Virtually zero (mercury traces only). | Should be stable at virtually zero. |
| Use of mercury in pharmaceuticals, vaccines, eye drops | None | Very low levels of use. | Probably declining as some alternatives to use of mercury are available for some purposes. |
| Use of mercury in cosmetics | Marketing prohibited in EU by Directive 76/768. Limited exception for eye make-up. | Virtually zero (mercury traces only) for most products used in the EU. | |
| **Emissions of mercury** | | | |
| Coal combustion in power plants above 50 $MW_{th}$. | IPPC and Directive 2001/80 (no specific mercury controls in Directive 2001/80 but some mercury removed alongside other pollutants). | Responsible for about 27% of EU27 mercury emissions to air in 2000 | Emissions presently decreasing due to IPPC and LCP Directives plus reduced coal use. |
| Coal combustion below 50 $MW_{th}$ (small combustion plants and residential use) | None. | Responsible for about 25% of EU27 mercury emissions to air in 2000. | Declining. |
| Metal industry | IPPC Directive and Directive 84/156. New EQS under Directive 2000/60 would also apply. | About 8 t/yr to air from IPPC installations in EU15, plus 0.5 t to water. | Emissions should decline with application of IPPC. |
| Chlor-alkali industry | IPPC Directive and Directive 82/176. Any new EQS under Directive 2000/60 would also apply. | About 4-5 tonnes/yr to air and 0.5-1 tonne to water in EU15.(2) | Emissions declining and mercury cells will eventually be phased out |
| Cement production | IPPC Directive. | About 2.6 tonnes/yr to air in EU15. | Emissions should decline with application of IPPC. |
| Production of basic organic chemicals | IPPC Directive. | About 2 tonnes/yr to air in EU15. | Emissions should decline with application of IPPC. |
| Waste incineration | IPPC and waste incineration Directives. | About 1 tonne/yr to air in EU15. | Emissions declining. |
| Waste landfill | IPPC and Landfill Directives and Directive 84/156. | About 125 kg/yr direct to water and 387 indirect to water in EU15. | Emissions should fall as less mercury in waste enters landfills and landfill standards rise. |
| Mineral oil and gas refineries | IPPC Directive. | About 1.1 tonne/yr to air in EU15. | Emissions should decline with application of IPPC. |
| Phosphorous fertilisers | Directive 84/156 requires programmes to avoid or | About 11 t mercury applied to EU12 | Slight decline. |

| | | | |
|---|---|---|---|
| | eliminate pollution caused by discharges from diffuse sources. | agricultural land in 1989. | |
| Spreading of sewage sludge on agricultural land | Directive 86/278 and Directive 84/156. Possible revision of Directive 86/278. | About 4.3 tonnes of mercury brought to the agricultural soil in EU in 1999. | Increasing production of sewage sludge due to the urban wastewater Directive. |
| Cremation | None. | Circa 3 t/y in EU. Some countries report cremation as the biggest point source of mercury emission. | Increases in numbers of mercury fillings and cremation in some countries. About 1,300-2,200 tonnes in EU citizens' fillings – largest reservoir behind chlor-alkali. |
| **Recycling or disposal of mercury** | | | |
| Fate of general mercury containing waste | Controls on landfill and incineration plus specific waste streams. | Low levels of emissions from waste disposal (see above). | Levels of mercury in waste probably declining. |
| De-commissioning of mercury cells in the chlor-alkali industry | IPPC Directive (covers decommissioning of plant). | Probably high levels of mercury contamination at a relatively small number of sites. | Significant peak in the next few years as mercury cells are decommissioned. |
| **Control of mercury exposure** | | | |
| Mercury levels in air | No air quality standard but measurements are to be taken. | Levels of mercury in ambient air generally below a safe level. | Air quality generally improving. |
| Mercury levels in water | Mercury is a priority hazardous substance under Directive 2000/60. New EQS to be set. | Some continued exceedence of current EQS. | Generally improving. |
| Mercury levels in soil | None. Subject being considered under the soil strategy. | Little data available – evidence of disturbance of soil function. | Ongoing accumulation due to long residence time. |
| Mercury levels in food and drinks | Limits on mercury in fish and drinking water. Fish limits under review. | Risk of exceedence of PTWI for some high level fish consumers. | Probably improving with reductions in mercury uses and emissions. |
| Occupational exposure | Occupational Exposure Limit under consideration under Directive 98/24. | Variable according to the occupation. | Should decline with falling mercury use. |

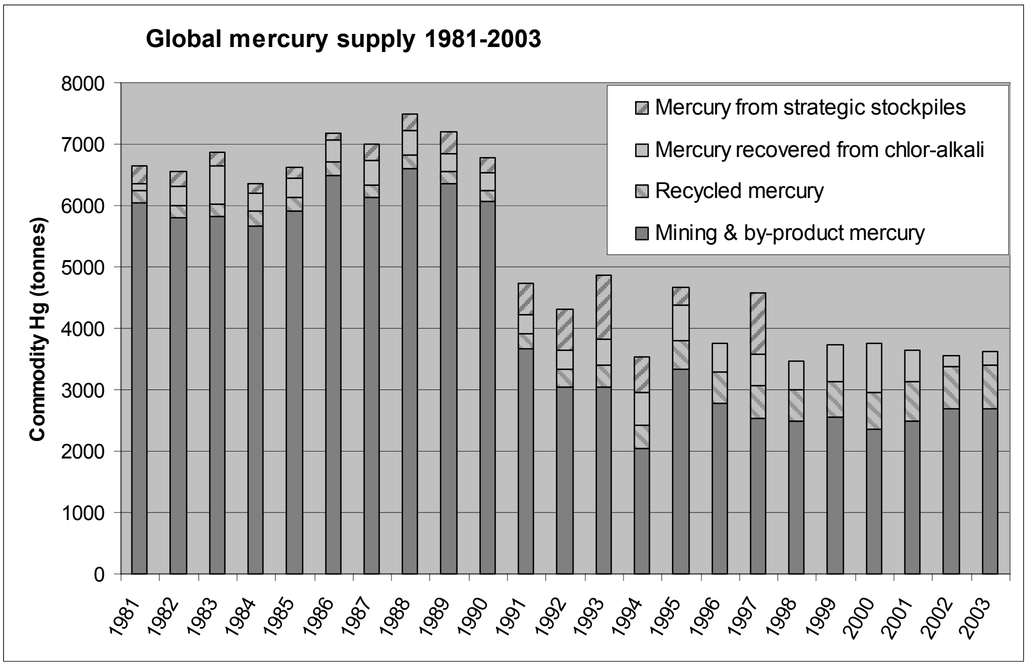
(1) Sources: European Pollutant Emission Register; Hylander, 2002; Maxson et al, 1991; Maxson, 2004 and 2005; OSPAR Commission, 2003a and 2003b; Pacyna et al, 2003; Pirrone et al, 2001; RPA, 2001; UNEP Chemicals, 2002.

(2) Note that there is a difference between consumption of mercury by the chlor-alkali industry and emissions. Consumption of about 120 tonnes includes emissions of about 6 tonnes, plus a small amount of loss of mercury in product, waste disposed of to landfill or treated by other means, and mercury retained in the equipment such as pipes and caustic soda tanks.

# 2. PRODUCTION AND SUPPLY OF MERCURY

The supply of mercury can be attributed to four main sources: primary mercury mining; by-product mercury; recycling; and recovery of mercury from decommissioned chlor-alkali facilities. Levels of supply are shown in Figure 6 below (Maxson, 2005). The figure also shows a fourth source – mercury from US and ex-USSR strategic stockpiles – but this ceased in 1997. MAYASA purchased and eventually traded most of the USSR stockpile that came onto the market during the 1990s. In the USA, meanwhile, sales of mercury stocks that had been built up for defence purposes, but were no longer needed, were suspended in 1994 for economic and environmental reasons. A US Government Environmental Impact Statement has concluded that it would be better to keep the remaining US mercury stockpile (4,436 tonnes) in storage, rather than to release it to the market (DLA, 2004).

**Figure 6 (Source: Maxson, 2005)**




## 2.1. Primary production (mercury mining)

A comprehensive summary of mercury mine operations is provided by Hylander and Meili (2003). This and the following paragraphs are drawn largely from this source plus additional analysis and interpretation by a consulting study commissioned to inform the development of the mercury strategy (Maxson, 2004), as subsequently updated by the same author (Maxson, 2005).

Global mercury supply is dominated by three main nations that mine and produce mercury for export (Spain, Kyrgyzstan and Algeria), and China, which has long supplied its own robust home market. Mine production globally and in Europe has substantially decreased in recent decades. The only primary mercury mine still operational in the EU (and in western countries as a whole) is the Almadén mine, operated by MAYASA.

Almadén mine production was more than 1,000 tonnes of mercury per year in 1995 and 1996. Due to its purchases of mercury from the ex-USSR stockpile, as well as supplies of mercury from decommissioned chlor-alkali plants, Almadén was able to maintain its customer base while reducing mercury production to approximately 400-500 tonnes per year during 1997-99, and even further to 236 tonnes in 2000. Thereafter, however, Almadén increased mercury production quite significantly, e.g. to 524 tonnes in 2001, 727 tonnes in 2002 and 745 tonnes in 2003, as receipts of mercury from decommissioned chlor-alkali plants were lower than in previous years. In July 2003, production was temporarily halted and has not yet restarted.

After Almadén, the most important primary mercury mine is in the Khaidarkan mining complex in Kyrgyzstan, which sells most of its output to Russia, CIS and China. The reported mercury production of Kyrgyzstan has been approximately 600 tonnes per year during the period 1996-1999, although in 2002 it was only 250 tonnes (USGS, 2004).

The other two main producing countries are Algeria and China. Algeria has recently produced between 120 and 320 tonnes per year,[72] and has a reported annual capacity of 450 tonnes (USGS, 2004). China produced a reported 835 tonnes of mercury in 1997, while the production for 1999 and 2000 was reported to be about 200 tonnes, although these figures may be underestimates. Chinese production is largely for supply to its own robust home market rather than for export. There are also reports of small scale, artisanal mining of mercury in Russia (Siberia), Outer Mongolia, Peru, and Mexico, but quantities have not been reported and are probably relatively minor (UNEP Chemicals, 2002).

### 2.2. Secondary production (production of mercury as a by-product)

Secondary production is where mercury is recovered from mining or processing activities where the primary mineral is gold, silver, copper, etc. In this case, mercury generally is removed only to keep in compliance with government regulations or to make the primary product more pure. Because the by-product mercury is generally in a similar condition to virgin mercury, it is sometimes called "secondary product" mercury. About 40-90 tonnes/year of such mercury was produced in Finland from 1994 to 2000 as a result of zinc production. Extraction of mercury as a by-product of gold production also reportedly occurs in other countries such as the USA and Peru (Maxson, 2004). The global figure for secondary production is estimated to be about 1,000-1,200 tonnes in 2003 (Maxson, 2005).

### 2.3. Recycled mercury

There has been increasing recycling of mercury from waste products in recent years. Nevertheless, until the start of the 1990s less than 50 tonnes/year mercury was recycled in the EU and the accession countries. In 2000 the figure was estimated at 180 tonnes (Maxson, 2004). The major products that are most

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72 See http://www.mem-algeria.org/fr/statistiques/stat-2002-fr.pdf and http://www.mem-algeria.org/fr/statistiques/resultats_2t-2003-fr.pdf.

commonly recycled for their mercury content are thermometers, barometers, manometers, dental amalgams, electrical switches and relays, thermostats, fluorescent (including compact fluorescent) tubes and lamps, high-intensity-discharge lamps, batteries, etc.

### 2.4. Recovery of mercury from decommissioned chlor-alkali facilities

Apart from the mercury wastes (contaminated old equipment, solids from water and brine purification, etc.) that are routinely recycled or disposed of by the chlor-alkali industry during normal operations, large quantities of mercury are recovered from these sites during decommissioning. Nearly 6,000 tonnes of mercury were made available by Western European plant closures during the period 1980-2000, although a significant part of this went directly to other operating chlor-alkali plants. Global mercury inventories associated with chlor-alkali plants that remain in operation have been estimated at some 25,000 tonnes, of which about half are in Western Europe (Maxson, 2004). This matches well with a recent figure from Euro Chlor of 11,600 tonnes of mercury remaining in operating mercury cells in the EU.

### 2.5. Total mercury supply

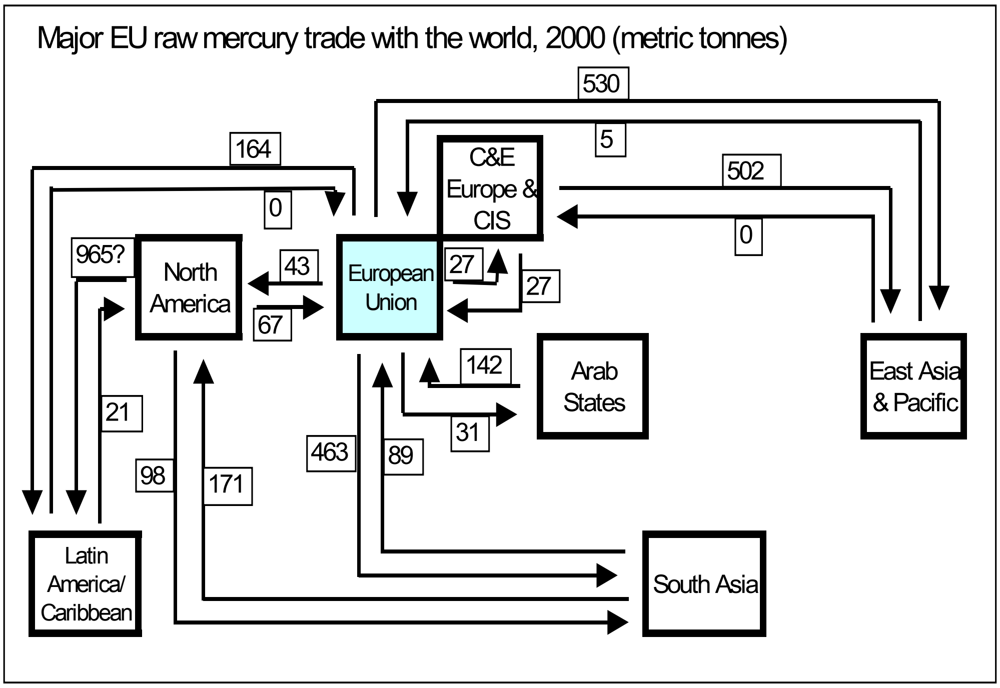
Total mercury supply from 1991-2000 averaged about 4,000 tonnes per year, and for 2003 is estimated in the range 3,600-3,700 tonnes (Maxson, 2005).

## 3. TRADE

### 3.1. Global trade patterns

The picture of the main global trade patterns in raw mercury has been summarised as shown in Figure 7 (Maxson, 2004).

**Figure 7 (Source: Maxson, 2004)**



Trade in mercury is complex, with many uncertainties. The figure above does not show intra-region trades, for example, between EU Member States. Nevertheless, it is apparent that the EU is the major global exporter of raw mercury, with a net export of around 1,000 tonnes in 2000. This is shown in Table 19 below (based on data in Maxson, 2004).

**Table 19 – Mercury exports and imports in tonnes between regions in 2000 (not including intra-region transfers)**

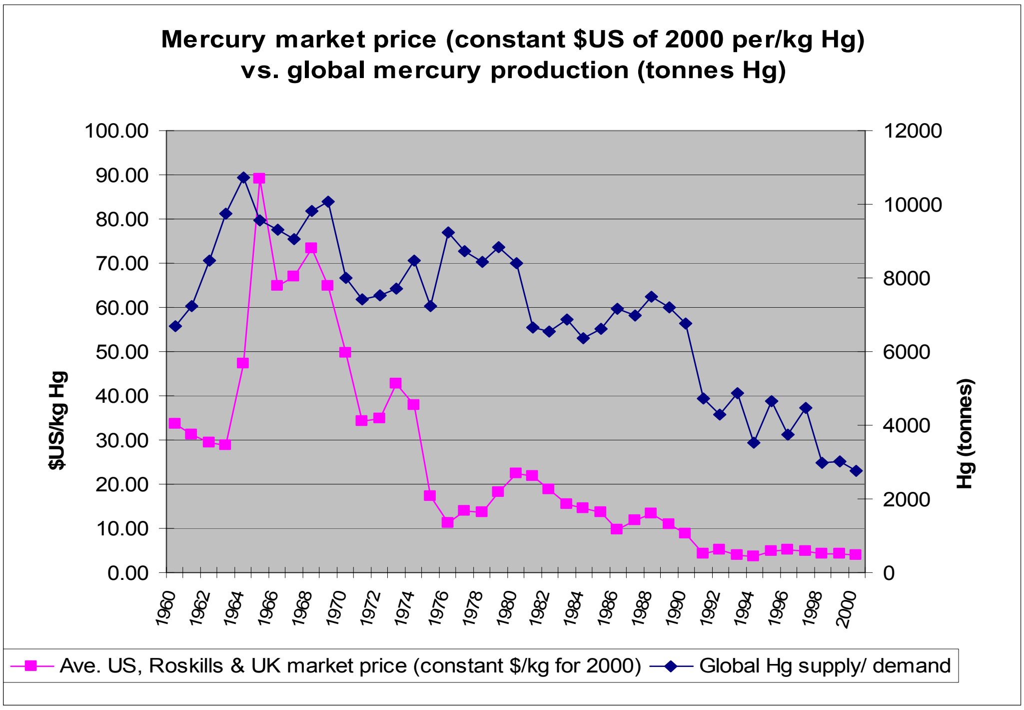
| Region | Export | Import | Net Export (Import) |
|---|---|---|---|
| EU (15) | 1,406 | 377 | 1,029 |
| North America | 1,168 | 319 | 849 |
| Other OECD | 150 | 192 | (42) |
| Central and Eastern Europe and CIS | 639 | 44 | 595 |
| Arab States | 174 | 34 | 141 |
| East Asia and Pacific | 10 | 1,100 | (1,090) |
| Latin America and Caribbean | 21 | 1,197 | (1,176) |
| South Asia | 355 | 628 | (273) |
| Sub-Saharan Africa | 18 | 34 | (16) |
| Not Specified | 68 | 87 | (19) |

The three regions that imported the most raw mercury in 2000 were Latin America/Caribbean with 1,197 tonnes, East Asia with 1,100 tonnes, and South Asia with 628 tonnes. Of those amounts, the EU supplied about half of the mercury needs of East Asia, and virtually all of the needs of South Asia. Spain, the Netherlands and the UK (followed some distance behind by Germany) were the main suppliers from within the EU, especially for low-priced, low-grade mercury (Maxson, 2004).

## 3.2. Price and demand

Mercury prices have been on a downhill slide for most of the past 40 years, as shown in Figure 8 (Maxson, 2004), which also shows how supply and demand have fallen.

**Figure 8 (Source: Maxson, 2004)**




Adjusting for inflation, mercury has fallen to less than 5% of its peak price of the 1960s. The market price fell from over US $1,000/flask in the late 1960s, with a peak of about $3,000, to a price of about $140-180/flask during the 1990s, or about $4-5/kg (one "flask" is about 2.5 litres and weighs 34.5 kg). The price remained about this level until around the end of 2002. A modest and gradual rise in the US dollar price was then seen until early 2004. In February 2004, for example, the price stood at around $200/flask. However, this increase appears to have simply reflected the falling value of the US dollar over this period, rather than a real recovery in the price of mercury. In other major currencies, therefore, the price of mercury varied little from the early 1990s to early 2004, the level in Euros being around €5/kg.

In mid 2004 the price increased significantly and quickly, including by 50% in the second half of August alone. By the start of September 2004 it stood at around US $500/flask, a 20-year high. This rapid increase was attributed to the temporary halt in production in Almadén, as well as other supply problems such as flooding in Kyrgyzstan and shipment delays from Algeria (Hayes, 2004). However, the same report also noted the view among traders that mercury is a "dying metal", and the prospect of a long-term surplus.

It therefore seems appropriate to use the long-run prices seen for most of the time since the early 1990s, rather than this recent peak, to represent the typical price of mercury under normal conditions in today's market. This gives a net market value of the recent annual global mercury supply of around 3,600 tonnes of about €18 million. The annual net value of EU exports is around €5 million.[73]

## 4. INTERNATIONAL USE OF MERCURY IN PRODUCTS AND PROCESSES

### 4.1. Level of mercury consumption

The main uses of mercury in products and processes, in the EU and globally, are shown in Figures 9 and 10 respectively (Maxson, 2005). The data relate to EU15 so the figures for the enlarged EU will be somewhat different.

**Figure 9 (Source: Maxson, 2005)**

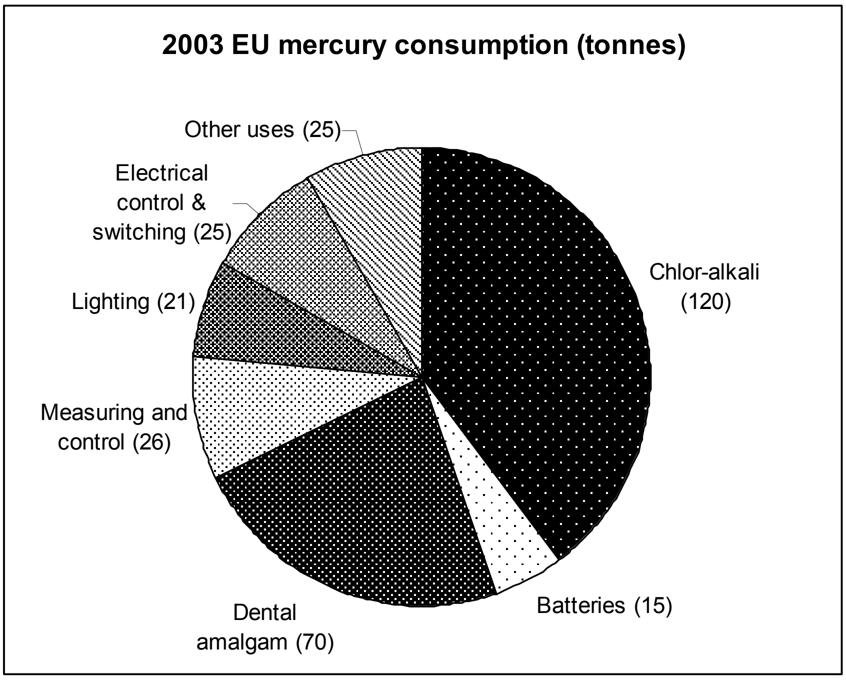
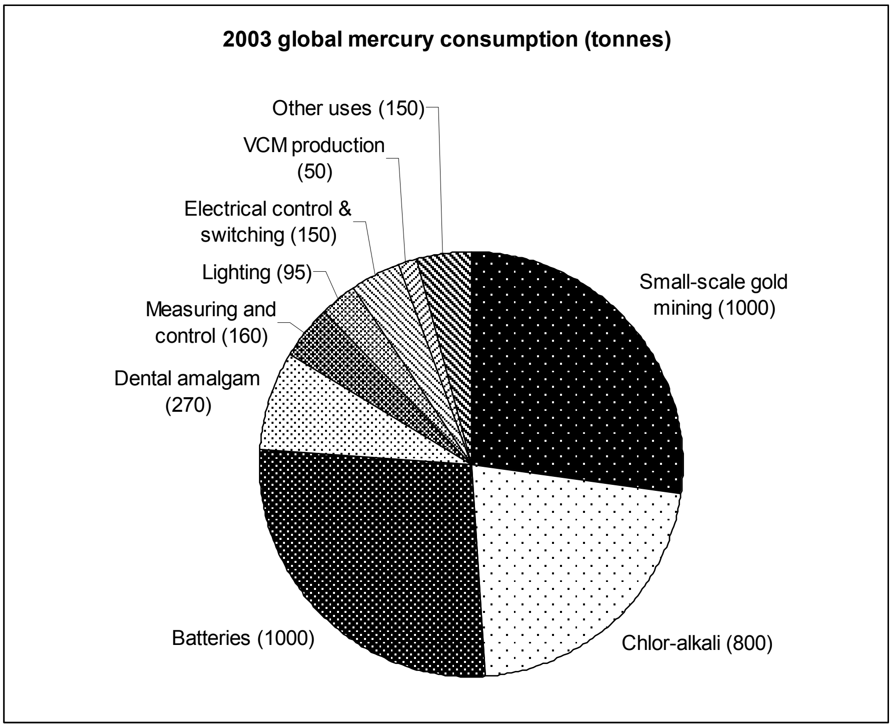



**Figure 10 (Source: Maxson, 2005)**

[73] The full economic picture is somewhat more complex. For example, mercury may be re-traded several times between producer and final user, with an extra premium demanded at each trade. Value is also added when mercury is converted into compounds or incorporated in products.




Patterns of EU versus global use differ. Gold and silver mining, the chlor-alkali industry and batteries are major uses globally, but of these only the chlor-alkali industry is a major user in the EU, and use here is diminishing as mercury cells are phased out.

## 4.2. Small scale gold and silver mining

Mercury is used in an amalgam process typically applied in small scale gold mining, which takes place in many countries in Africa, South America (including French Guyana) and Southeast Asia. Mercury is mixed with ore to form an amalgam, which is then heated to evaporate the mercury so that the gold can be collected. The same process can be applied to silver mining, but is not widespread except when the market price of silver is exceptionally high.

This use of mercury is often illegal, but nevertheless widespread as mercury can be imported for a stated legal purpose (such as dentistry) and then diverted to mining. The mining process is often done with little or no effort to capture the volatilised mercury, which is therefore emitted to air and inhaled by miners and their families, as well as causing environmental pollution, leading to high levels of methylmercury in fish, etc. It takes place because poor, marginalised communities and individuals rely on the income from mining to better or maintain their lives, notwithstanding the health threat from the mercury itself.

DG Environment has discussed the problem of, and potential solutions to, the use of mercury in mining with the GEF/UNDP/UNIDO Global Mercury Project team, which has carried out significant work in this area. The team is of the opinion that it is not realistic at this stage to expect to be able to eliminate mercury use. In any case, the next available alternative process involves cyanide, which is even worse from a health perspective. However, there are relatively simple technical ways to reduce mercury losses from such mining, such as introduction of more efficient mineral processing technologies based on gravity separation and not requiring mercury, or recycling of mercury using “retorts”. The GEF/UNDP/UNIDO Global Mercury Project has also advised that the degree of mercury loss during artisanal gold mining is closely related to the price and accessibility of mercury, as illustrated in Table 20.

**Table 20 – Price and loss of mercury in mining in selected countries (Source: GEF/UNDP/UNIDO Global Mercury Project)**

| Country | Mercury loss (tonnes/annum) | Mercury price (US$/kg) |
|---|---|---|
| China | 250-300 | 5-7 |
| Indonesia | 60-100 | 9-15 |
| Brazil | 20-30 | 15-20 |
| Zimbabwe | 15-20 | 12-25 |
| Tanzania | 3-5 | 18-25 |
| Sudan | 1-2 | 25-30 |
| Lao | 0.001-0.002 | 75-88 |

It is clear from this table that the price of mercury is low in some countries, such as China, and the losses are high, whereas the price is high in Lao, for example, and the losses are low. However, the precise cause-effect relationship is unclear. Clearly price is only one factor affecting the level of mercury loss, with others potentially including the amount of mining taking place, the nature of the ores processed, the availability and understanding of approaches to reduce mercury loss, the degree of enforcement of prohibitions on mercury use, and so on. Nevertheless, the GEF/UNDP/UNIDO Global Mercury Project is clearly of the view that reducing the present easy and cheap access to mercury by miners is an important part of the solution, alongside promoting technical ways to reduce mercury losses.

## 4.3. Batteries

Mercury is used in small batteries to prevent leaching and explosions. Community legislation[74] prohibits the marketing of batteries containing more than 0.0005% of mercury by weight. Button cells with mercury content less than 2% by weight are exempted. As a result of this legislation, the amount of mercury in batteries placed on the EU market is now small. Similar controls have been adopted in some other countries, principally in the OECD. However, there are fewer such controls in many other countries, particularly in East and

74 Directive 91/157/EEC of 18 March 1991 on batteries and accumulators containing certain dangerous substances, OJ L 78, 26.3.91, adapted to technical progress by Commission Directives 93/86/EEC of 4 October 1993, OJ L 264, 23.10.93, and Directive 98/101/EC of 22 December 1998, OJ L 1, 5.1.99.

South Asia, with a result that mercury oxide batteries (containing around 30% mercury by weight) remain prevalent. This sector therefore remains one of the largest present users of mercury, even though in technical terms the possibility to use significantly less mercury is not in doubt.

### 4.4. Chlor-alkali industry

Mercury is used as a fluid cathode in one of the three main types of electrolytic process for production of chlorine and sodium hydroxide from salt brine. Other well known mercury-free processes are widely used, and it is generally accepted that these alternative processes will replace the mercury process over time.

Consumption of mercury in the chlor-alkali industry includes emissions to air, water and wastewater, loss of mercury in product, waste disposed of to landfill and other means, and mercury retained in equipment such as pipes and caustic soda tanks. The retained mercury should normally be recovered during plant maintenance or decommissioning.

The IPPC Directive is the only legally binding Community instrument that governs the phase-out of mercury cells. The mercury cell process is not considered to be BAT for the chlor-alkali sector, and it will be for the local competent authority to decide on BAT-based permit conditions for individual installations on a plant-by-plant basis. All existing installations should meet permit conditions based on BAT and operate in accordance with the requirements of the Directive by 30 October 2007. Before the IPPC Directive was adopted, a number of Member States had also signed-up to OSPAR Decision 90/3 of 14 June 1990 with the objective of phasing out mercury cell plants completely by 2010.

In addition, the members of Euro Chlor have committed to closing or converting their mercury cell chlor-alkali plants to non-mercury processes when the plants reach the end of their economic lives. The phase-out of mercury cells in Western Europe under this commitment should be completed by 2020. Hence this could be seen as the latest date for the end of mercury cell chlor-alkali production in the EU, which would apply in the absence of any earlier closures or conversions brought about in fulfilment of the IPPC and OSPAR obligations.

The chlor-alkali industry remains a large global consumer of mercury, at about 800 tonnes in 2000, of which around one eighth was consumed in the EU. In contrast, over half of the global mercury cell production capacity is in the EU. This is shown in Table 21.

**Table 21 – Global mercury cell chlorine production and mercury consumption 2000 (Maxson, 2004)**

| Region | Mercury cell chlorine production capacity (thousand tonnes) | Mercury consumption (tonnes) | Relative mercury consumption (grams of mercury consumed per tonne of production capacity) |
|---|---|---|---|
| Western Europe | 6,592 | 95 | 14 |
| United States | 1,409 | 72 | 51 |
| Rest of World (ROW) | 4,200 | 630 | 150 |
| Total | 12,201 | 797 | 65 |

It can be seen from this table that, relative to production capacity, mercury consumption in Western Europe is low – approximately one third that in the USA and one tenth that in the rest of the world. This reflects substantial improvement in the performance of the European chlor-alkali industry in recent decades, in part driven by the requirements of Community legislation.[75] At the same time, it illustrates the significant potential for major global reductions in consumption of mercury in the chlor-alkali industry. For example, if the entire global mercury cell chlor-alkali industry were to match the performance of European industry, then consumption of mercury would be cut from around 800 tonnes per year to around 175 tonnes per year.

There are no specific legislative requirements or industry commitments, similar to those described above for the EU, dictating the phase-out of mercury cells globally. In the absence of any such measures, the main driving force for the phase-out will be economic. Most plants would be expected to reach the end of their normal economic lives by around 2030. This is sufficiently distant to make the large potential emission reductions, noted in the previous paragraph, clearly worth pursuing.

In fact, Euro Chlor has suggested that present day ROW consumption is significantly lower than that for 2000 shown in Table 21, at around 50 g of mercury per tonne of chlorine production capacity. This would put ROW consumption at about 210 tonnes and total global consumption at around 400 tonnes. If this is correct, it means that a major improvement has already been realised, though more is possible. Yet it also raises the question: if the chlor-alkali industry uses 400 tonnes less mercury than previously thought, where has this amount gone to make up the supply-demand balance?

## 4.5. Dental amalgam

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75 Especially Council Directive 82/176/EEC of 22 March 1982 on limit values and quality objectives for mercury discharges by the chlor-alkali electrolysis industry, OJ L 81, 27.3.82.

The estimated EU use of mercury in dental amalgam stands at around 70 tonnes per year, compared to a global use of around 270 tonnes. There are no controls on the use of such dental amalgam at Community level. The UNEP Global Mercury Assessment noted that, while there has been substantial development work on a range of alternatives, there is not yet a consensus that substitutes can adequately replace mercury amalgams in all dental applications.[76] No country in the EU or elsewhere is known to have phased out mercury amalgam fillings completely. However, some Member States have introduced restrictions. For example, in Denmark mercury amalgam fillings are permitted only in molar teeth where the fillings are worn.

Amalgam waste from dental care is stipulated by Community waste legislation to be hazardous waste.[77] Moreover, Article 4 of the Waste Framework Directive[78] requires that Member States take the necessary measures to ensure waste is recovered or disposed of without endangering human health and without using processes or methods that could harm the environment. Member States can comply with these obligations, for example, by ensuring use of amalgam filters and separators at dental practices so the amalgam waste is not released into water or drains without the possibility of control after discharge. The Commission has delivered a Reasoned Opinion to the UK for failing to apply these provisions correctly in practice to the disposal of dental amalgam waste.[79] A report for the Commission (RPA, 2002) has suggested that the use of amalgam filters and separators at dental practices is also lacking in some other Member States.

### 4.6. Measuring and control equipment

The main measuring and control devices that may contain mercury are thermometers, sphygmomanometers (blood pressure gauges) and pressure measuring and control equipment. Total EU consumption of mercury by this product group has been estimated at about 26 tonnes per year (although this is possibly an underestimate), as compared to global consumption of around 160 tonnes.

There are no present Community controls on the use of mercury in measuring and control equipment. The issue has been discussed in the working group established under Directive 76/769 on marketing and use restrictions. The Commission is also required to present proposals by 13 February 2005 for including electrical and electronic medical devices and monitoring and control

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76 However, this was a subject of considerable comment in responses to the consultation on mercury. See Annex 7.

77 Commission Decision (2000/532/EC) of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Directive 75/442 on waste and Council Decision 94/904 establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689EEC on hazardous waste, OJ L226/3, 6.9.2000 (as amended).

78 Directive 75/442/EEC on waste, OJ L 194, 25.7.75, as amended by Directive 91/156/EEC, OJ L 78, 26.3.91.

79 See: http://europa.eu.int/rapid/start/cgi/guesten.ksh?p_action.gettxt=gt&doc=IP/04/52|0|RAPID&lg=EN&display.

instruments under Directive 2002/95. However, some of the more significant mercury users in this product group (e.g. thermometers) are not electrical or electronic devices, so such a proposal would not affect them. Moreover, various products have already been banned or restricted in a number of countries, such as Denmark, France, the Netherlands, Norway and Sweden. OSPAR has also requested that the EU consider further marketing and use controls in this area (OSPAR, 2000).

### 4.7. Electrical control and switching

Mercury has been, and still is, used in a great variety of electrical and electronic switches and relays. However, most standard uses in electrical and electronic equipment in the EU are to be substituted after 2006 under Directive 2002/95. As a result, the estimated EU consumption figure of around 25 tonnes per year is expected to decline significantly. Global use, which stands at around 150 tonnes per year, also appears to be falling.

### 4.8. Lighting

Mercury is used in small amounts per lamp in a number of different types of discharge lamps, with fluorescent tubes and compact fluorescent lamps (CFLs) as the most common examples. It is also used in the lighting required for liquid crystal displays, e.g. for televisions and computers. This is an area where there is an acknowledged environmental benefit presently associated with the use of mercury. For example, the UNEP Global Mercury Assessment notes that, in the case of energy efficient fluorescent lamps, as long as there are no competitive substitutes that do not contain mercury, it is generally preferable from a product life-cycle perspective to use a mercury-containing energy-efficient lamp rather than to use a less efficient standard incandescent lamp containing no mercury. Directive 2002/95 therefore exempts fluorescent lamps from the requirement for substitution of mercury. However, the exemption only applies up to specified mercury levels per lamp, hence a significant reduction from the EU consumption figure of around 21 tonnes per year should occur anyway. Moreover, each such exemption must be reviewed every four years with a view to considering deletion.

### 4.9. Vinyl chloride monomer (VCM) production

Maxson (2005) has recently pointed to a demand category not previously singled out, namely production of acetaldehyde and VCM (a raw material for PVC). The estimate of 50 tonnes is based on limited information from China and Russia. These production processes are similar to those implicated in the Minamata pollution, typically having high mercury losses and generating large amounts of methylmercury.

### 4.10. Other

“Other” uses consume about 25 tonnes of mercury per year in the EU and about 150 tonnes globally. Remaining other uses in the EU will or may include the following:

- Laboratory chemicals, electrodes and apparatus for analysis
- Pharmaceuticals
- Preservatives in vaccines
- Preservatives in eye drops
- Catalysts for polyurethane/other polymer production
- Cosmetics.

The UNEP Global Mercury Assessment also pointed to other possible uses of mercury in different parts of the world, such as in pesticides/biocides, paints and pigments, tanneries, browning and etching steel, skin lightening creams, recoil softeners for rifles, arm and leg bands (for tennis elbow) and executive toys. However enquiries made during the consultation on the preparation of the mercury strategy found no evidence of any of these other uses in the EU (some of which have been prohibited in any case).

## 5. EMISSIONS OF MERCURY FROM PRODUCTS AND PROCESSES

### 5.1. Global emissions by source

Emissions of mercury may occur during various processes, ranging from raw mercury production to incineration of waste products containing mercury. Global emissions to air have been broken down by source as shown in Table 22 below (Pacyna et al, 2003).

**Table 22 – Global emissions of total mercury from major anthropogenic sources in 1995 (tonnes/year) (Source: Pacyna et al, 2003)**

| Continent | Stationary combustion | Non-ferrous metal production | Pig iron and steel production | Cement production | Waste disposal | Total |
|---|---|---|---|---|---|---|
| Europe | 185.5 | 15.4 | 10.2 | 26.2 | 12.4 | 249.7 |
| Africa | 197.0 | 7.9 | 0.5 | 5.2 | | 210.6 |
| Asia | 860.4 | 87.4 | 12.1 | 81.8 | 32.6 | 1,074.3 |
| North America | 104.8 | 25.1 | 4.6 | 12.9 | 66.1 | 213.5 |
| South America | 26.9 | 25.4 | 1.4 | 5.5 | | 59.2 |
| Australia and Oceania | 99.9 | 4.4 | 0.3 | 0.8 | 0.1 | 105.5 |
| Total 1995 | 1,474.5 | 165.6 | 29.1 | 132.4 | 111.2 | 1,912.8 |
| Total 1990(1) | 1,295.1 | 394.4 | 28.4 | 114.5 | 139.0 | 2,143.1(2) |

(1) Estimates of maximum values, which are regarded as close to the best estimate value.

(2) The total emission estimate for 1990 includes also 171.7 tonnes of Hg emission from chlor-alkali production and other less significant sources.

The table above only covers selected sources. In particular, it does not include emissions from the use of mercury in artisanal gold mining in South America, China, Southeast Asia and Africa. The UNEP Global Mercury Assessment quotes various estimates for consumption of mercury in this use during the 1980s and 1990s ranging from 350 to 1,000 tonnes per year, of which a very high percentage is lost to the environment. This leads to severe elevation of local concentrations in the short term, and a significant addition to the "global pool" in the long term.

The largest anthropogenic source shown in Table 22 is stationary combustion of coal. This is a significant source in all continents, but particularly in Asia. Similarly, three quarters of the total 2000 mercury emissions shown in Figure 5 (Annex 2) were attributed to combustion of fossil fuels, in particular coal combustion in China, India, and South and North Korea. The increase in mercury emissions in Asia between 1990 and 2000 has been attributed to the increasing demands for energy in this region (Pacyna et al, 2003).

## 5.2. European emissions by source

As noted in Annex 2, total European emissions of mercury to air fell significantly from 1990 to 2000, both in absolute terms and as a percentage of global emissions. A closer look at emission reductions in Europe (EU 27 and other European countries[80]) from 1980 to 2000 reveals that the biggest relative reduction in emissions (78.5%) has come from industrial processes – see Figure 11 (Pacyna, 2003). Emissions resulting from combustion of fuels also fell significantly – by 67% from 1980 to 2000 – but remained the largest source in 2000.

**Figure 11 (Source : Pacyna, 2003)**

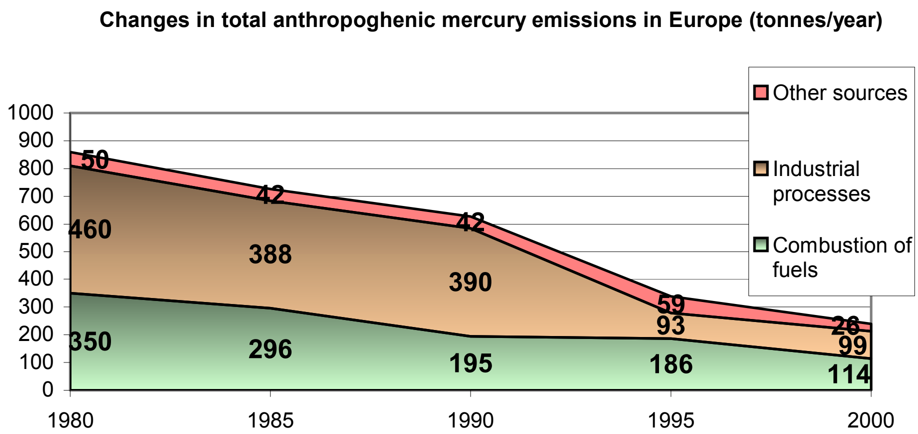


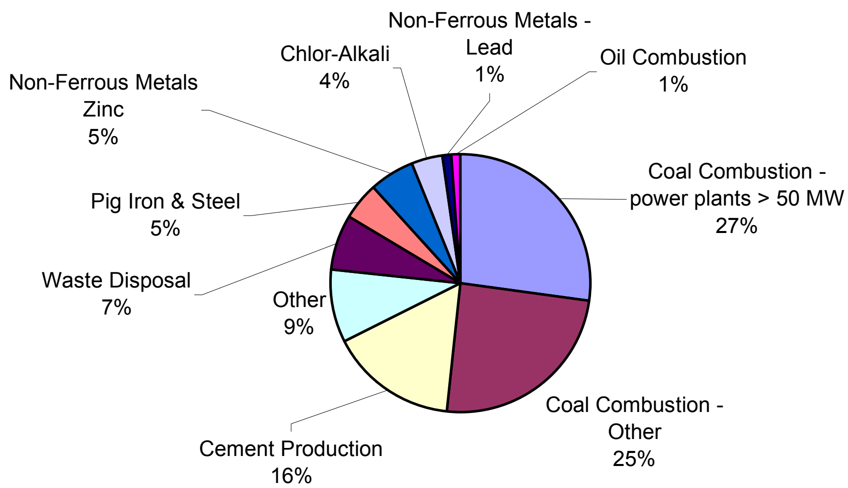

Table 23 below provides a further breakdown of emissions to air in 2000 in the EU27 and other European countries covered by Figure 11, listing activities in descending order of significance (Pacyna, 2003). Figure 12 presents the same data graphically for EU27 countries to show the percentage of emissions coming from each sector.

80 Data for all EU27 countries except Malta. Other European countries covered by the data are: Albania, Belarus, Bosnia-Herzegovina, Croatia, Iceland, Former Yugoslav republic of Macedonia, Moldova, Monaco, Norway, Russia (European part), Switzerland, Ukraine, Turkey (European part) and Yugoslavia (Serbia-Montenegro).

**Table 23 – Emissions of mercury to air (tonnes) in EU27 and other European countries, 2000 (Source: Pacyna, 2003)**

| Sector | EU27 emissions | Other European emissions | Total emissions |
|---|---|---|---|
| Coal Combustion – Power Plants Above $50MW_{th}$ | 38.24 | 25.23 | 63.47 |
| Coal Combustion – Power Plants Below 50 $MW_{th}$ and Residential Heat | 34.58 | 14.14 | 48.72 |
| Chlor-Alkali | 5.64 | 34.76 | 40.40 |
| Cement Production | 22.17 | 8.01 | 30.18 |
| Other | 12.96 | 2.30 | 15.26 |
| Pig Iron & Steel | 6.70 | 5.92 | 12.62 |
| Waste Disposal | 9.85 | 1.72 | 11.57 |
| Non-Ferrous Metals – Zinc | 7.64 | 0.20 | 7.84 |
| Non-Ferrous Metals – Lead | 1.63 | 6.00 | 7.63 |
| Oil Combustion | 1.47 | 0.22 | 1.69 |
| TOTAL 2000 | 140.88 | 98.50 | 239.38 |

**Figure 12 – Percentage of mercury emissions by sector in EU27 countries, 2000 (Source: Pacyna, 2003)**




The data used for Table 23 and Figure 12 are those submitted by parties to the UNECE CLRTAP or estimated by experts for the purposes of EMEP modelling. The accuracy of the emissions has been estimated as follows (Pacyna, 2003):

- stationary fossil fuel combustion: ± 25 %,
- non-ferrous metal production: ± 30 %,
- iron and steel production: ± 30 %,
- cement production: ± 30 %[81], and
- waste disposal: a factor of up to 5.

## 5.3. Coal combustion

Table 23 and Figure 12 above show coal combustion in power plants and residential heating to be the major sources of mercury emissions. This is despite significant reductions in emissions in recent decades, partly due to improved control, but also due to large decreases in coal consumption. For example, in the 1960s more than 50% of electricity was from coal combustion, compared to only 27% in 2001 (IEA, 2003c). National patterns of coal consumption and mercury emissions also vary greatly. This is shown for a selection of countries in Figures 13 (concerned with power plants above 50 $MW_{th}$) and 14 (concerned with power plants below 50 $MW_{th}$ and residential combustion) (both derived from data in Pirrone et al, 2001 and Pacyna et al, 2003)[82].

81 As noted, the data have been submitted by parties to the UNECE CLRTAP or estimated by experts, and the accuracy estimate refers to the accuracy of these data. Separately, in response to the DG Environment consultation on mercury CEMBUREAU (the European Cement Association) suggested a figure for EU25 mercury emissions from cement production in 2000 of 7.8 tonnes.

82 As these two figures have been produced using data from two separate sources they should be interpreted with care.

**Figure 13 - Mercury (tonnes/year) from coal combustion in power plants above 50 MWth**

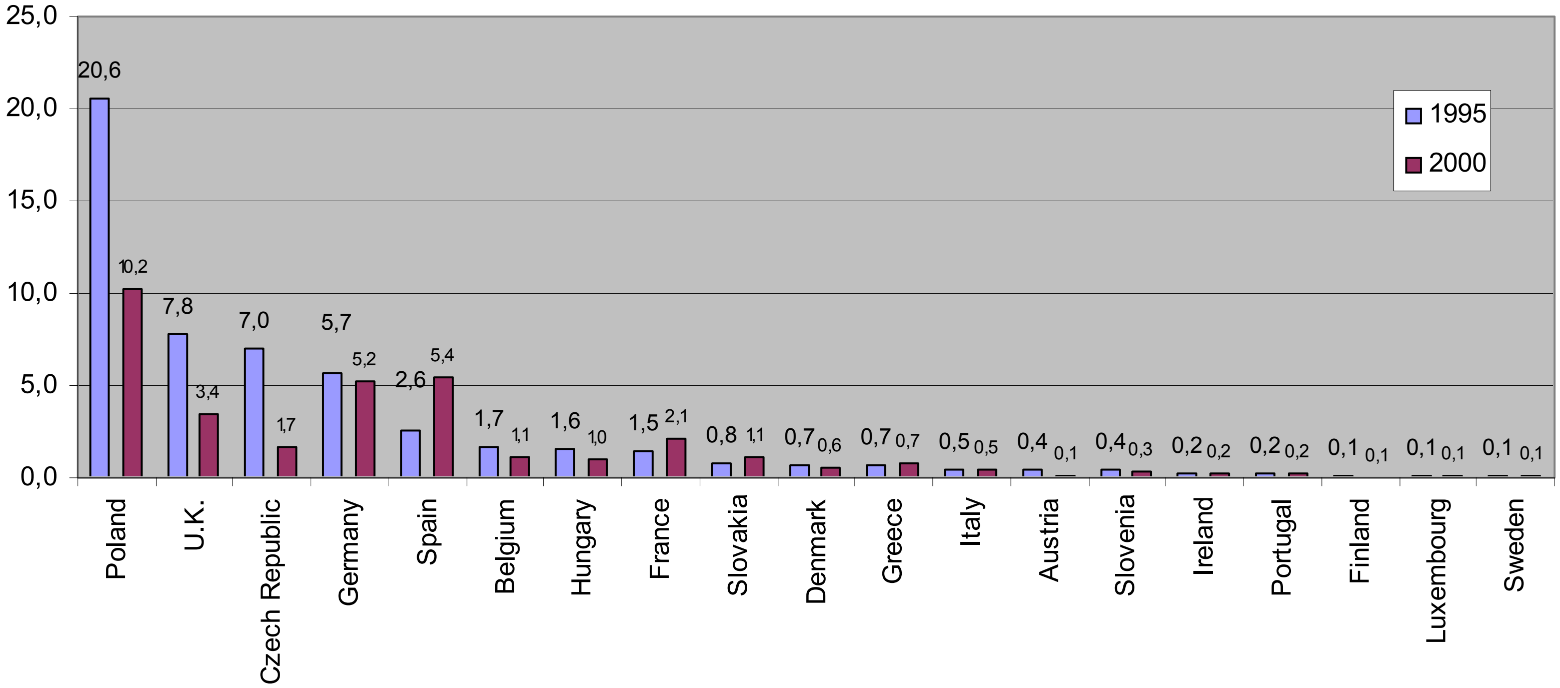
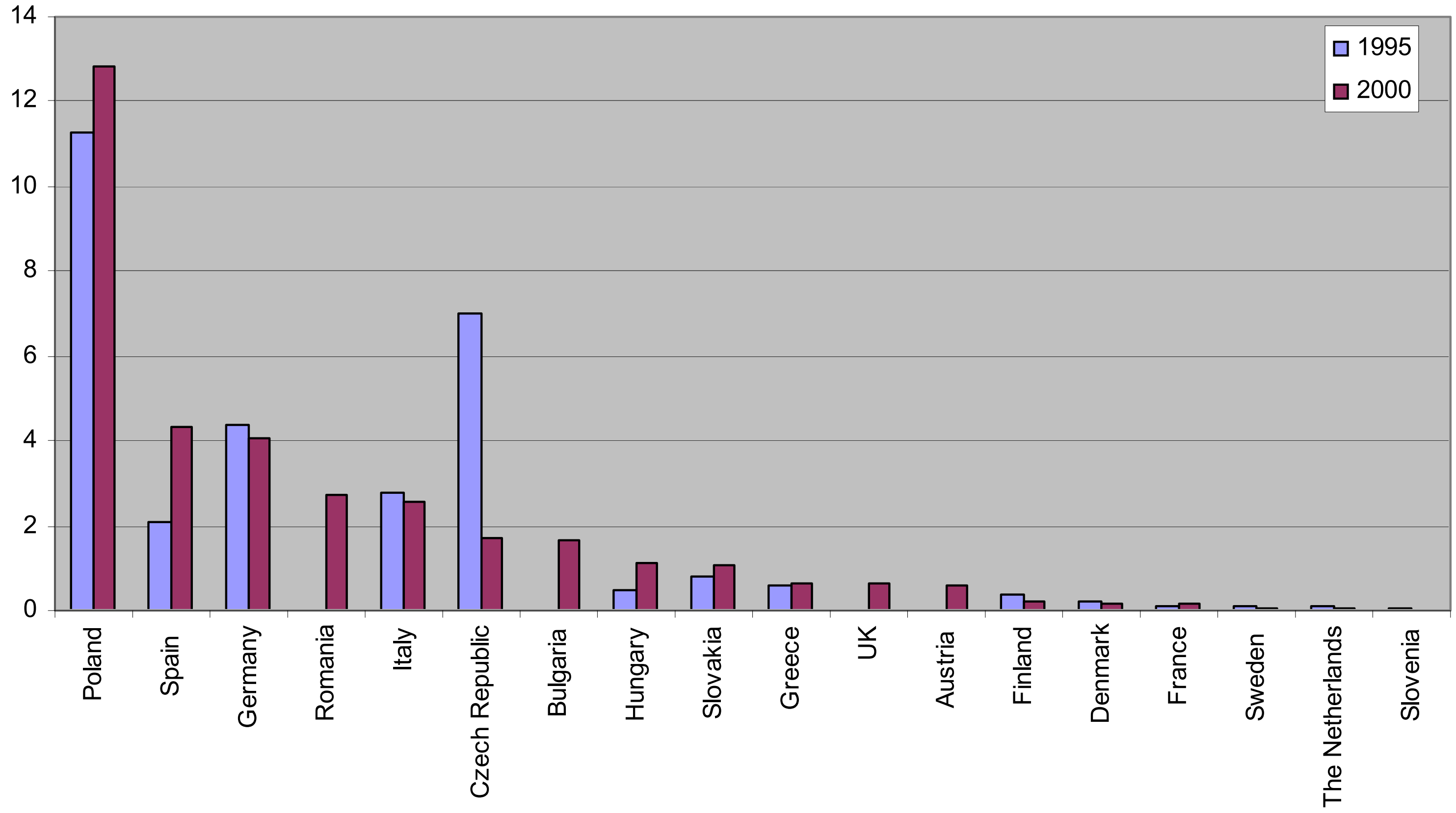


**Figure 14 - Mercury (tonnes/year) from power plants below 50 MWth and residential coal combustion**

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Despite a 50% reduction in emissions from power plants above 50 $MW_{th}$ between 1995 and 2000, Poland still accounted for the largest proportion of such emissions (26.6%[83]). The second biggest was Spain (14%), then Germany (13.7%), the UK (8.9%), France (5.4%) and the Czech Republic (4.5%). Together, these countries were responsible for 73% of total mercury emissions from coal combustion in power plants above 50 $MW_{th}$.

For power plants below 50 $MW_{th}$ and residential coal consumption, in 2000 the biggest mercury emissions came from Poland (36.7%), Spain and Germany (ca. 12% each) and Italy and Romania (ca. 7% each). These countries accounted for 75.7% of total emissions. The overall emission reductions are far less significant than in the case of power plants above 50 $MW_{th}$, although partially this may be due to better data accuracy for 2000.

## 5.4. Emissions from other installations covered by the IPPC Directive

In addition to large combustion plants (above 50 $MW_{th}$ input), major industrial activities are regulated in the EU under the IPPC Directive. Annex III of the Directive sets out an indicative list of the main polluting substances, including metals and their compounds as pollutants to both air and water. If an installation emits significant quantities of these pollutants, the emissions are to be curbed through legally binding limits based on the use of BAT. In addition, the EPER requires the reporting of mercury emissions from IPPC facilities where the release is greater than 10 kg per year to air, 1 kg direct to water or 1 kg indirect to water (i.e. via a sewage system). Using data from the first set of EPER returns for 2001, Table 24 below sets out the order of magnitude of mercury emissions generated by the groups of industrial sectors covered by the IPPC Directive.[84]

The EPER data can also be used to break emissions down by country, and to look more closely at individual facilities. Some facilities are particularly large emitters. For example, one chlor-alkali plant in the UK emitted 1,050 kg of mercury to air in 2001 – over 28% of total UK mercury emissions to air – while one metals plant in Italy emitted 3,130 kg per year to air – nearly half the Italian total and some 38% of the entire EU total for that sector. Hence it is evident that there are strong national and local responsibilities to address mercury emissions, as required by current Community legislation, in particular the IPPC Directive, alongside possibilities for further action at Community level under the mercury strategy.

**Table 24 – Mercury emissions in kg reported to EPER for 2001**

[83] Covering emissions from Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Monaco, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, the Netherlands, UK.

[84] The data are from the first EPER reporting year and therefore are not complete. The table covers 499 installations in the EU15 for which mercury emissions were reported. Note that there are significant differences between countries in terms of numbers of installations as well as between installations themselves in terms of emission levels. Note as well the major differences between these data and Table 23 above, which covers more countries, and is for a different year. For more detailed EPER data relating to individual facilities, or to the breakdown of data according to the sectors shown in a particular group in the table (e.g. cement, lime, glass, etc) see www.eper.cec.eu.int.

| **Activity Description** | **Emission To Air** | **Emission To Water Direct** | **Emission To Water Indirect** | **Total** |
|---|---|---|---|---|
| Metal industry and metal ore roasting or sintering installations; Installations for the production of ferrous and non-ferrous metals | 8,204.2 | 459.56 | 8.86 | 8,672.62 |
| Combustion installations > 50 $MW_{th}$ | 8,042.9 | 117.29 | 2.3 | 8,162,49 |
| Basic inorganic chemicals or fertilisers | 4,189.6 | 949.99 | 81.1 | 5,220.69 |
| Installations for the production of cement clinker (>500t/d), lime (>50t/d), glass (>20t/d), mineral substances (>20t/d) or ceramic products (>75t/d) | 2,570.3 | 76.3 | 0 | 2,646.6 |
| Basic organic chemicals | 2,008.8 | 274.16 | 16.6 | 2,299.56 |
| Installations for the disposal or recovery of hazardous waste (>10t/d) or incineration of municipal waste (>3t/h) | 1,082.6 | 87.63 | 43.25 | 1,213.48 |
| Mineral oil and gas refineries | 1,106.8 | 58.34 | 2 | 1,167.14 |
| Installations for the disposal of non hazardous waste (>50t/d) and landfills (>10t/d) | 58.8 | 125.6 | 387.28 | 571.68 |
| Industrial plants for pulp from timber or other fibrous materials and paper or board production (>20t/d) | 65.8 | 157.26 | 40.1 | 263.16 |
| Installations for surface treatment or products using organic solvents (>200t/y) | 71 | 0 | 0 | 71 |
| Slaughterhouses (>50t/d), plants for the production of milk (>200t/d), other animal raw materials (>75t/d) or vegetable raw materials (>300t/d) | 15 | 1.81 | 25.19 | 42 |
| Pharmaceutical products | 0 | 6.9 | 30.98 | 37.88 |
| Plants for the pre-treatment of fibres or textiles (>10t/d) | 0 | 9.04 | 7.9 | 16.94 |
| Installations for the production of carbon or graphite | 16 | 0 | 0 | 16 |
| Biocides and explosives | 0 | 8 | 0 | 8 |
| Coal gasification and liquefaction plants | 0 | 3.23 | 0 | 3.23 |
| Coke ovens | 0 | 0 | 1.6 | 1.6 |
| **TOTAL** | 27,431.8 | 2,335.11 | 647.16 | **30,414.07** |

## 5.5. Other sources of emissions

### 5.5.1. Cremation

Cremation gives rise to emissions of mercury principally due to the use of mercury in dental amalgam fillings. This source is not covered by the EPER data.

An analysis in 2002 suggested a total emission from cremation in EU15 and three of the then accession states (Poland, Czech Republic and Slovenia) of about 3 tonnes of mercury per year (RPA 2002). Mercury missions from crematoria reported by 9 countries[85] for a 2003 OSPAR report, meanwhile, amounted to approximately 1 tonne per year (OSPAR, 2003a). Simply scaling these figures up to cover EU27 on the basis of population sizes would give a rough total emission estimate in the range of around 2 to 3.5 tonnes per year, which would be some 1.4-2.4% of the total mercury emission shown in Table 23.

There are cultural issues attached to the subject of cremation. It is generally more common in Northern Europe, while in other countries it is rarely practised or even forbidden (e.g. Greece). Also, the type of cremation installation varies. There are small crematoria, where the family attends the ceremony, but there are also large ones, operating 24 hours per day, including some with heat recovery.

The need for emissions control at crematoria is also illustrated by the estimated 1,300-2,200 tonnes of mercury in fillings in EU and EFTA states (Hylander and Meili, 2003). This is the largest reservoir of mercury in society behind the chlor-alkali industry, highlighting the possibility of significant emissions for many years to come in the absence of abatement.

### 5.5.2. Agriculture

Agriculture principally gives rise to mercury emissions through two activities: the spreading of sewage sludge and the application of phosphate fertilisers.

The content of mercury in **sewage sludge** results mostly from the intentional use of mercury in products and processes. Directive 86/278[86] contains provisions relating to the mercury content of sewage sludge and the rate of application to agricultural land. According to information provided to the Commission by Member States, 4.3 tonnes of mercury were added to EU agricultural land in 1999 by the spreading of sewage sludge.

The mercury content of **phosphate fertilisers**, in contrast, is due to the natural presence of mercury in phosphate rock. Data are scarce, but use of phosphate fertilisers was estimated to have applied about 11 tonnes of mercury to EU12 agricultural land in 1989 (Maxson et al, 1991). However, phosphate fertilisers are spread over a much larger area than sewage sludge, so the amount of mercury

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85 Belgium, Denmark, France, Germany, Netherlands, Norway, Sweden, Switzerland and UK.

86 Council Directive 86/278/EEC of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture, OJ L181, 4.7.86.

applied per unit of area by phosphate fertilisers will be smaller. Moreover, there is a substantial downward trend in the rate of phosphate fertiliser consumption. A fall of 60% in the use of such fertiliser by 2013 has been predicted, compared to 1973 when consumption peaked (EFMA, undated).

# 6. RECOVERY, RECYCLING AND DISPOSAL OF MERCURY

## 6.1. Controls in place

There is already considerable Community waste legislation that may apply to mercury in one way or another. This includes product-related restrictions included in waste legislation (e.g. batteries, vehicles[87], electrical and electronic equipment), plus measures that may be applicable once mercury or a mercury-containing material becomes "waste". These latter measures include general legislation relating to the management of waste and hazardous waste, and measures concerning particular waste treatment options (incineration[88], landfill[89] and spreading of sewage sludge).

## 6.2. General mercury-containing waste

There is a general question over whether it is better to encourage or ban recycling of mercury-containing waste. Present Community policy encourages recycling generally, with specific provisions concerning batteries, electrical and electronic equipment and end-of-life vehicles. In contrast, Swedish policy is that mercury should not be recycled, but should be disposed of terminally in a safe and environmentally sound way. Clearly, any such policy choice needs to be coherent with the broader position concerning mercury supply and use. For example, if use of mercury in products is still seen as legitimate, it would appear better to encourage recycling as environmentally preferable to production of virgin mercury (see Annex 6). Conversely, Swedish policy is that mercury should be phased out of products and processes as far as possible.

It should be noted that a large "reservoir" of mercury is contained in products still in use, in storage and "on the users' shelves" in society. If responsibly collected, recycled and managed as these products are replaced or no longer used, this reservoir could be a much more significant source of society's real needs for mercury in future years. Attempts have been made to quantify these reservoirs of mercury in Sweden, the Netherlands, Denmark and the US, among others. Hylander (2002) has estimated the quantity of mercury contained in goods and products (i.e., completely apart from mercury cell chlor-alkali plant inventories) in Western Europe at 2-5 thousand tonnes, with another 4-8 thousand in Central & Eastern Europe (excluding former Soviet states). A recent estimate for the US points to at least 3,000 tonnes in that economy (EPA/NRMRL, 2002), not including mercury cell chlor-alkali plant inventories or government stockpiles.

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87 Directive 2000/53/EC of the European Parliament and of the Council of 18 September 2000 on end-of-life vehicles, OJ L 269, 21.10.2000.

88 Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the incineration of waste, OJ L 332, 28.12.2000.

89 Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste, OJ L182, 16.7.99.

If these figures are extrapolated, in line with "development" indicators, to other countries of the world, one arrives at a global inventory of some 20-30 thousand tonnes of mercury in existing products and processes, in addition to the 20-30 thousand tonnes held by the chlor-alkali sector. Much of this inventory could eventually be made available for recycling and recovery, given the proper incentives.

### 6.3. Mercury from the chlor-alkali industry

Mercury presently used in the chlor-alkali industry will become surplus as the mercury cell process is phased-out. In those cases where the surplus mercury is not considered to be "waste", or where it is considered "waste" but is subject to "recovery", the chlor-alkali producer (or the recoverer) presently would be free to sell the mercury on the market. However, Euro Chlor has established a contractual agreement whereby chlor-alkali producers sell their surplus mercury to MAYASA. MAYASA then resells the mercury received. This agreement has been in operation for some years. The amounts of mercury sent to MAYASA by chlor-alkali plants in recent years, and the figures for new production, are shown in Table 25.

**Table 25**

| Year | New mercury production by MAYASA (tonnes) | Returned from chlor-alkali industry (tonnes) | Total (tonnes) |
|---|---|---|---|
| 2001 | 523 | 506 | 1,029 |
| 2002 | 727 | 182 | 909 |
| 2003 | 745 | 227 | 972 |

Research carried out for DG Environment has investigated the potential impacts of the surplus mercury from the chlor-alkali industry entering the mercury market under different timing scenarios (Maxson, 2004). Under any scenario, the availability of the surplus mercury on the market has the potential to increase the already existing oversupply, keep prices low (and possibly reduce them further), and result in higher consumption by stimulating demand. At the same time, Euro Chlor's agreement with MAYASA is recognised as a responsible effort by the industry to avoid adding yet another mercury source, since an alternative would have been for chlor-alkali producers to effectively compete with MAYASA and other suppliers by selling their mercury directly.

## 7. CONTROLLING MERCURY EXPOSURE

Exposure to methylmercury via diet is the main problem from a human health point of view. Community legislation has already set limits on mercury in fish. EFSA will further investigate specific dietary intakes of different types of fish and seafood among vulnerable subpopulations (e.g. pregnant women, children).

Regarding occupational exposure to mercury, the generally applicable legislation for worker protection currently in force at Community level is considered to give an adequate framework to protect against risks to health and safety resulting from exposure to mercury at the workplace. This includes Directive 89/391[90] on measures to improve the safety and health of workers, Directive 98/24[91] on protection from the risks due to exposure to chemical agents, Directive 92/85[92] on measures to improve the safety and health of pregnant workers and workers who have recently given birth or are breastfeeding, and, for the specific case of mines, Directive 92/104[93] on the minimum requirements for improving the safety and health protection of workers in surface and underground mineral-extracting industries. To strengthen the protection provided by the requirements of the generally applicable Directives, the Commission, within the framework of Directive 98/24, is developing an Occupational Exposure Limit value that will provide a specific EU objective for the control of exposure to mercury at the workplace.

Levels of mercury in ambient air are not generally seen as a problem although some high levels were recorded locally in some heavily industrialised areas in the mid and late 1990s.

Levels of mercury in the aquatic environment are already controlled under Community legislation (Directive 76/464 and daughter Directives) and will be further controlled under the Water Framework Directive 2000/60.

Levels of mercury in soil are not presently controlled or monitored under Community legislation, although some aspects affecting soil (e.g. sewage sludge) are regulated. However, the thematic strategy on the protection of soil will provide a basis for further action.[94]

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90 Council Directive 89/391/EEC of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work, OJ L 183, 29.6.89.

91 Directive 98/24/EC of 7 April 1998 on the protection of the health and safety of workers from the risks related to chemical agents at work, OJ L 131, 5.5.98.

92 Council Directive 92/85/EEC of 19 October 1992 on the introduction of measures to encourage improvements in the safety and health at work of pregnant workers and workers who have recently given birth or are breastfeeding (tenth individual Directive within the meaning of Article 16 (1) of Directive 89/391/EEC), OJ L 348, 28.11.92.

93 Council Directive 92/104/EEC of 3 December 1992 on the minimum requirements for improving the safety and health protection of workers in surface and underground mineral-extracting industries (twelfth individual Directive within the meaning of Article 16 (1) of Directive 89/391/EEC), OJ L 404, 31.12.92.

94 See the Commission’s Communication towards a Thematic Strategy for Soil Protection, COM (2002) 179 final, 16.4.2002.

## Annex 4: Current and Anticipated Community Legislation and Policy Relating to Mercury and its Compounds

# 1. LEGISLATION

## 1.1. Integrated Pollution Prevention and Control

| | |
|---|---|
| **LEGAL INSTRUMENT** | Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control (OJ L 257, 10.10.96). |
| **MAIN RELEVANT PROVISIONS** | The purpose of this Directive is to achieve integrated prevention and control of pollution arising from the activities listed in Annex I of the Directive (energy industries, production and processing of metals, mineral industry, chemical industry, waste management and other activities like intense livestock farming, pulp and paper industry and tanneries). It lays down the requirement to prevent or, where that is not practicable, to reduce pollution of the air, water and land, including from mercury and its compounds, from the above-mentioned activities, including measures concerning waste, in order to achieve a high level of protection of the environment taken as a whole. Control is to be achieved by way of a permitting regime whereby the operator of an installation applies for a permit and a competent authority determines whether or not a permit is to be issued. Among other requirements, permits are to include emission limit values (or equivalent parameters or technical measures) which are to be based on the "Best Available Techniques" (BAT) for the sector, but taking account of the technical characteristics of the installation concerned, its geographical location and the local environmental conditions. |
| **DEADLINE FOR IMPLEMENTATION** | The Directive entered into force on 30 October 1999. New installations, and substantial changes to existing installations, require a permit issued in accordance with the Directive before they are brought into operation. Existing installations must be brought into compliance with the requirements of the Directive no later than 30 October 2007. |
| **OTHER REVELANT INFORMATION** | In order to support the implementation of the Directive the Commission is producing a series of BAT Reference documents (BREFs) on best available techniques for the main industry sectors under the Directive. An important document concerning mercury is the BREF on chlor-alkali manufacturing, which concludes that mercury cells are not BAT.<br><br>(http://eippcb.jrc.es/pages/FActivities.htm). |

### 1.2. European Pollutant Emission Register

| | |
|---|---|
| **LEGAL INSTRUMENT** | Commission Decision 2000/479/EC of 17 July 2000 on the implementation of a European pollutant emission register (EPER) according to article 15 of Council Directive 96/61 concerning integrated pollution prevention and control (OJ L 192, 28.7.2000) |
| **MAIN RELEVANT PROVISIONS** | This Decision requires Member States to submit reports to the Commission on emissions from all individual facilities with one or more activities mentioned in Annex I to Directive 96/61 (see section 1.1). The reports must include details of emissions to air and water for all pollutants for which the thresholds specified in an Annex are exceeded. The reporting thresholds for mercury and its compounds are 10 kg/year for emissions to air and 1 kg/year for emissions to water. |
| **DEADLINE FOR IMPLEMENTATION** | The first reports, for emissions in 2001, were to be sent by Member States to the Commission by June 2003. The data from the first reporting cycle were published in February 2004 (see www.eper.cec.eu.int). The next reporting year is 2004, for publication in 2006. |
| **OTHER REVELANT INFORMATION** | The EPER is expected to be replaced by a broader Pollutant Release and Transfer Register (PRTR) developed under the auspices of the OECD. This would go beyond the requirements of the EPER, for example by including the production of waste. The possible first reporting year is 2007. |

### 1.3. Incineration of Waste

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|---|---|
| **LEGAL INSTRUMENT** | Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the incineration of waste (OJ L 332, 28.12.2000). |
| **MAIN RELEVANT PROVISIONS** | The aim of this Directive is to prevent or to limit as far as practicable negative effects on the environment, in particular pollution by emissions into air, soil, surface water and groundwater, and the resulting risks to human health, from the incineration and co-incineration of waste.<br><br>Emission limit values for discharges of waste water from the cleaning of exhaust gases at incineration plants are established in Annex IV of the Directive. The limit value for mercury is 0.03 mg/l. Air emission limit values for incineration plants are set out in Annex V. The limit value for mercury is 0.05 mg/m$^3$, as an average value over a minimum period of 30 minutes and a maximum of 8 hours (a limit of 0.1 mg/m$^3$ applies until 1 January 2007 for existing plants for which the permit to operate was granted before 31 December 1996). Mercury in emissions to air has to be measured at least twice per year; mercury in emissions to water at least once per |

| | |
|---|---|
| | month. |
| **DEADLINE FOR IMPLEMENTATION** | These provisions apply to new installations as from 28 December 2002 and to existing installations as from 28 December 2005. |
| **OTHER REVELANT INFORMATION** | Most waste incineration facilities will also fall under the scope of Directive 96/61 of 24 September 1996 concerning integrated pollution prevention and control (see section 1.1). Where the application of Directive 96/61 would entail stricter requirements than those of Directive 2000/76, then these stricter requirements take precedence. Work on a BAT Reference document on best available techniques for waste incineration is underway. |

## 1.4. Electrical and Electronic Equipment

| | |
|---|---|
| **LEGAL INSTRUMENT** | Directive 2002/95/EC of the European parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS) (OJ L 37, 13.2.2003).<br><br>Directive 2002/96/EC of the European parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment (WEEE) (OJ L 37, 13.2.2003). |
| **MAIN RELEVANT PROVISIONS** | Directive 2002/95/EC requires the substitution of certain heavy metals and other substances, including mercury, in new electrical and electronic equipment by 1 July 2006. Some applications of mercury are exempted. For mercury, these are:<br>• the use of mercury in compact fluorescent lamps not exceeding 5 mg per lamp<br>• the use of mercury in straight fluorescent lamps not exceeding<br>⇒ halophosphate – 10 mg<br>⇒ triphosphate with normal lifetime – 5 mg<br>⇒ triphosphate with long lifetime – 8 mg<br>• the use of mercury in straight fluorescent lamps for special purposes<br>• the use of mercury in other lamps not specifically mentioned in the annex.<br><br>Each exemption must be reviewed at least every four years with the aim of considering deletion A comitology procedure is established to provide for this, and to consider any further exemptions. Some of the exempted applications, including use of mercury in straight fluorescent lamps, are identified as priorities for review by this comitology procedure. The comitology procedure also has to be followed to determine maximum concentration values for mercury (or other substances). To take into account new scientific evidence, a review of the measures in the Directive as a whole is to be |

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|---|---|
| | undertaken before 13 February 2005. The Commission is also requested to present proposals by 13 February 2005 for including medical devices and monitoring and control instruments under the scope of the Directive.<br><br>Directive 2002/96/EC aims to prevent the generation of WEEE and to support the reuse, recycling and other forms of recovery of such waste. It also seeks to improve the environmental performance of all operators involved in the life cycle of electrical and electronic equipment. In particular, it required that producers, or third parties acting on their behalf, set up systems by 13 August 2004 to provide for the treatment of WEEE using best available treatment, recovery and recycling techniques. Member States must achieve a high level of separate collection for WEEE, and any mercury-containing components must be removed from any separately collected WEEE. |
| **DEADLINE FOR IMPLEMENTATION** | 13 August 2004 |
| **OTHER REVELANT INFORMATION** | The Commission services have prepared a draft Decision and consulted stakeholders on the proposed maximum concentration values for mercury and other substances that would be considered tolerable for non-exempt electrical and electronic equipment. This would set a maximum concentration value of 0.1% by weight in homogeneous materials for lead, mercury, hexavalent chromium, polybrominated biphenyls and polybrominated biphenyl ethers. |

### 1.5. End-of-Life Vehicles

| | |
|---|---|
| **LEGAL INSTRUMENT** | Directive 2000/53/EC of the European Parliament and of the Council of 18 September 2000 on end-of-life vehicles (OJ L 269, 21.10.2000). |
| **MAIN RELEVANT PROVISIONS** | Directive 2000/53/EC lays down measures which aim, as a first priority, at the prevention of waste from vehicles and, in addition, at the reuse, recycling and other forms of recovery of end-of-life vehicles and their components so as to reduce the disposal of waste, as well as at the improvement in the environmental performance of all of the economic operators involved in the life cycle of vehicles and especially the operators directly involved in the treatment of end-of-life vehicles.<br><br>According to Article 4 of this Directive mercury, *inter alia*, is restricted in materials and components of vehicles. In particular, under Article 4(2)(a) Member States must ensure that materials and components of vehicles put on the market after 1 July 2003 do not contain mercury other than in bulbs and instrument display panels. In addition, under Article 6 Member States must ensure that end-of-life vehicles are stored and treated in accordance with minimum specified technical requirements, including the removal, as far as |

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|---|---|
| | possible, of all components identified as containing mercury. |
| **DEADLINE FOR IMPLEMENTATION** | 21 April 2002 |

### 1.6. Batteries and Accumulators Containing Certain Dangerous Substances

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| **LEGAL INSTRUMENT** | Council Directive 91/157/EEC of 18 March 1991 on batteries and accumulators containing certain dangerous substances (OJ L 78, 26.3.91) adapted to technical progress by Commission Directives 93/86/EEC of 4 October 1993 (OJ L 264, 23.10.93) and 98/101/EC of 22 December 1998 (OJ L 1, 5.1.99). |
| **MAIN RELEVANT PROVISIONS** | The aim of Directive 91/157/EEC is the collection and safe recovery and disposal of spent batteries and accumulators containing dangerous substances (mercury, cadmium or lead) in accordance with its Annex I. It requires Member States to take appropriate steps to ensure that spent batteries and accumulators are collected separately with a view to their recovery or disposal, and that batteries and accumulators are marked with information on separate collection, recycling and heavy metal content. Member States must also draw up programmes to reduce the heavy metal content of batteries and accumulators, reduce the amount of spent batteries and accumulators in household waste, and promote research on the use of less polluting substitute substances and methods of recycling.<br><br>The adaptation by Commission Directive 98/101/EC prohibited the marketing of batteries and accumulators containing more than 0.0005% of mercury by weight. Button cells with a mercury content of no more than 2% by weight are exempted. |
| **DEADLINE FOR IMPLEMENTATION** | These provisions entered into force on 1 January 1993. The mercury ban came into effect on 1 January 2000. |
| **OTHER REVELANT INFORMATION** | In November 2003 the Commission adopted a proposal for a Directive of the European Parliament and of the Council on batteries and accumulators and spent batteries and accumulators (COM (2003) 723 final, 21.11.2003). This would replace and repeal Directive 91/157/EEC. The limit on mercury content by weight of 0.0005%, and the exemption for button cells, would be retained. The explanatory memorandum that accompanies the new proposal notes that mercury consumption in batteries has declined significantly in the EU, but that many mercury batteries produced before the restrictions of Directive 91/157 entered into force are still in use. The new proposal aims to establish a closed loop system for all batteries to avoid their disposal by incineration or landfill. It would also require Member States to set up national collection systems so that consumers can return spent portable batteries free of charge. |

### 1.7. Hazardous Waste

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| **LEGAL INSTRUMENT** | Commission Decision (2000/532/EC) of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Directive 75/442 on waste and Council Decision 94/904 establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689EEC on hazardous waste (OJ L226/3, 6.9.2000) (as amended). |
| **MAIN RELEVANT PROVISIONS** | Directive 91/689/EEC contains general provisions on the management of hazardous wastes (e.g. mixing ban, permit requirement for establishments or undertakings, hazardous waste producer's record). Wastes are identified as hazardous based on properties listed in Annex III of the Directive. In this respect the Directive introduces an additional, more stringent, layer of controls applicable to hazardous waste on top of those that apply under the Community's more general waste framework Directive (75/442/EEC as amended by 91/156/EEC).<br><br>By Commission Decision 2000/532/EC a list of waste was adopted. It contains characteristics (concentration thresholds) for the majority of properties listed in Annex III of Directive 91/689EEC. The characteristics follow the classification system of Directive 67/548/EEC on the approximation of the laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances and its subsequent amendments, and of Directive 88/379/EEC on the approximation of the laws, regulations and administrative provisions of the Member States relating to the classification, packaging and labelling of dangerous preparations and its subsequent amendments.<br><br>The annex of the Decision explicitly contains the waste codes 05 07 01* "Sludges containing mercury" (as a waste from natural gas purification), 06 04 04* "Waste containing mercury", 16 06 03* "Mercury containing batteries", 18 01 10* "Amalgam waste from dental care" and 20 01 21* "Fluorescent tubes and other mercury containing waste". There are also other specific waste codes that include the expression "… containing dangerous" which would include mercury. |
| **DEADLINE FOR IMPLEMENTATION** | Council Directive 91/689EEC: 27 June 1995<br><br>Decision 2000/532/EC: 1 January 2002 |
| **OTHER REVELANT INFORMATION** | The determination that waste is hazardous has implications in respect of the application of other Community measures. For example, if waste is to be exported then Council Regulation (EEC) No 259/93 on the supervision and control of shipments of waste within, into and out of the European Community applies. This prevents hazardous waste being exported to non-OECD countries. |

## 1.8. Landfill of Waste

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| **LEGAL INSTRUMENT** | Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste (OJ L 182, 16.7.99)<br><br>Council Decision 2003/33/EC of 19 December 2002 establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of and Annex II to Directive 1999/31/EC (OJ L 11, 16.1.2003). |
| **MAIN RELEVANT PROVISIONS** | Directive 1999/31/EC aims to prevent or reduce negative effects on the environment and risk to human health from the landfilling of waste.<br><br>Article 4 requires that Member States classify landfills into the following categories:<br><br>– landfill for hazardous waste<br><br>– landfill for non-hazardous waste<br><br>– landfill for inert waste.<br><br>Member States must also ensure that certain wastes are not accepted in a landfill. These include liquid waste, and any other waste that does not fulfil the “acceptance criteria” determined in accordance with an annex. These acceptance criteria were set out in Decision 2003/33/EC. They include specific mercury leaching values for wastes acceptable at the different classes of landfill.<br><br>Decision 2003/33/EC also sets out criteria for underground storage of waste. For the acceptance of waste in underground storage sites, a site-specific safety assessment must be carried out. Additional considerations are specified for deep storage in hard rock.<br><br>Articles 7 and 8 of Directive 1999/31 require that operators of landfills apply for permits and that competent authorities ensure that certain conditions will be met in those cases where landfilling is authorised. One such condition is that landfills comply with certain technical standards set in an annex, for example concerning protection of soil and water. Another is that operators maintain adequate financial security to meet their obligations, including after-care. |
| **DEADLINE FOR IMPLEMENTATION** | Directive 1999/31 entered into force on 16 July 1999 and was to be transposed in the Member States by 16 July 2001. Member States have until 16 July 2009 to bring existing landfills into compliance. |

## 1.9. Sewage Sludge

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| **LEGAL INSTRUMENT** | Council Directive 86/278/EEC of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture (OJ L 181, 4.7.86). |
| **MAIN RELEVANT PROVISIONS** | Directive 86/278/EEC aims to regulate the use of sewage sludge in agriculture in such a way as to prevent harmful effects on soil, vegetation, animals and humans, while encouraging its correct use.<br><br>Member States must prohibit the application of sewage sludge to soil where the concentration of one or more metals in the soil exceeds the limit values laid down in a first annex. For mercury, the soil limit value is 1 to 1.5 mg/kg of dry matter for soils with a pH higher than 6 and lower than 7.<br><br>Member States must also regulate the use of sludge such that the accumulation of heavy metals in soil does not exceed the limit values. They can do this in one of two ways:<br><br>a) by laying down the maximum quantities of sludge which may be applied per unit of area per year while observing limit values for heavy metal concentration in sludge set in accordance with a second annex – for mercury this limit value is 16 to 25 mg/kg of dry matter; or<br><br>b) by observing the limit values for the quantities of metals introduced into the soil per unit of area and unit of time as specified in a third annex – for mercury this limit value is 0.1 kg/ha/yr.<br><br>Reference methods for sampling and analysis are specified. Member States must also ensure that up-to-date records are kept of the quantities of sludge produced and used in agriculture, the composition and properties of the sludge, the type of treatment carried out, and the place where the sludge is used. |
| **DEADLINE FOR IMPLEMENTATION** | 4 July 1989 |
| **OTHER REVELANT INFORMATION** | A possible revision of Directive 86/278 is being considered as part of the development of the broader thematic strategy on soil (see section 2.3). |

### 1.10. Packaging and Packaging Waste

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| **LEGAL INSTRUMENT** | European Parliament and Council Directive 94/62/EC of 20 December 1994 on packaging and packaging waste (OJ L 365, 31.12.94), as amended by Directive 2004/12/EC of the European Parliament and of the Council of 11 February 2004 (OJ L 47, 18.2.2004). |
| **MAIN RELEVANT PROVISIONS** | Directive 94/62/EC aims to harmonise national measures concerning the management of packaging and packaging waste in order to prevent environmental impacts in the Member States and third countries, and to avoid obstacles to trade in packaged goods. It lays down measures aimed, as a first priority, at preventing the production of packaging waste and, as additional fundamental principles, at reusing packaging, at recycling and other forms of recovering packaging waste and, hence, at reducing the final disposal of such waste.<br><br>Article 10 sets a specific reduction plan for heavy metals present in packaging. The sum of concentration levels of lead, cadmium, mercury and hexavalent chromium present in packaging or packaging components must not exceed specified levels, reducing with time. The maximum level was set at 600 ppm by weight by 30 June 1998, reducing to 100 ppm by weight by 30 June 2001. |
| **DEADLINE FOR IMPLEMENTATION** | The Directive entered into force on 31 December 1994. Deadlines for heavy metal content are shown above. |
| **OTHER REVELANT INFORMATION** | The amendment to the Directive adopted on 11 February 2004 did not change the provisions concerning heavy metal content. However, a revision clause is included to allow for the possibility of such changes in the future. The Commission will be launching a study on this issue, with a view to submitting a report to the Council and European Parliament in mid 2005. |

### 1.11. Discharges of Dangerous Substances to Water

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| **LEGAL INSTRUMENT** | Council Directive 76/464/EEC of 4 May 1976 on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community (OJ L 129, 18.5.76)<br><br>Council Directive 82/176/EEC of 22 March 1982 on limit values and quality objectives for mercury discharges by the chlor-alkali electrolysis industry (OJ L 81, 27.3.82)<br><br>Council Directive 84/156/EEC of 8 March 1984 on limit values and quality objectives for mercury discharges by sectors other than the chlor-alkali electrolysis industry (OJ L 74, 17.3.84). |

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| **MAIN RELEVANT PROVISIONS** | According to Article 2 of Directive 76/464/EEC, Member States shall take the appropriate steps to eliminate pollution in inland surface, territorial and internal coastal waters by the dangerous substances included in List I of the Annex, which includes mercury and its compounds. Articles 5 and 6 lay down the provisions for authorisation of discharges and provide that Member States can choose whether to base their authorisations on emission limit values or quality objectives. Directive 82/176/EEC provides for specific Community-wide emission limit values and quality objectives applicable to discharges of mercury from the chlor-alkali electrolysis industry, and Directive 84/156/EEC does the same for other industry sectors. In addition, Article 4 of Directive 84/156 stipulates the requirement to draw up programmes to avoid or eliminate pollution caused by discharges of mercury from diffuse sources. |
| **DEADLINE FOR IMPLEMENTATION** | Directive 76/464 was adopted and entered into force on 4 May 1976. Member States had to comply with an initial set of limit values or quality objectives in Directive 82/176 from 1 July 1983, with a stricter set of standards taking effect from 1 July 1986. The provision of Directive 84/156 requiring a pollution reduction programme for mercury applied from 1 July 1989. |
| **OTHER REVELANT INFORMATION** | Article 16(10) of the Water Framework Directive 2000/60/EC (see section 1.12) requires that the Commission reviews, revises and possibly repeals Directives 82/176 and 84/156, including their limit values and quality objectives. Thus, in effect, the controls established by Directives 82/176 and Directive 84/156 under the framework of Directive 76/464 will be superseded by new measures established under the framework of Directive 2000/60. Directive 76/464 will therefore be repealed on 22 December 2013 (thirteen years after the entry into force of Directive 2000/60). |

## 1.12. Protection of Waters

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| **LEGAL INSTRUMENTS** | Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (OJ L 327, 22.12.2000)<br><br>Decision 2001/2455/EC of the European Parliament and of the Council of 20 November 2001 establishing the list of priority substances in the field of water policy (OJ L 331, 15.12.2001). |

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| **MAIN RELEVANT PROVISIONS** | Directive 2000/60/EC establishes a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater. Article 16 provides for the adoption of Community measures for substances included in a list of priority substances, i.e. those which present a significant risk to or via the aquatic environment. There are two levels of measures: (i) "priority substances" are subject to progressive reduction of pollution; and (ii) "priority hazardous substances" are subject to cessation or phasing-out of emissions, discharges and losses within 20 years after adoption of measures.<br><br>The list of priority substances is set out in Decision 2001/2455/EC, wherein mercury is identified as a "priority hazardous substance". According to Article 16(8) of Directive 2000/60, following the inclusion of a substance on the list, the Commission must submit proposals, at least including emission controls for point sources and environmental quality standards. However, in the absence of agreement at Community level on the basis of these proposals six years after the entry into force of Directive 2000/60, Member States must establish environmental quality standards for all surface waters affected by discharges of the priority substances, and controls on the principal sources of such discharges based, *inter alia*, on consideration of all technical reduction options.<br><br>The recitals to Decision 2001/2455/EC note that, for substances occurring naturally such as mercury, complete phase-out of emissions, discharges and losses from all potential sources is impossible. Therefore, when the relevant daughter Directives are drawn up, this situation must be properly taken into account, and measures should aim at cessation of emissions, discharges and losses into water of those priority substances which derive from anthropogenic activities. |
| **DEADLINE FOR IMPLEMENTATION** | Directive 2000/60 entered into force on 22 December 2000, with a deadline for transposition of 22 December 2003. The date for achievement of the environmental objectives is 22 December 2015, with ongoing implementation cycles thereafter. For mercury and other priority hazardous substances, the cessation or phasing-out of emissions, discharges and losses should be achieved within 20 years after adoption of measures, which have yet to be put in place. |
| **OTHER REVELANT INFORMATION** | Directive 2000/60 provides for the review, revision and possible repeal of a number of pre-existing Directives, including Directives 76/464/EEC, 82/176/EEC and 84/156/EEC on discharges of dangerous substances (see section 1.11), Directive 80/68/EEC on groundwater (see section 1.13), and Directive 79/923/EEC on the quality required of shellfish waters (see section 1.14). |

### 1.13. Protection of Groundwater

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| **LEGAL INSTRUMENTS** | Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances (OJ L 20, 26.1.80). |
| **MAIN RELEVANT PROVISIONS** | Directive 80/68/EEC aims to prevent the pollution of groundwater by substances set out in two lists in an Annex, and as far as possible to check or eliminate the consequences of pollution which has already occurred. Mercury and its compounds are included in the "List I of Families and Groups of Substances", to which the most stringent requirements apply. Direct discharges (introduction without percolation through the ground or subsoil) of substances in List I into groundwater are prohibited. Any disposal or tipping of List I substances which might lead to indirect discharge (introduction after percolation through the ground or subsoil) must be subject to prior investigation. Member States must then prohibit such activity, or authorise it provided that all the technical precautions necessary to prevent such discharge are observed. In addition, all appropriate measures deemed necessary must be taken to prevent any indirect discharge of List I substances due to activities on or in the ground other than disposal or tipping. |
| **DEADLINE FOR IMPLEMENTATION** | 17 December 1981 |
| **OTHER REVELANT INFORMATION** | Article 11 of the Water Framework Directive 2000/60/EC (see section 1.12) repeats the prohibition of direct discharges of pollutants into groundwater contained in Directive 80/68. However, Directive 2000/60 is concerned with protecting groundwater not just against pollution from discharges and disposals, but also against pollution from other activities. Article 17 calls for the adoption of specific measures to prevent and control groundwater pollution, with the aim of achieving "good groundwater chemical status". The Commission has therefore proposed a further Directive (COM (2003) 550 final, 19.9.2003), pursuant to Article 17 of Directive 2000/60/EC, which includes:<br>• Criteria for the assessment of good groundwater chemical status; and<br>• Criteria for the identification and reversal of significant and sustained upward trends and for the definition of starting points for trend reversals.<br>For mercury, the proposed Directive would not itself set any threshold values for concentrations in groundwater, but rather it would require Member States to set such threshold values – at the national, river basin or local level – by 22 December 2005. Member States would then have until 22 December 2015 (the date specified by Directive 2000/60) to restore the quality of groundwater not meeting such threshold values. The threshold values set by the Member States would also have to be reported to the Commission, |

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| | on the basis of which the Commission could propose Community-level threshold values.<br><br>In the expectation of new legislation on groundwater being established as outlined above, Directive 80/68 will be repealed by Directive 2000/60 on 22 December 2013. Up to that date, the prior investigations and authorisations carried out pursuant to Directive 80/68 would have to take account of the provisions of the proposed new groundwater Directive, when adopted. |

### 1.14. Quality of Shellfish Waters

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| LEGAL INSTRUMENTS | Council Directive 79/923/EEC of 30 October 1979 on the quality required of shellfish waters (OJ L 281, 10.11.79). |
| MAIN RELEVANT PROVISIONS | Member States must designate "shellfish waters", which are coastal and brackish waters identified by the Member States as needing protection or improvement in order to support shellfish (bivalve and gastropod molluscs) life and growth, and thus to contribute to the high quality of edible shellfish products. Member States must then establish programmes in order to reduce pollution and to ensure that the designated waters conform to certain standards for parameters listed in an annex. For mercury and certain other metals, these programmes must ensure that the concentration of each substance in shellfish water or shellfish flesh does not exceed a level which gives rise to harmful effects on the shellfish and their larvae, taking synergistic effects of the metals into consideration. The programmes must also endeavour to ensure that the concentration of each substance in shellfish flesh is so limited that it contributes to the high quality of shellfish products. Sampling must be carried out at least every six months. |
| DEADLINE FOR IMPLEMENTATION | Directive 79/923 had to be brought into effect in the Member States by 30 October 1991, including through the initial designation of shellfish waters. Designated waters were to conform with the standards specified within six years of designation. |
| OTHER REVELANT INFORMATION | Article 16(10) of the Water Framework Directive 2000/60/EC (see section 1.12) will repeal Directive 79/923 on 22 December 2013, by which time it is anticipated that a much broader set of environmental quality standards and related measures will have been put in place under the former Directive. |

### 1.15. Drinking Water Quality

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| LEGAL INSTRUMENTS | Council Directive 98/83/EEC of 3 November 1998 on the quality of water intended for human consumption (OJ L 330, 5.12.98). |

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| **MAIN RELEVANT PROVISIONS** | According to Article 5 and Annex I, a maximum level of 1.0 µg/l is specified for mercury in drinking water. |
| **DEADLINE FOR IMPLEMENTATION** | The Directive entered into force on 25 December 2000. |

## 1.16. Air Quality

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| **LEGAL INSTRUMENT** | Council Directive 96/62/EC of 27 September 1996 on ambient air quality assessment and management (OJ L 296, 21.11.96)<br><br>Proposed Directive of the European Parliament and of the Council relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air (COM (2003) 423 final, 16.7.2003). |
| **MAIN RELEVANT PROVISIONS** | The air quality framework Directive (96/62/EC) defines the basic principles for a common approach for the assessment and management of ambient air quality in the EU. It requires Member States to assess ambient air quality throughout their territory. It sets requirements to define environmental objectives (limit values, target values, alert thresholds) for a number of air pollutants stated in an Annex to the Directive. It also sets obligations whereby Member States are required to draw up plans and programmes to show by which measures they are going to comply with a certain limit value by a certain attainment date. Details of the specific air quality assessment requirements, including the definition of limit values, are regulated in daughter directives.<br><br>A first reading agreement has been achieved with the European Parliament and Council on the fourth daughter Directive relating to arsenic, cadmium, nickel, mercury and polycyclic aromatic hydrocarbons (PAH). This provides target values for As, Cd, Ni and Benzo(a)pyrene as a marker for PAH in ambient air that should not be exceeded as from 31 December 2012.<br><br>Methylmercury is recognised as a possible human carcinogen while elemental mercury is considered not to be classifiable in terms of carcinogenicity. In Europe, concentrations of mercury in ambient air are below a level where they are believed to have adverse effects on human health. Therefore, mercury in ambient air is not regulated via a target value in the fourth daughter Directive. However, regardless of the concentration level, all substances covered by the measure, including mercury, are to be measured at background sampling points with a spatial resolution of 100,000 km$^2$ in order to provide information on geographical variation and long term trends. The same requirements are laid down for deposition measurements |

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| | of heavy metals and PAH. Monitoring of particulate and gaseous divalent mercury is also recommended. |
| **DEADLINE FOR IMPLEMENTATION** | The air quality framework Directive entered into force on 21.11.96. Member States had to transpose it by 21.5.98. The first reading agreement on the fourth daughter Directive requires transposition within 24 months after entry into force. |
| **OTHER REVELANT INFORMATION / STUDIES** | The first reading agreement on the proposed fourth daughter Directive foresees a review of implementation by the end of 2010. This is to cover, *inter alia*, experience of applying the Directive, the results of the most recent scientific research on the effects of mercury exposure on human health and the environment, and technological developments including progress in methods of assessing concentrations in ambient air as well as deposition. Taking account of measures adopted pursuant to the mercury strategy the report is also to consider whether there would be merit in taking further action in relation to mercury, taking account of technical feasibility and cost-effectiveness and any significant additional health and environmental protection that this would provide. |

## 1.17. Restrictions on Marketing and Use of Dangerous Substances

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| **LEGAL INSTRUMENT** | Council Directive 89/677/EEC of 21 December 1989 amending for the 8th time Directive 76/769/EEC on the approximation of the laws, regulations and administrative provisions of the Member States relating to restrictions on the marketing and use of certain dangerous substances and preparations (OJ L 398, 30.12.89). |
| **MAIN RELEVANT PROVISIONS** | Directive 76/769/EEC creates a framework legislative procedure under which the Community may ban or restrict the use of hazardous chemicals by adding the substances and controls to an annex. Additions of chemicals have been done in several amendments. The following controls on mercury were added by Directive 89/677/EEC:<br><br>Mercury compounds may not be used as substances and constituents of preparations intended for use:<br><br>a) to prevent the fouling by micro-organisms, plants or animals of:<br><br>– the hulls of boats,<br><br>– cages, floats, nets and any other appliances or equipment used for fish or shellfish farming,<br><br>– any totally or partly submerged appliances or equipment; |

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| | (b) the preservation of wood;<br><br>(c) the impregnation of heavy-duty industrial textiles and yarn intended for their manufacture;<br><br>(d) in the treatment of industrial waters, irrespective of their use.” |
| **DEADLINE FOR IMPLEMENTATION** | These provisions have been in force since mid 1991. |
| **OTHER REVELANT INFORMATION** | The Commission has recently proposed a major new EU chemicals regime (see section 1.22). This will eventually repeal the framework Directive 76/769, encompass the various controls adopted under it, and provide a more streamlined procedure for the adoption of any further restrictions. |

## 1.18. Restrictions on Marketing and Use of Plant Protection Products

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| **LEGAL INSTRUMENTS** | Council Directive 79/117/EEC of 21 December 1978 prohibiting the placing on the market and use of plant protection products containing certain active substances (OJ L 33, 8.2.79).<br><br>Commission Directive 91/188/EEC of 19 March 1991 amending for the fifth time the Annex to Council Directive 79/117/EEC prohibiting the placing on the market and use of plant protection products containing certain active substances (OJ L 92, 13.4.91). |
| **MAIN RELEVANT PROVISIONS** | According to Article 3 of Council Directive 79/117/EEC, plant protection products containing one or more of the following active substances may be neither placed on the market nor used: mercury oxide, mercurous chloride (calomel), other inorganic mercury compounds, alkyl mercury compounds, alkoxyalkyl and aryl mercury compounds. Commission Directive 91/188/EEC deleted some limited exemptions from these restrictions which had previously been allowed. |
| **DEADLINE FOR IMPLEMENTATION** | 1 January 1981 |

## 1.19. Restrictions on Marketing of Biocides

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| **LEGAL INSTRUMENTS** | Directive 98/8/EC of the European Parliament and of the Council of 16 February 1998 concerning the placing of biocidal products on the market (OJ L 123, 24.4.98). |

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| **MAIN RELEVANT PROVISIONS** | Biocidal products cannot be placed on the market and used in the territory of the Member States unless authorised in accordance with Directive 98/8/EC. No biocidal products containing mercury have been authorised and accordingly they are banned in the Community. |
| **DEADLINE FOR IMPLEMENTATION** | Directive 98/8 entered into force on 14 May 1998. |

## 1.20. Export and Import of Certain Dangerous Chemicals

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| **LEGAL INSTRUMENTS** | Regulation (EC) No. 304/2003 of the European Parliament and of the Council of 28 January 2003 concerning the export and import of dangerous chemicals (OJ L 63, 6.3.2003). |
| **MAIN RELEVANT PROVISIONS** | Regulation 304/2003 implements the Rotterdam Convention on the Prior Informed Consent (PIC) Procedure for Certain Hazardous Chemicals and Pesticides in International Trade.<br><br>The Convention provides for an exchange of information between its parties on restrictions on hazardous chemicals and pesticides and their import and export. The trigger for action is when a party takes regulatory action to ban or severely restrict a hazardous chemical or pesticide in its own territory in order to protect human health and/or the environment. The party must then notify the Secretariat of the Convention of that ban or restriction. It should also make export of the substance subject to a notification procedure, whereby the first export annually to any party would have to be notified in advance to the designated authority in that country of destination. This obligation ends when the substance becomes subject to the PIC procedure and the importing party has given an import decision (see below).<br><br>When two notifications of bans or severe restrictions for the same substance have been received under the Convention from two geographic regions, a chemical review committee will consider whether these meet the criteria of Annex II to the Convention. The committee may recommend that the substance be added to the PIC procedure and prepare a decision guidance document (DGD), containing relevant information to help parties take an informed decision on whether or not to accept imports. If the Conference of the Parties decides that the chemical should be included in the PIC procedure, the DGD is circulated and all parties to the Convention should communicate an import decision to the Secretariat on whether and under what circumstances they wish to receive imports of the substance. Exporting parties are then obliged to ensure that their exporters comply with these wishes. |

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| | Mercury compounds are listed in Annex I, Part 1 to the Regulation as banned or severely restricted within the Community and are thus subject to the export notification requirements, which are laid down in Article 7 of the Regulation. These requirements apply to exports to all countries. Mercury compounds used as pesticides, including inorganic mercury compounds, alkyl mercury compounds and alkyloxyalkyl and aryl mercury compounds are also included in Part 3 of Annex I to the Regulation as chemicals subject to the PIC procedure. Thus, in accordance with Article 13 of the Regulation, *inter alia*, EU exporters must comply with the import decisions taken by third countries. The Regulation in fact goes further than the Convention in this respect, in that it requires exports of PIC substances to have the explicit consent of the importing country (whereas under the Convention exports would, after a certain period of time, be permitted to a country that has failed to communicate an import decision). Like export notification, this requirement extends to exports to all countries, irrespective of whether or not they are parties to the Convention.<br><br>The Regulation also bans the export from the Community of certain chemicals and articles, listed in Annex V. Cosmetic soaps containing mercury are subject to this ban. |
| **DEADLINE FOR IMPLEMENTATION** | The Regulation entered into force on 7 March 2003. |

### 1.21. Classification, Packaging and Labelling of Dangerous Substances

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| **LEGAL INSTRUMENT** | Council Directive 67/548/EEC of 27 June 1967 on the approximation of the laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances (OJ B 196, 16.8.67) as amended by Commission Directive 2001/59/EC of 6 August 2001 (OJ L 225, 21.8.2001). |
| **MAIN RELEVANT PROVISIONS** | The following substances have a harmonised classification and labelling in accordance with the provisions laid down in the Directive as amended and are included in its Annex I:<br><br>mercury (Index No. 080-001-00-0, EC No. 231-106-7);<br><br>inorganic mercury compounds with the exception of mercuric sulphide and those specified elsewhere in Annex I to Council Directive 67/548/EEC (Index No. 080-002-00-6);<br><br>dimercury dichloride, calomel (Index No. 080-003-00-1, EC No. 233-307-5);<br><br>organic mercury compounds with the exception of those specified elsewhere in Annex I to Council Directive 67/548/EEC (Index No. |

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| | 080-004-00-7);<br><br>mercuric fulminate, fulminate of mercury (Index No. 080-005-00-2, EC No. 211-057-8);<br><br>mercuric oxycyanide (Index No. 080-006-00-8, EC No. 215-629-8);<br><br>dimethylmercury; diethylmercury (Index No. 080-007-00-3);<br><br>phenylmercury nitrate; phenylmercury hydroxide; basic phenylmercury nitrate (Index No. 080-008-00-9);<br><br>2-methoxyethylmercury chloride (Index No. 080-009-00-4, EC No. 204-659-7);<br><br>mercury dichloride, mercuric chloride (Index No. 080-010-00-X, EC No. 231-299-8);<br><br>phenylmercury acetate (Index No. 080-011-00-5, EC No. 200-532-5). |
| **DEADLINE FOR IMPLEMENTATION** | These provisions entered into force on 1 July 2000 (Commission Directive 98/98/EC of 15 December 1998, OJ L 355, 30.12.98). |

### 1.22. Registration, Evaluation and Authorisation of Chemicals

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| **LEGAL INSTRUMENT** | Proposal for a Regulation of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency and amending Directive 1999/45/EC and Regulation (EC) {on Persistent Organic Pollutants},<br><br>Proposal for a Directive of the European Parliament and of the Council amending Council Directive 67/548/EEC in order to adapt it to Regulation (EC) of the European Parliament and of the Council concerning the registration, evaluation, authorisation and restriction of chemicals,<br><br>COM (2003) 644 final, 29.10.2003. |
| **MAIN RELEVANT PROVISIONS** | Current Community legislation on chemicals distinguishes between "existing" and "new" chemicals, based on the cut-off date of 1981. While new chemicals have to be tested, there are no such provisions for the 100,106 "existing" substances put on the market before 1981. The European Commission has therefore presented a proposal for a new Community regulatory framework for chemicals called REACH (Registration, Evaluation and Authorisation of Chemicals). This would replace over 40 existing Directives and Regulations, including Directive 76/769/EEC (see section 1.17) under which certain present Community restrictions on the use of mercury have |

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| | been established.<br><br>**<u>Registration</u>**<u>:</u> Chemicals manufactured or imported in quantities of more than one tonne per year and per manufacturer/importer would be registered in a central database managed by a new European Chemicals Agency. The registration would include information on properties (such as physicochemical, toxicological and eco toxicological properties), uses and safe ways of handling the chemicals. Information would be passed down the supply chain, so that those that use chemicals in their own production processes – to produce other products – could do so in a safe and responsible way. To cope with the large number of "existing" substances a phased approach is proposed. The deadlines for registration are set according to the volume of the substance on the market or the hazard. The shortest deadlines apply to very high volume substances (above 1000 tonnes), and carcinogenic, mutagenic or reproduction-toxic (CMR) substances above 1 tonne. These will have to be registered within 3 years.<br><br>**<u>Evaluation</u>**: The competent authorities could evaluate any substance where they had justified reasons to suspect that there was a risk to human health or the environment. The programme of substance evaluations would be based on rolling plans prepared by Member State Competent Authorities. The programme would take account of criteria for setting priorities drawn up by the Agency.<br><br>**<u>Authorisation:</u>** All substances of very high concern will be subject to authorisation. Authorisations apply to particular uses of the substance in question. Authorisation will be granted only if the producer or importer can show that risks from the use in question can be adequately controlled, or that the socio-economic benefits of the use of the substance outweigh the risks. In the latter case, the possibility of substitution should be considered.<br><br>Mercury, and any mercury compounds produced or imported at levels above one tonne per year, will therefore have to be registered under REACH. However, it seems unlikely registration would be required within the first three years of the scheme, as the high level production threshold is unlikely to be met and no mercury compounds are classed as CMR under Directive 67/548. The authorisation provisions would then apply to mercury if the Member States were to agree on a dossier (prepared by one of the Member States or the Agency) showing that mercury falls into the "serious and irreversible harm to health/environment" criterion. |
| **DEADLINE FOR IMPLEMENTATION** | This is a proposed Regulation which remains subject to further negotiation. The registration provisions would apply from 60 days after the Regulation enters into force. The provisions for substance evaluation would apply two years after the Regulation enters into force when it is likely that a number of registrations will be |

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| | available for substance evaluation. |

### 1.23. Safety of Toys

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| **LEGAL INSTRUMENT** | Council Directive 88/378/EEC of 3 May 1988 on the approximation of the laws of the Member States concerning the safety of toys (OJ L 187, 16.7.88). |
| **MAIN RELEVANT PROVISIONS** | Directive 88/378/EEC controls the placing of toys on the market in order to protect the health and safety of users and third parties. Annex II sets out essential safety requirements for toys. It provides that bioavailability resulting from the use of toys must not, as an objective, exceed levels specified for a variety of chemicals. The level for mercury is 0.5 µg per day. |
| **DEADLINE FOR IMPLEMENTATION** | Member States were to apply provisions necessary to comply with Directive 88/378 from 1 January 1990. |

### 1.24. Medical Devices

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| **LEGAL INSTRUMENT** | Council Directive 76/764/EEC of 27 July 1976 on the approximation of the laws of the Member States on clinical mercury-in-glass, maximum reading thermometers (OJ L 262, 27.9.76) (now repealed)<br><br>Council Directive 93/42/EEC of 14 June 1993 concerning medical devices (OJ L 169, 12.7.93). |
| **MAIN RELEVANT PROVISIONS** | Directive 76/764/EEC was intended to harmonise the provisions governing the manufacture and control of clinical mercury-in-glass thermometers, in order to support trade in these instruments between the Member States. It set out a series of criteria (for example the scale range, maximum permissible errors, etc.) which thermometers had to satisfy in order to qualify for an EEC verification mark.<br><br>Directive 93/42/EEC repealed Directive 76/764 and set out a broader regime for the certification and inspection of medical devices in general, again as a means of avoiding barriers to trade, while ensuring that medical devices are effective and do not compromise the safety and health of patients, users and other persons. Essential requirements of medical devices are set out in an annex. Specific medical devices are then assessed against these requirements by an independent third party certifier. The Commission (DG Enterprise) also produces guidelines on implementation of the Directive.<br><br>Clinical thermometers (whether for household or professional use), |

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| | sphygmomanometers and dental amalgam are all classed as medical devices under Directive 93/42. |
| **DEADLINE FOR IMPLEMENTATION** | 1 July 1994 |

### 1.25. Cosmetics

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| **LEGAL INSTRUMENT** | Council Directive 76/768/EEC of 27 July 1976 on the approximation of the laws of the Member States relating to cosmetic products (Official Journal L 262 , 27.9.76). |
| **MAIN RELEVANT PROVISIONS** | Mercury and its compounds may not be present as ingredients in cosmetics, including soaps, lotions, shampoos, skin bleaching products, etc. (except for phenyl mercuric salts for conservation of eye makeup and products for removal of eye make-up in concentrations not exceeding 0.007 percent weight-to-weight) that are marketed within the European Community. |
| **DEADLINE FOR IMPLEMENTATION** | Member States had to bring into force the measures needed to comply with Directive 76/768/EEC no later than 27 March 1978. |

### 1.26. Protection of the Health and Safety of Workers from the Risks related to Chemical Agents at Work

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| **LEGAL INSTRUMENT** | Council Directive 98/24/EC of 7 April 1998 on the protection of the health and safety of workers from the risks related to chemical agents at work (OJ L 131, 5.5.98). |
| **MAIN RELEVANT PROVISIONS** | Directive 98/24/EC lays down minimum requirements for the protection of workers from risks to their safety and health arising, or likely to arise, from the effects of all chemical agents that are present at the workplace or as a result of any work activity involving chemical agents. Consequently this framework Directive regulates all substances including mercury and its compounds. |
| **DEADLINE FOR IMPLEMENTATION** | Member States were to have brought this Directive into effect no later then 5 May 2001. |
| **OTHER REVELANT INFORMATION** | The EU Scientific Committee on Occupational Exposure Limits (SCOEL) has held extensive discussions on mercury and mercury compounds in order to come up with a Recommendation to the Commission for an occupational exposure limit value. The Committee has proposed levels of 0.02 mg/m$^3$ as an 8-hour time-weighted average, and 0.01 mg/l in blood and 0.03 mg/g creatinine in urine as biological limit values. |

### 1.27. Contaminants in Foodstuffs

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| **LEGAL INSTRUMENTS** | Commission Regulation (EC) No. 466/2001 of 8 March 2001 setting maximum levels for certain contaminants in foodstuffs (OJ L 77, 16.3.2001) as amended by Commission Regulation (EC) No. 221/2002 of 6 February 2002 (OJ L 37, 7.2.2002).<br><br>Commission Directive 2001/22/EC of 8 March 2001, laying down the sampling methods and the methods of analysis for the official control of the levels of lead, cadmium, mercury and 3-MCPD in foodstuffs (OJ L 77, 16.03.2001). |
| **MAIN RELEVANT PROVISIONS** | Under Commission Regulation (EC) No 466/2001, a maximum level of 0.5 mg/kg wet weight is set for mercury in fishery products, with the exception of the following fish species for which a separate maximum level of 1 mg/kg wet weight applies: anglerfish (*Lophius* spp.), atlantic catfish (*Anarhichas lupus*), bass (*Dicentrarchus labrax*), blue ling (*Molva dipterygia*), bonito (*Sarda* spp.), eel (*Anguilla* spp.), emperor or orange roughy (*Hoplostethus atlanticus*), grenadier (*Coryphenoides rupestris*), halibut (*Hippoglossus hippoglossus*), marlin (*Makaira* spp.), pike (*Esox lucius*), plain bonito (*Orcynopsis unicolor*), portuguese dogfish (*Centroscymnes coelolepis*), rays (*Raja* spp.), redfish (*Sebastes marinus*, *S. mentella*, *S. viviparus*), sail fish (*Istiophorus platypterus*), scabbard fish (*Lepidopus caudatus*, *Aphanopus carbo*), shark (all species), snake mackerel or butterfish (*Lepidocybium flavobrunneum*, *Ruvettus pretiosus*, *Gempylus serpens*), sturgeon (*Acipenser* spp.), swordfish (*Xiphias gladius*) and tuna (*Thunnus* and *Euthynnus* spp.). |
| **DEADLINE FOR IMPLEMENTATION** | Commission Regulation 466/2001 has applied with effect from 5 April 2002. |
| **OTHER REVELANT INFORMATION / STUDIES** | The results of a scientific cooperation (SCOOP) task involving data collection from 12 EU Member States and Norway on heavy metals such as mercury in foodstuffs have been published. An opinion from the European Food Safety Authority on mercury and methylmercury in food has also been published, taking account of the SCOOP data, and the decision in June 2003 of the FAO/WHO Joint Expert Committee on Food Additives to revise its Provisional Tolerable Weekly Intake for methylmercury from 3.3 to 1.6 µg/kg body weight. Both the SCOOP report and the EFSA opinion can be accessed through:<br><br>http://europa.eu.int/comm/food/food/chemicalsafety/contaminants/cadmium_en.htm. |

## 2. OTHER STRATEGIES

### 2.1. Environment and Health

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| **NATURE OF INITIATIVE** | European Environment and Health Action Plan 2004-2010 |
| **MAIN RELEVANT PROVISIONS** | In June 2004 the Commission published a Communication to the Council, the European Parliament and the European Economic and Social Committee entitled "A European Environment and Health Action Plan 2004-2010" (COM (2004) 416 final, 9.6.2004). The Action Plan identifies 13 actions with a focus on:<br>– improving the information chain by developing integrated environment and health information<br>– filling the knowledge gap by strengthening research on environment and health and identifying emerging issues<br>– reviewing and adjusting risk reduction policy and improving communication<br><br>The Action Plan can be summarised as follows:<br><br>1 - IMPROVE THE INFORMATION CHAIN by developing integrated environment and health information to understand the links between sources of pollutants and health effects:<br><br>Action 1: Develop environmental health indicators<br><br>Action 2: Develop integrated monitoring of the environment, including food, to allow the determination of relevant human exposure<br><br>Action 3: Develop a coherent approach to biomonitoring in Europe<br><br>Action 4: Enhance coordination and joint activities on environment and health<br><br>2 - FILL THE KNOWLEDGE GAP by strengthening research on environment and health and identifying emerging issues<br><br>Action 5: Integrate and strengthen European environment and health research<br><br>Action 6: Target research on diseases, disorders and exposures<br><br>Action 7: Develop methodological systems to analyse interactions between environment and health<br><br>Action 8: Ensure that potential hazards on environment and health are identified and addressed |

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| | 3 - RESPONSE: REVIEW POLICIES AND IMPROVE COMMUNICATION by developing Awareness Raising, Risk Communication, Training & Education to give citizens the information they need to make better health choices, and to make sure that professionals in each field are alert to environment and health interactions.<br><br>Action 9: Develop public health activities and networking on environmental health determinants through the public health programme<br><br>Action 10: Promote training of professionals and improve organisational capacity in environment and health by reviewing and adjusting risk reduction policy<br><br>Action 11: Coordinate ongoing risk reduction measures and focus on the priority diseases<br><br>Action 12: Improve indoor air quality<br><br>Action 13: Follow developments regarding electromagnetic fields<br><br>During this initial period the Action Plan focuses particularly on gaining a better understanding of the links between environmental factors and respiratory diseases, neurodevelopmental disorders, cancer and endocrine disrupting effects. For these multi-causal diseases and conditions, there are indications and some initial evidence that environmental factors can play a role in their development and aggravation. To characterise the environmental contribution more precisely, and to focus on the most important diseases and conditions within the disease groups, more information is needed. The Action Plan will set up targeted research actions to improve and refine knowledge of the relevant causal links, and at the same time, health monitoring will be improved to obtain a better picture of disease occurrence across the Community.<br><br>The other key information aspect is to monitor exposure through the environment, including food, to the factors most linked to the occurrence of these diseases. In order to develop a coherent framework for integrated exposure monitoring, three pilot projects were carried out on substances for which data collection and monitoring is already in place (dioxins & PCBs, heavy metals and endocrine disrupters). The Action Plan will apply this framework to assess exposure not only to the pilot substances but to all the principal environmental factors associated with health problems, and will adapt environment and food monitoring where needed.<br><br>Once the necessary risk-based information is available the appropriate risk management decisions can be taken, either by |

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| | individuals or public policy makers. In both cases communication and awareness-raising will be important in ensuring that well informed, science based decisions are made.<br><br>The concerns of children are integrated throughout the Action Plan. A number of major child health issues will be covered in the monitoring, as will exposure to the environmental stressors to which children are particularly sensitive. |
| **TIMESCALE** | The Action Plan runs from 2004 to 2010. |
| **OTHER REVELANT INFORMATION** | The Action Plan is building on nine baseline reports being prepared by a wide range of environmental and health professionals. These include baseline reports on neurodevelopmental disorders and on the integrated monitoring of heavy metals. One of the immediate actions to implement the Action Plan is to launch a study to identify which pollutants are most directly linked with health effects, to assess current and proposed monitoring regimes to determine whether they give a good exposure assessment and to propose changes to monitoring as necessary. A working group will also be set up to develop a coherent approach to biomonitoring in Europe. |

### 2.2. Protection of the Marine Environment

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| **NATURE OF INITIATIVE** | Thematic Strategy being developed pursuant to the EU's 6$^{th}$ Environment Action Programme |
| **MAIN RELEVANT PROVISIONS** | In October 2002 the Commission published a Communication to the Council and the European Parliament entitled "Towards a strategy to protect and conserve the marine environment" (COM (2002) 539 final, 2.10.2002). As its title suggests, this anticipates the adoption of a thematic strategy on the marine environment, which under the 6$^{th}$ Environment Action Programme is due by 2005.<br><br>The Communication proposed the overall objective of promoting the sustainable use of the seas and conservation of marine ecosystems, including sea beds, estuarine and coastal areas, paying special attention to sites holding a high biodiversity value. It also identified a specific objective, among others, to progressively reduce discharges, emissions and losses of substances hazardous to the marine environment with the ultimate aim to reach concentrations of such substances in the marine environment near background values for naturally occurring substances and close to zero for man-made synthetic substances. In terms of action to achieve these objectives, the Communication stated that the Commission will actively pursue the implementation of the objectives set in the Water Framework Directive. It will also aim to integrate the objectives into Community policies regarding chemicals and pesticides and all other relevant policies so as to |

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| | achieve a progressive reduction of discharges, emissions and losses of these substances from all land- and sea-based sources, with the ultimate aim of halting these.<br><br>An annex to the Communication sets out an overview of the quality status of European seas. This notes that the levels of most heavy metals in the Baltic and Northeast Atlantic are either stable or even decreasing. In the Mediterranean Sea, mercury values are generally higher but this is believed mainly to be due to natural processes as a result of the region being in the Mediterranean-Himalayan mercuriferous belt. The annex recalls the very high mercury concentrations that were observed in some coastal “hot spots” in the early 1970s, but also notes that dramatic reductions in releases from chlor-alkali plants have allowed quick recoveries in biota (2-5 years for half-life of mercury) and indications of slower (6-33 years) reductions of concentrations in sediments. |
| **TIMESCALE** | The thematic strategy is due to be published in 2005. |

### 2.3. Protection of Soil

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| **NATURE OF INITIATIVE** | Thematic Strategy being developed pursuant to the EU’s 6th Environment Action Programme |
| **MAIN RELEVANT PROVISIONS** | In the 6th Environment Action Programme, among the priorities set for the conservation of biodiversity and natural resources, the Community took the commitment of addressing soil alongside water and air as an environmental medium to be preserved and to develop a Thematic Strategy for Soil Protection. As a follow up to the adoption of the 6th EAP, the Commission adopted on 16 April 2002 a Communication towards a Thematic Strategy for Soil Protection (COM (2002) 179 final). This Communication highlighted the need to integrate in other Community policies aspects pertaining to soil protection. It also identified the major threats to which soil is confronted in the EU, i.e. erosion, organic matter decline, contamination, loss of biodiversity, salinisation, compaction, sealing, floods and landslides.<br><br>Building on this first Communication and work carried out as a result of it, the Thematic Strategy now in preparation will comprise a package of measures including some pertaining to soil contamination, sludges and biodegradable waste management. These may contain specific provisions relating to mercury (see also section 1.9 on the existing sewage sludge Directive). |
| **TIMESCALE** | The Thematic Strategy is due to be published in 2005. |

### 2.4. Air Quality

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| **NATURE OF INITIATIVE** | Thematic Strategy being developed pursuant to the EU's 6th Environment Action Programme |
| **MAIN RELEVANT PROVISIONS** | Clean Air for Europe (CAFE) is a programme of technical analysis and policy development which will lead to the adoption of a thematic strategy on air pollution under the Sixth Environmental Action Programme. The major elements of the CAFE programme were outlined in the Communication on CAFE (COM (2001) 245 final, 4.5.2001). The programme was launched in March 2001. Its aim is to develop long term, strategic and integrated policy advice to protect against significant negative effects of air pollution on human health and the environment. CAFE is principally concerned with NOx, SOx, VOCs, ozone and ammonia as air pollutants. |
| **TIMESCALE** | The integrated policy advice from the CAFE programme is planned to be ready in early 2005. The European Commission aims to present its thematic strategy on air pollution around mid 2005, outlining the environmental objectives for air quality and measures to be taken to achieve the meet these objectives. |
| **OTHER REVELANT INFORMATION** | A study on emissions from small combustion installations has been undertaken within the context of the CAFE programme. |

### 2.5. Waste, Resources and Products

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| **NATURE OF INITIATIVE** | Thematic strategies on waste prevention and recycling and on sustainable use of resources being developed pursuant to the EU's 6th Environment Action Programme. Implementation of the Commission's Integrated Product Policy Communication (COM (2003) 302 final, 18.6.2003) is ongoing. |
| **MAIN RELEVANT PROVISIONS** | Development of the thematic strategy on waste prevention and recycling is intended to identify means to further develop Community waste management policy. As regards the prevention of waste, the aim is to develop a comprehensive strategy which includes assessing the option of setting prevention targets and measures needed to achieve them. For waste recycling, the aim is to investigate ways to promote recycling where potential exists for additional environmental benefits, and to analyse options to achieve recycling objectives in the most cost-effective way. The first step in the development of this strategy was the adoption of a Commission Communication (COM (2003) 301 final, 27.5.2003).<br><br>Development of the thematic strategy on sustainable use of resources has the aims of ensuring that the consumption of resources and their associated impacts do not exceed the carrying capacity of the environment and breaking the linkages between |

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| | economic growth and resource use. As with the waste strategy, the first step in the resources strategy was the adoption of a Communication (COM (2003) 572 final, 1.10.2003).<br><br>Work on integrated product policy (IPP) seeks to provide a framework for minimising the environmental degradation caused by products and services, whether from their manufacturing, use or disposal. IPP therefore involves looking at all phases of a product's life-cycle and taking action to reduce the environmental impacts where it is most effective.<br><br>These broad policy initiatives are not specifically concerned with mercury, but neverthless will form part of the context in which future Community measures concerning the prevention or treatment of mercury waste, use of mercury as a resource, or control of mercury-containing products could be considered. |
| **TIMESCALE** | The waste and resources strategies are due to be published in 2005. Implementation of the Commission's Integrated Product Policy Communication is ongoing. |

## Annex 5: Examples of Previous Attempts to Calculate the Externality Costs of Mercury

Valuation of the benefits of mercury emission reductions varies greatly depending on the approach and source of original emissions. For instance, the clean-up costs of thermometer spills might be relatively easy to assess, as the pollution is limited to a specific place. It is far more difficult to assess the benefits of reducing emissions to air, as the mercury can be transported over long distances. A review of the literature shows there have been few attempts to place a value on the cost of such mercury pollution.

**Valuations related to mercury uses**

The Sustainable Hospitals Project[95] provides an overview of some anecdotal experiences related to the costs of clean-up resulting from breakage of thermometers and other measuring equipment (Table 27).

**Table 27 – Costs of cleaning up after mercury spills**

| Source | Clean-up costs (US dollars) |
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| Thermometer | 1,000-5,000 |
| Sphygmomanometer | 5,000 |
| Barometer | 10,000 |
| Sink traps | 570,000 |
| Laboratory piping | 350,000 |

These values, if combined with an average equipment-breakage rate, could serve as a theoretical basis for assessing some of the monetary benefits of replacing mercury-containing products with substitutes. However, there are two factors that make monetising impacts in this way for the EU difficult. Firstly, the real clean up costs are not known and may vary greatly, from no costs (brush-and-bin) to high costs (specialised teams) from country-to-country. Secondly, the number of breakages remains uncertain, as not all are reported. The above data also do not show the costs of environmental and health damage from the mercury released to environment.

**Valuations related to emissions**

A persistent problem in valuation of the benefits of mercury emission reductions is lack of robust dose-response models. Traditional difficulties with such models – questions on willingness-to-pay transfers, ascribing values of statistical life, etc. – are amplified by the fact that mercury intake happens primarily via diet, which may be subject to change, caused for instance by crises such as BSE.

95 www.sustainablehospitals.org

As can be seen from Table 28, there are a number of difficulties and discrepancies in previous valuation efforts. For a start, the valuations cover a wide range, for example ranging from €2,600-158,000 per kg of mercury emitted to air – a difference of a factor of 60. In addition, it seems questionable that the benefit of preventing an emission of a kg of mercury to air is so much higher than that of preventing an emission to water (estimated at around €1,000 per kg), especially when such a large part of the concern in this area is the mercury content of fish. These differences can only partly be explained by the use of different valuation techniques.

**Table 28 – Range of environmental externalities associated with mercury (€)**

| **Cost per kg to air** | **Cost per kg to water** | **Cost per kg to soil** | **Source** |
|---|---|---|---|
| 25,000 | 1,000 | 36 | Norway Econ Report No. 338/95. Vennemo, Haakon (1995): *Miljøkostnader knyttet til ulike type avfall* (Environmental costs linked with different types of waste). |
| 158,000 | | | Tellus Institute (1992): *The Tellus Packaging Study.* Tellus Institute, Boston Massachusetts, USA (cited as a higher valuation in Norwegian cost-benefit analysis for incineration controls, which instead used the figures from Econ Report 338/95 above). |
| 7,900-17,700 | | | Minnesota Pollution Control Agency 1996 |
| 2,600-7,900 | | | Minnesota Office of Attorney General 1996 |
| | | | These figures were proposed in 1996 hearings in Minnesota to determine environmental costs associated with electricity generation. In the event, however, it was concluded that there was insufficient evidence to support a quantified range of environmental costs for mercury. See: Minnesota Public Utilities Commission, *In the matter of the quantification of environmental costs pursuant to Laws of Minnesota 1993, Chapter 356, Section 3*, Docket E-999/CI-93-583, December 1996. |

One can also look more closely at the individual valuation efforts and determine to what extent they are applicable to an EU mercury strategy. For instance, the Norwegian estimates in the above table were based on cancer risk estimates from a previous report.

Subsequent to its input to the 1996 hearings referred to in the table above, in 1999 the Minnesota Pollution Control Agency published the results of a contingent valuation study to assess the benefits of reduced mercury emissions in Minnesota (Hagen et al, 1999). For a baseline policy scenario, that assumed 12% deposition[96] (not emissions) reduction, the survey showed an annual willingness to pay of US $119 per household per year. This translated into a total willingness to pay of around US $0.12 per person per day for the state's population.

A more critical analysis of valuation of mercury emissions reduction benefits was published by the AEI-Brookings Joint Center for Regulatory Studies (Lutter et al, 2001). This calculated that introducing stricter mercury emission limit values may reduce "cases of subtle and mostly imperceptible neurological effects among children at a cost on the order of $150,000 per case avoided", and estimated that other environmental benefits were negligible. It should be noted, though, that their assessment of benefits is limited only to the US and does not take into account the global benefits.

In all of the cases referred to above there will also be question marks over the geographic sensitivity of the valuations. Given all of these uncertainties, it appears unreasonable to attempt to monetise the costs of mercury pollution for the purposes of this ExIA.

**Co-benefits of reducing mercury emissions to air**

Some reduction of mercury emissions to air can be obtained as a co-benefit of existing measures, aimed for instance at reducing pollutants such as particulate matter, $SO_2$ or $NO_x$. Similarly, requiring new, more ambitious levels of mercury emissions will bring co-benefits in reduction of other pollutants. Monetising these benefits can be easier than monetising the benefits of the mercury reductions, as there is more literature on dose-effect impacts. For instance, the US Environmental Protection Agency (EPA, 2004a), while estimating benefits of expected reductions of mercury emissions from coal combustion, explicitly says that "EPA is unable to model the impacts of the mercury and nickel emission reductions that may result from this regulation." However, EPA estimates that reducing mercury emissions by about 1/3 (about 14 tonnes) should also give rise to reductions of $SO_2$ and $NO_x$ emissions bringing a health benefit estimated at more than US $15 billion per year.

[96] Achieving 12% deposition reduction would be achieved by a 50% reduction in regional Midwest emissions

## Annex 6: Assessment of Mercury Supply Choices and Future Demand

## 1. INTRODUCTION

Mercury demand is declining but nevertheless still exists. In the long run it seems probable that supply will eventually exceed demand and there will be surpluses which will need to be "retired", i.e. stored or disposed of. Indeed this situation has already arisen in the USA. But the more immediate question is: where there is still demand, where should the mercury come from?

## 2. SUPPLY CHOICE

Raw mercury can be derived from four main sources as described previously: primary production, secondary production, recycling, and reuse of surpluses such as those from the chlor-alkali industry. The mercury that is generated from these sources is broadly identical, so there is no significant scope to differentiate on the basis of product quality. However, it is possible to draw distinctions between the supply choices themselves, on the basis of environmental impacts. Some distinction could also be made on the cost of production/supply. However, given the recent low price of mercury, and the fact that a price rise would be quite desirable, distinguishing between options on the basis of cost seems to be of little help.

### 2.1. Primary production

Primary production involves the extraction of mercury from geological ores. Hence, primary production increases the total amount of mercury released from relatively stable natural deposits into circulation in society, and potentially from there into the environment. Even if the mercury does not escape directly into the environment, therefore, it will add to the total amount of mercury held in societal reservoirs – already estimated at 40–60 thousand tonnes (Maxson, 2004b). Hence, primary production increases the amounts of mercury that can:

- be released to the environment during use
- be released to the environment at the stage of product disposal (e.g. via landfill or incineration)
- require storage/permanent disposal in the event that such an option is pursued in the future.

In addition, the production process itself releases mercury to the environment. Measurements and estimates at Almadén in the late 1990s suggested that up to 10 tonnes of mercury per year were lost to the atmosphere during roasting operations, at a production of up to 1,500 tonnes of mercury per year (Ferrara et al, 1998). This implies a release of the order of 0.7% of the amount of mercury produced. No more up to date data are available. Although the production of heavy metals is subject to EPER reporting, data on emissions of mercury from production at Almadén were not included in the first Spanish EPER submission. Production of primary mercury will also consume energy and generate certain wastes, but no specific data are available.

## 2.2. Secondary production

Secondary production, like primary production, releases mercury from relatively stable geographic deposits. It therefore has, to a degree, the same disbenefits, i.e. increasing the amount of mercury in circulation, and that may therefore be released to the environment, or may require storage or permanent disposal in the future. However, there is one critical difference. This is that the secondary mercury is produced not as the main objective of the operation, but as a by-product of producing something else, such as natural gas or zinc. And if the secondary mercury were not produced, it would either remain in the primary product – potentially making the product unusable or leading to mercury releases from the product – or it would go to disposal.

Secondary production will have impacts on energy consumption, and emissions. However, such impacts are expected to be negligible or even positive, because as stated above the mercury is a relatively minor product that has to be separated out from the other, main product anyway to meet purity standards. In other words, the emissions and energy consumption are principally associated with producing the primary product rather than the mercury.

To give an example, small quantities of secondary mercury are produced in the Netherlands as a by-product of refining natural gas. The purpose of removing the mercury from the gas is to prevent its emission at the point of combustion. The mercury is removed from the gas after winning and before distribution. Mercury and other impurities are initially removed into a sludge. Because of its high mercury content, the sludge cannot be landfilled in the Netherlands, since this would lead to diffuse distribution of mercury to air and groundwater, plus a need for percolate treatment which would produce another sludge. So instead, the mercury is extracted from the sludge. For the moment the intention is that this recycled mercury replaces primary mercury. However, the Netherlands' authorities also observe that demand may fall to the point where even recycled mercury is no longer required, in respect of which they are also considering the option of storing the mercury.

The recovery of mercury from waste sludge has environmental implications. The benefits are the prevention of diffuse distribution of mercury, since only about 0.4% of the mercury is left in the sludge. The amount of mercury emitted to air as a result of the recovery process is about 0.0015% of the content of the waste. This means that for every tonne of mercury recovered from the sludge, about 15 g of mercury is released to air. In contrast, the figures indicated above for Almadén would lead to a release of 7,000 g per tonne of mercury produced.

There will be some negative impact associated with the energy consumption of the mercury recovery. This has not been quantified, although the Netherlands' authorities point out that a low-energy, vacuum distillation technique is used.

Another example concerns the secondary production of mercury alongside zinc production in Finland. The alternative would be to leave mercury in the tailings, from where at least part of it would escape into the environment.

## 2.3. Recycling

Recycled mercury can be produced from a variety of waste materials, such as fluorescent tubes, dental amalgam, batteries, etc. If the mercury is not recycled, then two disbenefits can occur. Firstly, the amount of mercury going to final waste disposal, for example via landfill or incineration, will increase. Secondly, the presence of mercury in the waste may also inhibit the recycling of other materials.

Lamp recycling, which can be used as an example, involves two main stages. The first stage involves the separation of the different waste fractions. This produces a mercury-containing power, which is distilled in the second stage to produce metallic mercury. Figures from one recycling equipment manufacturer give an approximate energy consumption of 400 kWh for treating 20,000 120 cm fluorescent tubes, producing around 100-250 g of mercury. Emissions from the recycling equipment are said to be around 600 g mercury per tonne of recycled mercury produced, which again compares favourably with the situation at Almadén. Moreover, this emission must be seen against the alternative of not recycling, in which case many of the fluorescent tubes would be disposed of to landfill, where breakage would release a much greater amount of mercury.

## 2.4. Reuse of surpluses

Surpluses are stocks of mercury that already exist in liquid, elemental form. Hence there are no additional emissions, energy consumption or waste production associated with producing this mercury, because in fact no additional production is required. The main disadvantage of this source is that it uses the reservoir of mercury that could most easily be retired, and instead puts it back into circulation. In other words, it is much easier to retire mercury that is already in liquid form and held in large volumes at a small number of locations, than it is to retire mercury contained in numerous products and wastes dispersed throughout society.

## 2.5. Thoughts on a possible hierarchy

It seems evident from the discussion above that one can immediately distinguish between primary production on the one hand and secondary production, recycling and surpluses on the other. Primary production puts new mercury into circulation and also appears to generate high levels of emissions. Of the other three sources, only secondary production puts new mercury into circulation, but this is to avoid the mercury from contaminating another product or going to waste disposal. Hence primary production appears to be firmly at the bottom of a mercury supply hierarchy.

Differentiating between the other three sources is less clear cut. In essence, the choice would appear to depend on a long term view of mercury retirement. If there is no reasonable expectation that any mercury retirement will be pursued, then there seems to be no good reason why surpluses should not be used, apart from the fact that this might inhibit recycling and secondary production, leaving mercury that may escape to the environment following conventional waste disposal. On the other hand, if there is a reasonable expectation that retirement will be pursued, then it would seem unwise to release the main societal stocks of elemental mercury back into society and the environment, from where future recapture might be extremely expensive if not impossible.

## 3. FUTURE DEMAND SCENARIOS

Table 29 below tries to anticipate what demand scenarios could look like in 2010, 2015 and 2020. It shows figures which could be presented in international fora to illustrate how concerted efforts could achieve substantial reductions in global mercury use. These figures are inevitably speculative, but are not the most optimistic that could be presented. They simply reflect what could be achieved with present technology and management – they do not rely on any significant assumptions about the emergence of new technologies. For comparison, a baseline for 2003, and a "no additional action" global demand scenario for 2020 (based on Maxson, 2004, with modifications as described below), are also included.

**Table 29 – Future mercury demand scenarios**

| Mercury Use Category | Baseline Global Demand 2003 | Future Scenarios with Global Demand Reduction Efforts | | | "No additional action" 2020 |
|---|---|---|---|---|---|
| | | 2010 | 2015 | 2020 | |
| **Chlor-alkali industry** | 800 | 300 | 100 | 0 | 280 |
| **Small scale gold mining** | 1,000 | 700 | 500 | 300 | 600 |
| **Batteries** | 1,000 | 630 | 365 | 100 | 100 |
| **Dental amalgam** | 270 | 260 | 255 | 250 | 250 |
| **Measuring and control** | 160 | 120 | 95 | 65 | 100 |
| **Lighting** | 95 | 105 | 115 | 120 | 120 |
| **Electrical control and switching** | 150 | 115 | 85 | 60 | 100 |
| **Vinyl Chloride Monomer** | 50 | 40 | 30 | 25 | 25 |
| **Other** | 150 | 125 | 110 | 90 | 130 |
| **Total** | **3,675** | **2,395** | **1,655** | **1,010** | **1,705** |
| **Reduction from 2003 baseline** | **N/A** | **35%** | **55%** | **73%** | **54%** |

Comments on the derivation of the figures in the table are provided below.

**Chlor-alkali**. It is assumed that mercury cells are phased out globally by 2020, with a 50% cut in use of mercury cells by 2010, 75% by 2015 and 100% by 2020. Note that this is by no means an unrealistic scenario, since in the EU 2020 is the latest date for the phase out, with regulatory decisions in Member States under the IPPC

Directive expected to bring the process forward. The ages of the mercury cells remaining in operation globally mean that they would probably be decommissioned by around 2030 anyway, even without any additional action bringing about earlier phase-out.

It is also assumed that, over the period up to 2020, performance in the chlor-alkali industry in other parts of the world moves towards that of the EU industry. As noted in Annex 3, US performance can improve by a factor of 3 and ROW performance by a factor of ten[97]. For the sake of this scenario, it is assumed that performance improves by 33% and 66% of these potentials by 2010 and 2015 respectively. Note also that even if all of the non-EU mercury cells were to remain in operation in 2020, but achieved the full emission reduction potential already illustrated in the EU, the demand by 2020 would only be about 90 tonnes per year.

**Gold mining**. The original "no additional action" consumption estimate for this sector in 2020 was 400 tonnes (Maxson, 2004). However, this was based on an estimate of current demand of 650 tonnes, whereas the UNDP/GEF/UNIDO Global Mercury Project has suggested the figure is more like 800–1,000 tonnes. Therefore, the no additional action scenario has been raised to 600 tonnes. With increased international attention and concerted efforts – for example increased capacity-building, enforcement of restrictions, and a rise in the price of mercury – demand could be cut demand further. Demand is therefore estimated at 700, 500 and 300 tonnes in 2010, 2015 and 2020 respectively.

**Batteries**. As discussed in Annex 3, technical advances that have virtually eliminated mercury in most batteries in the EU and USA have yet to be taken in many other parts of the world. There is therefore considerable reduction potential in this sector, such that even the "no additional action scenario" assumes demand will have fallen to 100 tonnes by 2020. This figure therefore is also used in the global demand reduction scenario for 2020. It is assumed that the fall would be linear to calculate the corresponding figures for 2010 and 2015.

**Dental amalgam**. The "no additional action scenario" assumes a gentle decline in use in this sector, from about 270 tonnes at present to 250 tonnes in 2020. The global demand reduction scenario therefore also uses this figure. The slight fall in consumption is assumed to be linear.

**Measuring and control**. The "no additional action" scenario projects a gentle decline in mercury use in this sector, from about 160 tonnes at present to 100 tonnes in 2020. A global demand reduction scenario can assume a greater cut in use, for example stimulated by further marketing and use restrictions in the EU and elsewhere. The table therefore shows a 60% cut by 2020, to be achieved linearly.

**Lighting.** The "no additional action scenario" assumes a slight increase in the amount of mercury used in lighting, from 95 tonnes to 120 tonnes in 2020. As there is at present an acknowledged environmental benefit to using mercury in some fluorescent lamps – albeit in limited amounts – no more ambitious figure is used for

[97] As also noted in Annex 3, Euro Chlor has suggested that ROW consumption may be about 400 tonnes less than the figure shown in Table 21 in that annex. If this is correct it makes the scenario for the chlor-alkali industry shown in Table 27 even more readily achievable.

the purposes of the global demand reduction scenario. The rise is assumed to be linear.

**Electrical control and switching**. The “no additional demand scenario” predicts a general decline in use, from 150 tonnes to 100 tonnes in 2020. In the EU, however, with limited exceptions mercury is to be almost entirely substituted in new electrical and electronic equipment from 2006. For the purposes of the global demand reduction scenario, it is assumed that a similar, albeit slower, substitution could take place at global level, reducing consumption by 60% by 2020.

**Vinyl chloride monomer.** The present consumption figure of 50 tonnes is rather uncertain (Maxson, 2005), but factors in a high degree of emissions. It is assumed for the purposes of the table that a reduction of 50% could be achieved linearly by 2020. The figures are quite small anyway, and so make little difference to the totals.

**Other**. The “other” category is hard to predict, but fortunately the figures again are not so large that they make a significant difference to the overall picture. The original “no additional action” scenario by Maxson (2004) predicted a modest decline, from 175 to 150 tonnes, a 15% reduction. However, the baseline figure has now been revised downwards to 150 tonnes (Maxson, 2005). A 15% reduction from this figure is therefore used to calculate the no additional action figure for 2020 of about 130 tonnes. The global demand reduction scenarios assume a higher, 30% cut, achieved linearly by 2020.

Overall, therefore, a positive yet realistic outlook on global mercury reductions gives mercury demands of around 2,400 tonnes in 2010, 1,650 tonnes in 2015 and 1,000 tonnes in 2020. These figures are especially dependent on reductions in use in the chlor-alkali and battery sectors. But here there is no doubt about the availability of technology, and it is really a matter of when rather than whether these reductions will occur.

## 4. MEETING FUTURE DEMAND FROM THE AVAILABLE SUPPLY CHOICES

Figures for the overall global mercury supply up to 2003 are presented in Annex 3, showing a recent annual average of around 3,600-3,700 tonnes per year, which also matches the estimate of global demand in 2003 shown in the table above. Of this total supply, Maxson (2005) has suggested that about 1,000-1,200 tonnes comes from secondary production, and about another 600-800 tonnes from recycling (with supply from both sources continuing to increase). The decommissioning of mercury cells in the EU by 2020 at the latest could provide, on average, a supply of 725 tonnes per year. Decommissioning of mercury cells elsewhere would provide further supply. If all of the world’s mercury cells were phased out by 2020, then the estimated holdings of about 25,000 tonnes would provide a supply of over 1,500 tonnes per year, on average.

Therefore this analysis suggests that, under a positive yet realistic demand scenario – and certainly not the most ambitious that could be pursued – adequate supply could be met by the following:

- **in 2010** (2,400 tonnes), by a combination of secondary production (conservatively assumed to remain at around 1,000 tonnes), recycling (estimated to have risen to around 900 tonnes (Maxson, 2004b)), and some but not all of the surplus mercury from the chlor-alkali industry. If one only considers the EU chlor-alkali surplus mercury, about 500 tonnes could make up the supply/demand balance, and about 225 tonnes would be unneeded. But if the global chlor-alkali surplus is considered, then the unneeded amount would be around 1,000 tonnes per year.

- **in 2015** (1,650 tonnes), by a combination of secondary production (1,000 tonnes) and recycling (900 tonnes). By this time none of the surplus mercury from the chlor-alkali industry would be needed, and even the amount of mercury generated via recycling and secondary production would exceed the anticipated demand.

- **in 2020** (1,000 tonnes), again by a combination of mercury from secondary production and recycling, but with the clear expectation that the supply would exceed demand and some surpluses would be generated even from these sources.

- Finally, note that even the “no additional action scenario” would see secondary production and recycling alone meeting demand needs in 2020.

## Annex 7: Summary of Consultation Responses

**1. Do you have any information to supplement the overall assessment of the use, control, emissions and impacts of mercury and its compounds presented in the consultation document?**

A significant amount of factual data was provided. This was especially the case for the subjects of dental amalgam, and emissions from coal combustion. Other subjects included use of mercury in gold mining, the impacts of mercury use in the chlor-alkali industry, a detailed Swedish study on deep bedrock disposal of mercury, uses and restrictions concerning mercury in certain products, and mercury pollution in the Arctic region and the Baltic Sea.

**2. Would you advocate other issues as priorities for further consideration in the mercury strategy, beyond or instead of those identified in the consultation document? If so, please provide quantitative data.**

Many other issues were proposed as priorities. However, most of the suggestions were put forward by one stakeholder each – i.e. there was very little consensus about the main issues beyond those already identified – and very few quantitative data or analyses were provided to back-up the suggestion that such issues should really be treated as priorities. Three subjects were addressed by relatively large numbers of respondents. These were:

- The suggestion that the strategy should place more emphasis on seeking global reductions of mercury use, alongside actions to be taken in the EU. Accordingly, this ExIA has made an assessment of the scope to achieve global use reductions (see Annex 6), and the strategy itself identifies the need to support and promote international actions.

- The health and environmental impacts, and the possibility of substitution, of mercury-based dental amalgam. The consultation document had identified the level of use of mercury in dental amalgam. It had not examined the possibility of marketing and use restrictions, or other policy options in this area, as it seemed that the necessary consensus about the acceptability of substitutes was lacking. However, as this sector will soon be the major user of mercury in the EU, and given the contribution of dental amalgamation to human mercury exposure, it seems appropriate to re-examine this matter. The Commission will therefore raise this issue for consideration in the Medical Devices Expert Group, and will also seek an opinion from the Scientific Committee on Health and Environmental Risks.

- The need to address the large amount of mercury held in products already circulating in society, for example through more active collection and recycling. Few specific details or quantitative were provided, however. Nevertheless, the Commission recognises this as an important subject and therefore proposes to launch a study to quantify the issue and to explore the policy options.

**3. Should the EU take any action on raw mercury supply and trade issues? Should such action only be taken through international measures, and what would be the advantages and disadvantages of EU action even if there is no concerted global effort?**

A significant majority of stakeholders who expressed a view on this issue stated a preference for EU action even if there is no global effort. Five Member States (Austria, Denmark, Finland, Netherlands and Sweden) and Norway, plus responses from two public authorities, three NGOs and the GEF/UNDP/UNIDO Global Mercury Project advocated stopping production of mercury in, or export from, the EU, or both. The UK noted that it is not logical for the EU to continue to supply mercury and advocated consideration of how to manage demand downwards, while France advocated replacement of primary production by recycling and use of surpluses from the chlor-alkali industry. One Member State (Germany) suggested that the EU should not take action on supply and trade in the absence of an international effort, as did a number of responses from the chlor-alkali industry.

**4. Would it be desirable to include mercury under the Prior Informed Consent procedure of the Rotterdam Convention?**

This option received considerable support, with favourable responses from seven Member States and Norway plus many other responses from a broad range of stakeholders (business, NGOs, etc.). Finland was among the Member States that explicitly supported the option, but also noted that new and more explicit mercury bans might be needed at Community level to allow mercury to be covered by the PIC procedure. Only one stakeholder (the Austrian Federal Economic Chamber) explicitly opposed this option.

**5. Should the EU take additional action to limit the marketing of measuring and control equipment, such as thermometers? What would be the advantages and disadvantages of such action, and the appropriate scope in terms of the type of equipment covered?**

There was strong support for EU action. All eight Member States who responded to the consultation favoured EU action, as did Norway, the HELCOM Commission, three NGO responses and the UK water industry association (which noted the negative impacts of mercury use in products on the water industry and sewage sludge), among others. Several Member States which supported action also identified the need for exceptions, in some cases illustrated by the provisions of their national legislation. Some opposition to EU action was expressed by equipment manufacturers. Generally such comments suggested that mercury use needed to continue for certain equipment (e.g. high precision equipment) rather than for all measuring and control equipment.

**6. Over the long term, would it be appropriate for the EU to aim at the complete phase out of the intentional use of mercury in products, allowing exceptions for uses considered essential (e.g. pharmaceuticals)? If so, what type of policy tools should be used (e.g. regulation, voluntary agreements, information, etc.)?**

There was strong support for a complete phase-out with exceptions for essential uses. All eight Member States who responded to the consultation generally favoured this approach, as did Norway, three NGO responses and three trade associations, among others.

The majority of respondents who favoured a complete phase-out advocated use of legislative means, i.e. marketing and use restrictions. Some respondents suggested other approaches. For example, the UK advocated exploring voluntary agreements to achieve short, medium and long term targets for reducing to the minimum demand for mercury, but also noted that some underlying legislative force would also be required.

Few respondents stated opposition to a phase-out. Two trade associations (the Austrian Federal Economic Chamber and the US National Electrical Manufacturers Association) were opposed to such an approach in principle, while the French Syndicat des Halogènes & Dérivés proposed that the phase-out of mercury should concentrate on those products that posed the greatest risks.

While support for a phase-out was generally high, however, little practical detail was put forward. One Member State (Germany) and one NGO response (Greenpeace / Natural Resources Defense Council / Mercury Policy Project) suggested a general EU measure prohibiting mercury use, with specific exceptions to be identified. This would differ from the usual EU approach to marketing and use restrictions, which has involved identifying those products to which restrictions apply. Denmark and the Netherlands put forward information detailing how they have already introduced such general prohibitions, entailing exemptions for various products.

Limited data are presently available on the remaining EU uses of mercury in products, beyond the main product groups discussed in this ExIA. The Commission therefore plans to undertake further study of this issue.

**7. What would be the advantages and disadvantages of further potential EU measures to reduce mercury emissions from coal combustion in power plants? Please provide quantified data on emissions and costs, and indicate any proposed difference in approach (e.g. what type of measures) between large and small plants.**

Most respondents to this question sought to provide factual data on the possibilities and costs of emissions control, and/or expressed positions on the possibility of further EU measures. A number of stakeholders associated with the coal and power industries (including Euracoal, the World Coal Institute, the UK Association of Electricity Producers and Eurelectric) submitted detailed information relating to the expected impacts of existing policies and the scope for further action, some explicitly concluding that further EU action was not justified at this stage. The Netherlands also opposed further EU action, preferring to continue with the application of IPPC. France and the UK neither supported nor opposed further EU action at this stage but called for more assessment of the impact of current legislation.

One Member State (Germany), one NGO response (Greenpeace / Natural Resources Defense Council / Mercury Policy Project) and one other response (HELCOM Commission) explicitly called for additional EU action at this stage

The majority of respondents to this question indicated a preference for adoption of specific EU-level emission controls over an incentive-based system.

**8. Are there any measures that should be taken to address the problem of mercury emissions from residential coal burning? What would be the appropriate level for such measures: EU, national or local?**

There were a reasonable number of responses to this question but none of significant detail. Four Member States (France, Germany, Netherlands, UK) thought that this was not an appropriate area for EU action. Three responses (Greenpeace / Natural Resources Defense Council / Mercury Policy Project, the Flemish Ministry Government, and the HELCOM Commission) favoured EU action but no specific suggestions on what this might entail were put forward.

**9. What would be the added value of any EU action on emissions of mercury from crematoria, on top of that already in place at national level and as recommended by OSPAR?**

This question was intended to seek data that would enable the Commission to judge whether EU action would have sufficient added value to be worthwhile. In the event, however, few such data were provided, and the majority of stakeholders who responded to this issue mainly indicated whether or not they favoured EU action. The outcome was fairly evenly balanced. Three Member States (France, Netherlands, Sweden) supported EU action and three (Finland, Germany, UK) opposed it. More of the other stakeholders who addressed this question favoured EU action than opposed it, although some (e.g. the Flemish Ministry Government) recognised the relatively small contribution of this sector to mercury emissions. The most detailed response to this question, by the UK National Association of Funeral Directors, noted the lack of real emissions data for the sector and called for this issue to be addressed further ahead of deciding on any legislative action.

**10. Should the EU continue to support recycling of mercury-containing waste, or should such recycling be discouraged or limited?**

There was about a two-to-one ratio of responses that favoured mercury recycling versus those that opposed it. Most responses were from Member States and NGOs. Seven Member States (Austria, Denmark, France, Finland, Germany Netherlands, UK) supported recycling, although Austria stated that recycling should at least be limited, while Sweden and Norway opposed recycling and favoured permanent disposal of mercury-containing wastes. Among NGOs, two (Arnika and Greenpeace / Natural Resources Defense Council / Mercury Policy Project) favoured recycling and one opposed it (Health Care Without Harm). The response from OVAM suggested that recycling should be promoted as long as there is a justified demand for mercury, in order to avoid production of freshly mined mercury, but banned if mercury trade stops or supply exceeds the justified demand.

## 11. What would be the best option for handling decommissioned mercury from the chlor-alkali industry?

The consultation document had identified three main actions: no additional EU action, temporary storage and permanent disposal. Some responses referred to “permanent storage” and it was not always clear whether this meant temporary storage or permanent disposal as discussed in the consultation document, or something else.

Respondents from the chlor-alkali industry, and two Member States (France and UK) favoured the no additional action option. However, France indicated that beyond meeting “essential uses” the surplus mercury should be stored. Similarly, the UK advocated development of measures to ensure the mercury is used only for “legitimate purposes”. The responses from the chlor-alkali industry noted their preference for storage over permanent disposal, in the event that the mercury cannot be returned to the market. Euro Chlor advised that the industry has plans for long term storage and stated its opinion that underground storage of liquid mercury in steel containers would be the best option.

Two Member States (Austria and Finland) and one NGO response (Greenpeace / Natural Resources Defense Council / Mercury Policy Project) favoured storage. Two Member States (Denmark and Sweden) plus Norway and some other responses from companies and individuals favoured permanent disposal. Sweden submitted a detailed study on this issue. Germany advised that is also evaluating a concept for temporary storage. The Netherlands thought that the fate of the surplus mercury could only sensibly be addressed as part of a broader vision on mercury supply and demand.

The GEF/UNDP/UNIDO Global Mercury Project advocated that the surplus mercury should not be exported from the EU, since it could find its way to relatively uncontrolled use in artisanal gold mining. This would therefore require storage or disposal of the mercury, although the GEF/UNDP/UNIDO Global Mercury Project did not state a preference between these two options.

## 12. Would it be desirable to promote other international agreements relating to mercury?

The idea that the EU should promote or support other international agreements was strongly supported. Eight of the responding Member States (all except the UK) took this view, as did Norway and many other respondents (businesses, trade associations, NGOs and individuals). However, while various general suggestions were made about the possible subject matter of such international agreements – including mercury production, trade, use and emissions – there was little detail about how an international measure might work and no consensus on the appropriate focal point. The UK indicated that it was not convinced of the benefits of negotiating an internationally legally binding instrument on mercury, and thought that there are actions that could be taken building on existing international frameworks and infrastructure.

**13. What other action should the EU take to support or promote mercury control and emission reduction measures in other parts of the world (for example in respect of coal burning, artisanal gold mining, etc.)?**

Most of the respondents who addressed this question focused on the issue of gold mining. A variety of suggestions were put forward, mostly centring around the possibility of funding or otherwise supporting projects in developing countries to promote careful use of mercury in gold mining, encourage use of substitute techniques, etc.

More broadly there was considerable support for active EU involvement in the work of UNEP on capacity-building concerning the subject of mercury, and for engagement in bilateral activities with countries where mercury use or emissions remain high. Again, most of the focus here was on developing countries although Denmark and Norway advocated attention to Eastern Europe, Russia and the Arctic.

# Annex 8: Mercury Research

## 1. SELECTED STUDIES RELATING TO MERCURY FINANCED BY THE COMMUNITY

Note: most of the following project details are extracted from the CORDIS database (www.cordis.lu). The database includes a great many projects that relate to heavy metals or toxic pollutants in general, rather than just to mercury. Only a selection of such projects are included here.

**Project Title:** Treatment of sludges from demercurisation of waste waters of chloralkali units
**Lead Organisation:** Montedipe SpA
**Objectives:** To improve existing treatment processes for waste waters in order to reach 99% mercury recovery.
**Date:** 1982-1983
**Programme:** Pre-1984 programmes

**Project Title:** Evaluation of acceptable levels of human exposure to certain metals (Hg, As, V)
**Lead Organisation:** Université Catholique de Louvain
**Objectives:** Elucidation of dose-response relationship for mercury and pollutant metabolism in man for arsenic and vanadium.
**Date:** 1982-1984
**Programme:** Pre-1984 programmes

**Project Title:** Cardiovascular effects in rats and rabbits exposed to heavy metals
**Lead Organisation:** Università Cattolica del Sacro Cuore
**Objectives:** To establish whether and how the cardiovascular effects of certain heavy metals are linked to perturbations of essential trace metal metabolism.
**Date:** 1982-1984
**Programme:** Pre-1984 programmes

**Project Title:** Mercury Uptake by Mytilus Edulis
**Lead Organisation:** Centre d'Etudes et de Recherches de Biologie et Océanographie Médicale
**Objectives:** Assessment of the ecological effects of mercury pollution on mussels
**Date:** 1982-1984
**Programme:** Pre-1984 programmes

**Project Title:** Ecotoxicological processes of bioaccumulation and transfers in freshwater environment: interactions between derivates of mercury and membranes
**Lead Organisation:** Université de Bordeaux I
**Objectives:** Study of the molecular mechanisms of membrane passage of derivatives of mercury.
**Date:** 1982-1986
**Programme:** Pre-1984 programmes

**Project Title:** Ecotoxicological models in freshwater environment: bioaccumulation studies
**Lead Organisation:** Université de Bordeaux I
**Objectives:** To study the dynamics of bioaccumulation and transfers of mercury in the food chain of aquatic organisms.
**Date:** 1982-1986
**Programme:** Pre-1984 programmes

**Project Title:** Recovery of zinc, manganese dioxide and mercury from zinc carbon and alkaline manganese primary battery scrap
**Lead Organisation:** Varta Batterie AG
**Objectives:** Development and demonstration of the technical and economic feasibility of a reclaiming process for primary battery scrap.
**Date:** 1983-1986
**Programme:** Pre-1984 programmes

**Project Title:** The origin of natural methylmercury
**Lead Organisation:** Johannes Gutenberg Universitaet Mainz
**Objectives:** Assessment of the biotic and abiotic methylmercury formation in the freshwater and marine environment.
**Date:** 1985-1986
**Programme:** Pre-1984 programmes

**Project Title:** Origin and Fate of Methylmercury
**Lead Organisations:** Università degli Studi di Genova, Forschungszentrum Jülich GmbH, Université de Bordeaux I, Università degli Studi di Siena
**Objectives:** Related projects to investigate to what extent biotic and abiotic processes are responsible for the formation of methylmercury observed in freshwater and marine organisms.
**Date:** 1988-1992
**Programme:** First Framework Programme

**Project Title:** Mercury detection device for continuous monitoring of emissions
**Lead Organisation:** Verewa Meß- und Regeltechnik GmbH
**Objectives:** To develop, manufacture, and test a sampling and measuring device for the continuous determination of mercury and its compounds in the flue gas of incineration plants.
**Date:** 1990-1991
**Programme:** Environment

**Project Title:** Identification of the biotic and abiotic matrices in ecosystems in which the transformation of inorganic mercury to methylmercury and of methylmercury to other mercury species occurs
**Lead Organisation:** Ente per le Nuove Tecnologie l'Energia e l'Ambiente (ENEA)
**Objectives:** To identify the biotic and abiotic matrices in terrestrial, freshwater and marine ecosystems in which the transformation of inorganic mercury to methylmercury and of methylmercury to other mercury species occur; to quantify these chemical, physical, and biological transformation processes; to determine the pathways of methylmercury in various ecosystems; and to elaborate environmental quality criteria for methylmercury.

**Date:** 1990-1993
**Programme:** Second Framework Programme

**Project Title:** The Determination of Methylmercury Species in the Environment and in Food
**Lead Organisation:** DK Teknik
**Objectives:** To develop a methodology for accurate determination of MeHg in food.
**Date:** not recorded in CORDIS
**Programme:** Second Framework Programme

**Project Title:** Database for toxic materials in human tissues and fluids
**Lead Organisation:** National Institute of Occupational Health
**Objectives:** To establish a database for "reference values" (normal levels) of heavy metals (i.e. toxic metals such as mercury, cadmium, chromium and lead) in human tissues and fluids by evaluation of publications in the international scientific literature.
**Date:** 1991-1996
**Programme:** International Cooperation

**Project Title:** Detection of early neurotoxicity in children with environmental methylmercury exposure
**Lead Organisation:** Odense Universitet
**Objectives:** Identification of population groups at risk of neurotoxic effects due to methylmercury exposures; development and validation of evoked potentials from the brain as an early and potentially reversible indicator of neurotoxicity in children exposed to environmental pollutants; evaluation of the possible relationship between prenatal exposure to methylmercury and early neurbehavioural dysfunctions as indicated by evoked potentials and other parameters.
**Date:** 1993-1995
**Programme:** Third Framework Programme

**Project Title:** Demonstration of high temperature oxidation technology for the recovery of mercury from hazardous wastes
**Lead Organisation:** AVR-Chemie C.V.
**Objectives:** To demonstrate the suitability of the High Temperature Oxidation process to remove metallic reusable mercury from hazardous wastes.
**Date:** 1994-1995
**Programme:** LIFE Environment

**Project Title:** Methylmercury in Sediments - a proposed reference material
**Lead Organisation:** Studio di Ingegneria Ambientale
**Objectives:** To evaluate the state-of-the-art of methylmercury determination in sediment through an interlaboratory study involving 15 expert EU laboratories and to subsequently certify a sediment reference material for its total Hg and MeHg contents
**Date:** 1994-1996
**Programme:** Third Framework Programme

**Project Title:** Microbial diversity and function in metal contaminated soils
**Lead Organisation:** Wye College
**Objectives:** To determine the effects of metal contamination as a result of long term sewage sludge application on the diversity and selected functions of the entire soil microbial community as well as the diversity of specific microbial groups and to relate the observed effects to concentrations of the bioavailable fraction of heavy metals in the soils.
**Date:** 1994-1997
**Programme:** Third Framework Programme

**Project Title:** Mercury in seawater: preparation of a certified reference material
**Lead Organisation:** Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek
**Objectives:** To carry out an interlaboratory study to check the feasibility of coastal seawater material preparation and evaluate the analytical state of the art, and to organise a certification campaign of a (natural) coastal seawater CRM to be certified for its total mercury content.
**Date:** 1995-1996
**Programme:** Third Framework Programme

**Project Title:** Exploitation of voluminous mercury-containing rectifiers without any environmental pollution
**Lead Organisation:** Gesellschaft für Metallrecycling mbH
**Objectives:** To allow the complete recycling of voluminous mercury-containing rectifiers without any environmental damage.
**Date:** 1995-2000
**Programme:** LIFE Environment

**Project Title:** Mercury Removal from Waste Sources
**Lead Organisation:** EA Technology Ltd.
**Objectives:** To develop a treatment unit to recover mercury from: (a) brine sludges from the chloralkali industry; (b) residues from fluorescent light fittings.
**Date:** 1996-1999
**Programme:** Fourth Framework Programme

**Project Title:** A mechanistic in-vitro approach to risk assessment and biomonitoring of neurotoxic metals
**Lead Organisation:** Fondazione Salvatore Maugeri – Clinica del Lavoro e della Riabilitazione
**Objectives:** To determine the role of in vitro systems as an alternative experimental approach to characterise the mode of action and molecular effects of neurotoxic metals of major environmental importance.
**Date:** 1996-1999
**Programme:** Fourth Framework Programme

**Project Title:** Development of Options for Damage Limitation and Environmental Restoration of the Mercury-Contaminated Areas in North-Central Kazakhstan
**Lead Organisation:** University of Southampton
**Objectives:** Following accidental release of mercury from the acetaldehyde plant AO Karbide in the Karaganda region of north-central Kazakhstan: (i) to study the

distribution of mercury and the mechanisms by which it is transported; (ii) to develop a model capable of predicting the spread of pollution and simulating the effect of different interventions; (iii) to identify a set of economically feasible technical options and management strategies for damage limitation and for remediation of the polluted area.
**Date:** 1997-1999
**Programme:** Fourth Framework Programme

**Project Title:** Study of the mercury of the river Nura with a view to the development of an effective management strategy for the polluted technogenic sediments
**Lead Organisation:** University of Southampton
**Objectives:** To study the chemical fate of mercury in the river Nura in the Karaganda region of Kazakhstan with the objective of identifying conditions of water flow and water quality that will reduce the transport of mercury downstream and its spread into the wider environment; to study the distribution, transport and behaviour of the mercury-laden silts, with the aim of defining economic containment techniques; to identify economically viable engineering, chemical, biological and river management strategies which will minimise risks to the people of the area and to the environment.
**Date:** not recorded in CORDIS
**Programme:** International Cooperation

**Project Title:** Pavlodar environmental project
**Lead Organisation:** Crowe Schaffalitzky and Associates Ltd.
**Objectives:** To define the distribution and degree of the mercury contamination in the Pavlodar region in northeast Kazakhstan; to carry out a detailed survey and a sampling programme in the critical areas; to prepare cost measures to remediate soil and groundwater in the heavily contaminated areas; to develop protocols and guidelines for monitoring and assessment of mercury contaminated areas in Kazakhstan.
**Date:** not recorded in CORDIS
**Programme:** International Cooperation

**Project Title:** Microbial Removal of Mercury Compounds from Industrial Waste Streams
**Lead Organisation:** Gesellschaft für Biotechnologische Forschung mbH (GBF)
**Objectives:** To demonstrate in pilot scale an efficient, cost-effective, environmentally friendly and sustainable microbiological process for removing mercury compounds from waste water; to develop marketable plants which are capable of treating mercury containing waste water (from chlorine-alkali-electolysis processes, waste deposits, catalyst production etc.)
**Date:** 1997-1999
**Programme:** LIFE Environment

**Project Title:** Neurotoxic effects of methylmercury in the neocortex of the rat: cellular electrophysiological and mutagenicity studies
**Lead Organisation:** Vrije Universiteit Brussel
**Objectives:** To compare the cytotoxic and genotoxic effects of methylmercury compounds in neocortical neurons of newborn rats of mothers, who were treated chronically by MMC before and during pregnancy together with changes of their multimodal electrophysiological parameters.

**Date:** 1997-2000
**Programme:** Fourth Framework Programme

**Project Title:** Mediterranean atmospheric mercury cycle system
**Lead Organisation:** National Research Council of Italy
**Objectives:** To develop the Mediterranean Atmospheric Mercury Cycle System (MAMCS) as a merger of state-of-the-art meteorological and dispersion models, chemical-physical transformation models, and dry and wet deposition models.
**Date:** 1998-2000
**Programme:** Fourth Framework Programme

**Project Title:** Novel bioremediation technology for removal of mercury from aqueous waste streams using genetically engineered microorganisms – "GEMs"
**Lead Organisation:** Gesellschaft für Biotechnologische Forschung mbH
**Objectives:** To demonstrate the mercury removal process for real world waste streams.
**Date:** 1998-2001
**Programme:** Fourth Framework Programme

**Project Title:** Mercury species over Europe. Relative Importance of depositional methylmercury fluxes to various ecosystems.
**Lead Organisation:** Swedish Environmental Research Institute Ltd.
**Objectives:** To identify and quantify sources of atmospheric mercury species focusing on production and fluxes of methylmercury. The primary objective is to find the relative importance of the atmospheric deposition of MeHg, in comparison to methylation/demethylation processes in terrestrial and limnic ecosystems, in various parts of Europe.
**Date:** 1998-2001
**Programme:** Fourth Framework Programme

**Project Title:** Long term exposure to heavy metals and risk of myocardial infarction in Europe
**Lead Organisation:** Instituto de Salud "Carlos III"
**Objectives:** To quantify levels of mercury, zinc, iron and other heavy metals in toenail clippings from 700 cases of acute myocardial infarction and 700 population controls recruited in 8 European countries and Israel in the EURAMIC study. To evaluate the association and shape of the dose-response relationship between the levels of these heavy metals and the risk of first nonfatal myocardial infarction in men.
**Date:** 1998-2002
**Programme:** Fourth Framework Programme

**Project Title:** Preparation of a certified oyster tissue reference material for species of tin, mercury and selenium
**Lead Organisation:** ENEA – Ente per le Nuove Tecnologie, l'Energia e l'Ambiente
**Objectives:** To prepare an oyster reference material certified for species of tin, for methylmercury, for selenomethionine and selenocystine.
**Date:** 1998-2002
**Programme:** Fourth Framework Programme

**Project Title:** European Mercury Emission from Chlor-Alkali Plants
**Lead Organisation:** Scuola Superiore di Studi Universitari e di Perfezionamento S. Anna di Pisa
**Objectives:** To develop all the required tools to improve the understanding of the mercury pollution problem; analysers, dosimeters, a dispersion model and a software tonnage bio-environmental data.
**Date:** 2000-2003
**Programme:** Fifth Framework Programme

**Project Title:** Development of improved detection systems for monitoring of toxic heavy metals in contaminated ground waters and soils
**Lead Organisation:** Autonomous University of Barcelona
**Objectives:** To develop sensitive and robust sensing devices, including chemical sensors and biosensors, and biomimetic systems that are capable of on-line operation and real time measurements of THM, their effects and the corresponding risk assessment for various matrices of contained soils, groundwater bodies and surface waters.
**Date:** 2000-2003
**Programme:** Fifth Framework Programme

**Project Title:** Development of cost-effective methods for minimising risk from heavy metal pollution in industrial cities: a case study of mercury pollution in Pavlodar
**Lead Organisation:** University of Southampton
**Objectives:** To investigate environmental management options for remediation/mitigation of pollution by soluble heavy metals in industrial cities; in the first instance, to develop and test the methodology at Pavlodar; to make practical, economically feasible recommendations for resolving the Pavlodar crisis and produce a manual for investigating similar industrial sources of pollution in arid continental climates.
**Date:** 2000-2003
**Programme:** Fifth Framework Programme

**Project Title:** Study of sorption of the mobile forms of mercury by fly ash from thermal power plants with the aim of immobilising them in silts and soils
**Lead Organisation:** Ecole des Mines de Nantes
**Objectives:** To determine kinetic characteristics of the sorption/desorption reactions, including those at high sorbate concentrations, of different mercury species with power station fly ash and its sub-components; to add to the understanding of which components of power station fly ash are responsible for mercury immobilisation and the mechanisms through which this takes place; to identify, characterise and quantify the different forms of mercury that result from its interaction with power station fly ash and its sub-components; to assess the availability of mercury sorbed on power station fly ash to biological methylation; to provide fundamental kinetic data for future use in the estimation of the suitability of power station fly ash for the stabilisation and remediation of mercury contaminated sites.
**Date:** 2001-2003
**Programme:** International Cooperation

**Project Title:** Assessment of Neurobehavioural Endpoints and Markers of Neurotoxicant Exposures
**Lead Organisation:** University of Southern Denmark – University of Odense
**Objectives:** To examine risks associated with complex food contaminants, especially in regard to long term cognitive effects caused by developmental exposures, in a well characterised birth cohort where extremely high exposures to organohalogen compounds and methylmercury are known to occur.
**Date:** 2001-2004
**Programme:** Fifth Framework Programme

**Project Title:** Development of viable technologies and monitoring systems for the remediation/detection of mercury in South American waters. Design of chelators with therapeutical properties.
**Lead Organisation:** University of Surrey
**Objectives:** Designing selective, recyclable and low cost receptors for "on site" monitoring of mercury in water; developing a viable technology for mercury removal to be tested against phytoremediation agents based on natural resources of the region; exploring their potential for therapeutic use.
**Date:** 2002-2005
**Programme:** Fifth Framework Programme

**Project Title:** An integrated approach to assess the mercury cyclying in the Mediterranean basin
**Lead Organisation:** National Research Council of Italy
**Objectives:** To develop an integrated modelling system aimed to assess the relative contributions of different processes involved in the cycling of mercury in the Mediterranean Basin.
**Date:** 2002-2005
**Programme:** Fifth Framework Programme

**Project Title:** Small scale mobile devices for water pollution and air detection in situ based on novel high intensity electrodeless discharge lamps and a new high selective atomic absorption technique
**Lead Organisation:** Association pour le Développement de la Physique Atomique
**Objectives:** To prove the feasibility of a mobile water and air pollution detection and monitoring device based on spectroscopic techniques using novel intense high frequency electrodeless discharge lamps (HFELs) as light sources, focusing on the detection of heavy metals (and more especially mercury) with high precision.
**Date:** 2002-2005
**Programme:** International Cooperation

**Project Title:** Fisheries and pollution in the Marine environment: interrelationships and impact on seabirds
**Lead Organisation:** University of Glasgow
**Objectives:** Analysis of pollution by mercury from diverse fish species, throughout the major wintering areas of European seabirds, to identify areas and types of fish particularly risky for this toxic metal. Analysis of mercury from seabird feathers, collected at their breeding grounds, to indicate their potential prey and wintering grounds, and to contrast with data from isotopic analysis and satellite tracking. To check the possibility of using seabirds as indicators of mercury pollution away from

their breeding areas, the association of seabirds with commercial fisheries. To assess the role of this human activity in modifying diet and thus mercury levels of seabirds.
**Date:** 2003-2005
**Programme:** Fifth Framework Programme

**Project Title:** Toxic threats to the developing nervous system: in vivo and in vitro studies on the effects of mixture of neurotoxic substances potentially contaminating food
**Lead Organisation:** Karolinska Institutet
**Objectives:** To develop experimental models to improve predictive toxicity testing and mechanism-based risk assessment for neurotoxic food contaminants
**Date:** 2003-2006
**Programme:** Sixth Framework Programme

**Project Title:** Novel remediation technology for vaccine production effluents containing organomercurials
**Lead Organisation:** GBF – National Centre for Biotechnology
**Objectives:** To develop and test a micro pilot plant which allows continuous operation, contained use of genetically engineered bacteria and recovery of the metallic mercury from process waste water resulting from the production of vaccines
**Date:** 2004-2008
**Programme:** Fifth Framework Programme

**Project Title:** Estimation of willingness-to-pay to reduce risks of exposure to heavy metals and cost-benefit analysis for reducing heavy metals occurrence in Europe (ESPREME)
**Lead Organisation:** University of Stuttgart
**Objectives:** To update and consolidate data on heavy metal emissions, including mercury; to collect and assess information on how to reduce emissions; to improve models on heavy metal circulation and deposition in the environment; to estimate willingness-to-pay, including by means of Integrated Assessment Modelling; to estimate costs and benefits from applying different sets of measures aimed at emission reduction, against a business as usual scenario for 2010.
**Date:** 2004-2007
**Programme:** Sixth Framework Programme

## 2. POSSIBLE AREAS FOR FURTHER RESEARCH, DEVELOPMENT AND DEMONSTRATION PROJECTS CONCERNING MERCURY

### Human health

Toxic effects of different levels and chemical species or forms of mercury

Mixture effects

Long-term effects of low-dose exposures at critical life stages

### Movement and retention of mercury in the environment

Retention of deposited mercury in ecosystems in the short and long terms

Predicting rates of volatilisation of deposited mercury

Differences in levels of deposition and re-emission for dry versus wet deposited mercury and different ecosystem types

Watershed budgeting methods for mercury including significant but poorly understood influences such as forest fires

Development of better measurement techniques for determination of chemical species or forms of mercury and transport modelling

**Ecosystem sensitivity and toxicity**

Predicting and understanding variability among lakes/rivers in biotic mercury concentrations

Understanding the effects of watershed manipulation on fish mercury levels

Response time for environmental concentrations after changes in mercury deposition

Key receptors and mercury concentrations of key importance to be monitored

Tolerable mercury levels for sustainable ecosystem management

Appropriate mercury threshold values to protect soil microbiota under different ecological conditions

**Mercury products, emissions and waste**

Development of mercury-free alternatives to remaining uses of mercury

Development of techniques to reduce mercury releases from major sources

Quantities, fate and impacts of mercury-containing by-products of coal combustion and producing metals such as copper, zinc, lead, nickel

Methods for treatment/stabilisation and permanent disposal of raw mercury and mercury-containing waste